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

## Volume 2

## January 2019

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# 3.8 Marine Invertebrates

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## 3.8 Marine Invertebrates

### 3.8.1 Affected Environment

The purpose of this section is to supplement the analysis of impacts on Marine Invertebrates presented in the 2015 Mariana Islands Training and Testing (MITT) Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) with new information relevant to proposed changes in training and testing activities conducted at sea and on Farallon De Medinilla (FDM). New information made available since the publication of the 2015 MITT Final EIS/OEIS is included below to better understand potential stressors and impacts on Marine Invertebrates resulting from training and testing activities. Comments received from the public during scoping related to Marine Invertebrates are addressed in Section 3.8.3 (Public Scoping Comments).

Relative to new information, Smith and Marx (2016) presented results from dive surveys in waters surrounding the live-fire range off FDM that provide qualitative observations of water and sediment quality and noted the condition of the biological resources (see Section 3.1, Sediments and Water Quality). A moderate bleaching event was noted in 2007, and a barnacle infestation was noted in 2012 (Smith et al., 2013). The bleaching event was regional and extended from southern Japan through the Mariana Islands and south through waters surrounding Palau. Subsequent surveys observed soft and fire corals had recovered completely; 75 percent of the stony corals had recovered by 2008 and the coral fauna at FDM were observed to be healthy and robust (Smith & Marx, 2009, 2016). The nearshore physical environment and basic habitat types at FDM have remained unchanged over the 13 years of survey activity. These conclusions are based on (1) a limited amount of physical damage, (2) very low levels of partial mortality and disease (less than 1 percent of all species observed), (3) absence of excessive mucus production, (4) good coral recruitment, (5) complete recovery by 2012 of the 2007 bleaching event, and (6) a limited number of macrobioeroders and an absence of invasive crown of thorns starfish (*Acanthaster planci*). A recent coral reef survey by Carilli et al. (2018) at FDM verified ESA-listed corals, quantified coral reef health, and compiled observations of ordnance impacts. The survey results indicated that ESA-listed corals are present, but rare in waters of <20 meters (m) depth around FDM. Additionally, 77.3 percent of corals observed exhibited some form of bleaching, likely caused by regionally anomalous warm sea surface temperatures. Carilli et al. (2018) found little evidence of adverse impacts to coral from Navy training, including the use of high-explosive bombs, and scleractinian coral growth occurred on a substantial percentage of ordnance items expended.

Coral cover on Guam is generally similar to other southern Mariana Islands, but lower than the northern islands (Raymundo et al., 2016). Because coral distribution and coral cover on reefs is naturally patchy and heterogeneous, a single island-wide number is not a representative summary of the coral community. Long-term monitoring surveys conducted by the National Marine Fisheries Service’s Pacific Assessment and Monitoring Program found approximately 10−15 percent coral cover overall, but the recent multi-year coral bleaching events have had dramatic, if patchy, consequences for the reef communities on Guam. For example, Raymundo et al. (2017) estimated a 53 percent decline in staghorn *Acropora* spp. on Guam. Of the 21 sites in the study, 6 are on Joint Region Marianas-administered submerged lands including 4 in Apra Harbor. The estimated mean mortality of staghorn *Acropora* spp. was 80 percent at Big Blue Shoals, 80 percent at Western Shoals, 30 percent at Dogleg, and 90 percent at Gab Gab (Raymundo et al., 2016). In the past several years, corals in Guam have been bleaching regularly each summer and recovery has been limited, leading to significant levels of coral mortality (Harvey, 2016; Raymundo et al., 2017).

Even though the new studies show variability in coral cover at FDM, including decreases in cover of some coral species off Guam, this information does not appreciably change the analysis presented in the 2015 MITT Final EIS/OEIS because the species composition on the reefs has not changed.

#### 3.8.1.1 Sound Sensing and Production

New studies on particle motion detection by Roberts et al. (2016) reinforces the finding that mechanical receptors on some invertebrates are found on various body parts. In addition, these structures are connected to the central nervous system and can detect some movements or vibrations that are transmitted through substrate (Edmonds et al., 2016). However, the addition of this new information does not appreciably change the information or analysis presented in the 2015 MITT Final EIS/OEIS.

#### 3.8.1.2 General Threats

The health and abundance of marine invertebrates and general threats to coral reef systems are well documented and discussed in detail in the 2015 MITT Final EIS/OEIS. These threats include stress or damage 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), disease (Porter et al., 2001), predation, harvesting by the aquarium trade (Caribbean Fishery Management Council, 1994, 2016), anchors (Burke & Maidens, 2004), invasive species (Bryant et al., 1998; Galloway et al., 2009; National Marine Fisheries Service, 2010; Wilkinson, 2002), ship groundings (National Oceanic and Atmospheric Administration, 2010), oil spills (National Oceanic and Atmospheric Administration, 2010), marine debris (Lusher et al., 2016), disturbance by recreational activities at beaches, possibly human-made noise (Brainard et al., 2011; Vermeij et al., 2010), and global climate change, which includes impacts such as increases in sea surface temperature (van Hooidonk et al., 2016) and ocean acidification (Anthony, 2016; Hughes et al., 2003). Several studies suggest a direct link between declining water quality from increased runoff and sedimentation and coral reef health and bleaching (Ennis et al., 2016; Gailani et al., 2016; Nelson et al., 2016). Coral bleaching and bleaching of other invertebrates such as anemones, which occurs when symbiotic algae living in their tissues is expelled, is a stress response often tied to atypically high sea temperatures or changes in light availability but also can be attributed to nutrients, toxicants, and pathogens (National Oceanic and Atmospheric Administration, 2017). For example, toxicants such as oxybenzone and zinc and titanium oxide found in sunscreens and personal beauty products have been shown to induce severe and rapid coral bleaching due to the alteration of the symbiosis between coral and zooxanthellae (Corinaldesi et al., 2018; Downs et al., 2016).

#### 3.8.1.3 Endangered Species Act-Listed Species

In 2014, the National Marine Fisheries Service (NMFS) published the Final Rule (79 Federal Register 53851) protecting 22 coral species under the Endangered Species Act (ESA), including the two corals (elkhorn and staghorn) listed as threatened in 2006. NMFS also determined that the remainder of the proposed species do not warrant listing as endangered or threatened species, and three proposed species (proposed October 2013) were not determinable under the ESA. Only three coral species (*Acropora globicep*s, *A. retusa*, and *Seriatopora aculeata*) are listed under the ESA and occur in the Study Area (Table 3.8-1). New information that supplements existing knowledge on disturbance responses and survivorship of some ESA-listed corals in the genus *Acropora* is detailed in Drury et al. (2017), and reactions of some coral species to thermal stress during a coral restoration project in the Caribbean is documented in (Ladd et al., 2017)). Since the species were listed, there are only a few locations where a federal ESA-listed coral species has been positively identified in the Study Area. Carilli et al. (2018) found

ESA-listed corals are present, but rare in waters of <20 m depth around FDM. In April 2015, several colonies of ESA-listed *Acropora globiceps* were encountered during a 40-minute non-systematic survey at Spanish Steps in Outer Apra Harbor (Lybolt, 2015). The colonies were seen in very shallow water less than 3.3 feet (ft.) (1 m) deep. Spanish Steps is just inside the tip of the Orote Peninsula, which is a dynamic location that is exposed to some effect from the ocean outside the harbor. The area has high coral coverage of commonly seen species from Apra Harbor. A second colony was recorded from the reef crest south of Dadi Beach in September 2016. The single colony was approximately 10–15 inches (25–30 centimeters) across and was observed during a non-systematic survey of the nearshore area at Dadi Beach (Moribe et al., 2016). Even though these observations represent new information on ESA-listed corals, it does not alter the analysis from the 2015 MITT Final EIS/OEIS. Therefore, all other information presented in the 2015 MITT Final EIS/OEIS on corals that occur in the Study Area remains valid.

In 2017, NMFS determined that seven species of giant clam (*Hippopus, H. porcellanus, Tridacna costata, T. derasa, T. gigas, T. squamosa*, and *T. tevoroa*) were candidates that may warrant listing under the ESA (82 Federal Register 28946). A status review is currently being done for these species. Two species, *H. hippopus* and *T. gigas*, have historically been found in the Study Area, but are believed to have been locally extirpated (Meadows, 2016).

**Table 3.8-1: Status of Endangered Species Act-Listed Species Within the Study Area**

| Species Name and Regulatory Status | | | Presence in Study Area | |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | **Endangered Species Act Status** | **Open Ocean/ Transit Corridor** | **Coastal Ocean** |
| Staghorn/Stony coral | *Acropora globiceps* | Threatened | No | Yes |
| Staghorn/Stony coral | *Acropora retusa* | Threatened | No | Yes |
| Club finger coral | *Seriatopora aculeata* | Threatened | No | Yes |
| Giant clam | *Hippopus* | Candidate | No | * |
| Giant clam | *Tridacna gigas* | Candidate | No | * |

* May be locally extirpated

#### 3.8.1.4 Taxonomic Groups

The information presented on invertebrate taxonomic groups in the Study Area, as listed in the 2015 MITT Final EIS/OEIS, has not changed and remains valid.

### 3.8.2 Environmental Consequences

The 2015 MITT Final EIS/OEIS considered training and testing activities proposed to occur in the Study Area that may have the potential to impact marine invertebrates. The stressors applicable to marine invertebrates in the Study Area are the same stressors in the 2015 MITT Final EIS/OEIS and are listed below:

- Acoustic (sonar and other transducers, vessel noise, aircraft noise, weapons noise)
- Explosive (in-air explosions and in-water explosions)
- Energy (in-water electromagnetic devices and high-energy lasers)

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

This section evaluates how and to what degree potential impacts on marine invertebrates from stressors described in Section 3.0 (General Approach to Analysis) may have changed since the analysis presented in the 2015 MITT Final EIS/OEIS was completed. Tables 2.5-1 and 2.5-2 in Chapter 2 (Description of Proposed Action and Alternatives) list the proposed training and testing activities and include the number of times each activity would be conducted annually and the locations within the Study Area where the activity would typically occur under each alternative. The tables also present the same information for activities described in the 2015 MITT Final EIS/OEIS so that the proposed levels of training and testing under this Supplemental EIS (SEIS)/OEIS can be easily compared.

The Navy conducted a review of federal and state regulations and standards relevant to marine invertebrates and reviewed scientific literature published since 2015 for new information on marine invertebrates that could inform the analysis presented in the 2015 MITT Final EIS/OEIS. Since 2006, the Navy, non-Navy scientists, research groups, and universities have conducted scientific monitoring and research in and around ocean areas in the Pacific where the Navy has been and proposes to continue training and testing. The analysis provided in this SEIS/OEIS will be the third time Navy training and testing activities at sea have been comprehensively analyzed in the Study Area. Data collected from the Navy has increased the knowledge of corals in the Study Area. For example, Smith and Marx (2016) conducted a coral reef dive survey on Farallon de Medinilla that used new methods of georeferencing the locations of sighted coral, and documented the existence of a few specimens of two ESA-listed species (*Acropora globiceps* and *Pavona diffluens*), including one species (*P. diffluens*) that had not previously been positively identified in the Mariana archipelago. Habitat maps were also developed from previous surveys and were refined, confirming that only a small subportion of the nearshore waters were characterized as high-quality coral reef. The analysis presented in this section also considers standard operating procedures, which are discussed in Section 2.3.3 (Standard Operating Procedures) of this Draft SEIS/OEIS, and mitigation measures that are described in Chapter 5 (Mitigation). The Navy would implement these measures to avoid or reduce impacts on seafloor resources (including shallow-water coral reefs, live hard bottom, artificial reefs, and shipwrecks) from explosives during applicable activities, as described in Section 5.4.1 (Mitigation Areas for Seafloor Resources).

#### 3.8.2.1 Acoustic Stressors

Little information is available on the potential impacts on marine invertebrates from exposure to sonar and other sound-producing activities. Most studies have focused on a few species (squid or crustaceans) and the consequences of exposures to broadband impulsive air guns typically used for seismic exploration, rather than on sonar or explosions. While the number of training and testing events would change under this SEIS/OEIS, the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.8.3.1 (Acoustic Stressors), remains applicable. The changes in training and testing activities are not substantial and would not result in an overall change to existing environmental conditions or an increase in the level or intensity of acoustic stressors within the Study Area.

As stated in the 2015 analysis, marine invertebrates are generally not sensitive to most sounds that would result from the proposed activities. New information presented on particle motion detection by Roberts et al. (2016) found mechanical receptors on some invertebrates may be connected to the central nervous system and can detect some movements or vibrations that are transmitted through substrate. Even though some invertebrates may be able to sense or detect particle motion, they would not be impacted by acoustic sources used during training and testing activities, and a recent literature review on assessing impacts of underwater noise on marine fishes and invertebrates (Hawkins & Popper 2017) does not change this conclusion. Therefore, the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.8.3.1 (Acoustic Stressors), remains valid and applicable.

#### 3.8.2.1.1 Impacts from Acoustic Stressors Under Alternative 1

Under Alternative 1, there would be an overall decrease in the number of sonar hours used in the Study Area during training and testing activities compared to the number analyzed in the 2015 MITT Final EIS/OEIS (Table 3.0-2 and Figure 2.4-1). Therefore, the analysis in the 2015 MITT Final EIS/OEIS remains valid. Decreases in the number of training and testing events would potentially decrease the level of acoustic stressors in the Study Area. Decreases in sonar hours shown in Table 3.0-2 for activities proposed under Alternative 1 would have no appreciable change on the impact analysis or conclusions for acoustic stressors presented in the 2015 MITT Final EIS/OEIS.

As described in the 2015 MITT Final EIS/OEIS, marine invertebrates throughout the Study Area may be exposed to non-impulse sounds generated by low-, mid-, and high-frequency sonar and other acoustic sources, vessel noise, and aircraft noise during training and testing activities. Acoustic impacts on marine invertebrates under Alternative 1 would be inconsequential because most marine invertebrates would not be close enough to intense sound sources. Any marine invertebrate capable of sensing sound may alter its behavior and become disoriented due to masking of relevant environmental sounds if exposed to non-impulsive sound, although it is unknown if responses to non-impulsive sounds occur. Continuous noise, such as from vessels, may also contribute to masking of relevant environmental sounds. Because the distance over which most marine invertebrates are expected to detect any sounds is limited and vessels would be in transit, any sound exposures with the potential to cause masking or behavioral responses would last only minutes. Furthermore, invertebrate species have their best sensitivity to sound below 1 kilohertz and would not be capable of detecting the majority of sonars and other acoustic sources used in the Study Area. Therefore, non-impulsive sounds associated with Alternative 1 are not expected to impact the majority of marine invertebrates or cause more than a short-term behavioral disturbance (e.g., change in orientation or swim speeds) to those marine invertebrates capable of detecting nearby sound. No population-level impacts on the survival, growth, recruitment, or reproduction of marine invertebrate populations are expected under Alternative 1.

*Pursuant to the ESA, the use of sonar and other transducers associated with training and testing activities, as described under Alternative 1, would have no effect on ESA-listed coral species.*

#### 3.8.2.1.2 Impacts from Acoustic Stressors Under Alternative 2

Under Alternative 2, the number of sonar hours used during training and testing activities would decrease compared to the numbers analyzed in the 2015 MITT Final EIS/OEIS and increase compared to Alternative 1 of this SEIS/OEIS (Table 3.0-2 and Figure 2.4-1). Under Alternative 2, increases in the number of sonar hours would have no appreciable change on the impact conclusions for acoustic stressors as summarized above under Alternative 1 and as presented in the 2015 MITT Final EIS/OEIS. Therefore, acoustic impacts on marine invertebrates under Alternative 2 would be negligible.

*Pursuant to the ESA, the use of sonar and other transducers associated with training and testing activities, as described under Alternative 2, would have no effect on ESA-listed coral species.*

#### 3.8.2.1.3 Impacts from Acoustic Stressors Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Acoustic stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer acoustic stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for acoustic impacts on individual invertebrates, but would not measurably improve the status of invertebrate populations or subpopulations.

### 3.8.2.2 Explosive Stressors

Explosives 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. Impulse sounds are usually brief, but the associated rapid pressure changes can injure or startle marine invertebrates. While the number of training and testing events would change under this SEIS/OEIS, the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.8.3.1 (Acoustic Stressors), remains applicable. The changes in training and testing activities are not substantial and would not result in an overall change to existing environmental conditions or an increase in the level or intensity of explosive stressors within the Study Area.

As stated above, in the 2015 analysis, and results reported in Roberts et al. (2016) and Edmonds et al. (2016), marine invertebrates are generally not sensitive to most sounds that would result from the proposed activities, but likely have mechanical receptors that may be connected to the central nervous system that can detect some movements or vibrations that are transmitted through substrate. Given that the activities would also be conducted at similar levels as described in the 2015 analysis, there would be no change to the conclusions. Therefore, the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.8.3.1 (Acoustic Stressors), remains valid.

Although the vast majority of explosions occur at distances greater than 3 nautical miles (NM) from shore (where water depths are greater than the depths where shallow-water coral species occur), some explosions may occur close to marine invertebrates that would kill or injure those invertebrates. Explosions near the seafloor and very large explosions in the water column may impact shallow-water corals of any life stage, hard-bottom habitat and associated marine invertebrates, and deep-water corals. Effects could include physical disturbance, fragmentation, or mortality to sessile organisms and pelagic larvae. Energy from an explosion at the surface would dissipate below detectable levels before reaching the seafloor and would not injure or otherwise impact deep-water, benthic marine invertebrates.

#### 3.8.2.2.1 Impacts from Explosive Stressors Under Alternative 1

Under Alternative 1, there would be an overall decrease in the number of explosive ordnance used in the Study Area during training and testing activities compared to the number analyzed in the 2015 MITT

Final EIS/OEIS (Table 3.0-7 and Figure 2.4-2). Under Alternative 1, underwater detonations would increase for underwater demolition qualification/certification (Table 2.5-1). However, these activities would continue to occur in the same areas at the Agat Bay site, Piti, and Outer Apra Harbor sites, and would have no appreciable change in the impact analysis or conclusions for explosive stressors as presented in the 2015 MITT Final EIS/OEIS. Decreases in the number of training and testing events would not necessarily decrease the level of explosive stressors. Decreases in activities proposed under Alternative 1 would have no appreciable change on the impact analysis or conclusions for explosive stressors presented in the 2015 MITT Final EIS/OEIS.

Most explosions at the water surface would not injure benthic marine invertebrates because the explosive weights would be small compared to the water depth. As described above, explosions would likely kill or injure nearby marine invertebrates. Effects could include physical disturbance, fragmentation, or mortality to sessile organisms and pelagic larvae.

In addition, the vast majority of explosive detonations during training and testing activities would occur in waters greater than 3 NM from shore, which are not known to support ESA-listed coral species. However, if corals are present in areas overlapping with other training and testing activities using explosives, sessile shallow-water corals, hard-bottom, and deep-water corals, as well as eggs, sperm, early embryonic stages, and planula larvae of corals could be impacted by explosions. Consequences of exposure to an explosive shock wave could include breakage, injury, or mortality. Many corals and hard-bottom invertebrates are sessile, fragile, and particularly vulnerable. Because exposures to explosive shock waves are brief, limited in number, and spread over a large area, no long-term impacts are expected. Explosives may impact individual marine invertebrates and groups of marine invertebrates, but they are unlikely to impact populations or subpopulations. Therefore, acoustic impacts on marine invertebrates under Alternative 1 from explosives would be negligible.

As discussed in Section 5.4.1 (Mitigation Areas for Seafloor Resources), the Navy will implement mitigation to avoid or reduce impacts from explosives on seafloor resources in mitigation areas throughout the Study Area. For example, the Navy will not conduct explosive mine countermeasure and neutralization activities within a specified distance of shallow-water coral reefs, live hard bottom, artificial reefs, and shipwrecks. The mitigation will consequently also help avoid or reduce potential impacts on invertebrates that inhabit these areas. There is also procedural mitigation that affects "jellyfish aggregations," specifically for explosive torpedoes and sinking exercises (see Section 5.3.3 – Explosive Stressors). Additionally, the Navy will require Lookouts to observe the water's surface before and during sinking exercises and the use of explosive torpedoes to avoid or reduce jellyfish aggregations.

*Pursuant to the ESA, the use of explosives associated with training and testing activities, as described under Alternative 1, may affect ESA-listed coral species*

#### 3.8.2.2.2 Impacts from Explosive Stressors Under Alternative 2

Under Alternative 2, the number of explosives used during training and testing activities would decrease compared to the numbers analyzed in the 2015 MITT Final EIS/OEIS and increase compared to Alternative 1 (Table 3.0-7 and Figure 2.4-2). Under Alternative 2, increases in the number of underwater explosives would have no appreciable change on the impact conclusions for explosive stressors as summarized above under Alternative 1 and as presented in the 2015 MITT Final EIS/OEIS.

Therefore, impacts on marine invertebrates under Alternative 2 from explosives would be negligible.

*Pursuant to the ESA, the use of explosives associated with training and testing activities, as described under Alternative 2, may affect ESA-listed coral species.*

#### 3.8.2.2.3 Impacts from Explosive Stressors Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Explosive stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer explosive stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for explosive impacts on individual invertebrates, but would not measurably improve the status of invertebrate populations or subpopulations.

### 3.8.2.3 Energy Stressors

The energy stressors that may impact marine invertebrates include in-water electromagnetic devices and high energy lasers. The in-water electromagnetic devices stressor remains the same as analyzed in the 2015 MITT Final EIS/OEIS; high-energy lasers is a new stressor analyzed in this SEIS/OEIS. While the number of training and testing events would change under this SEIS/OEIS, the analysis presented in the 2015 MITT Final EIS/OEIS for in-water electromagnetic devices remains valid and an analysis of potential impacts from high-energy laser use is presented below.

As discussed in Section 3.0.5.3.1.2 (High-Energy Lasers), high-energy lasers are designed to disable surface targets, rendering them immobile. The primary concern is the potential for an invertebrate to be struck with the laser beam at or near the water's surface, where extended exposure could result in injury or death.

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 influence coral spawning or larval settlement. However, existing information suggests sensitivity to electric and magnetic fields in at least three marine invertebrate phyla: Mollusca, Arthropoda, and Echinodermata (Lohmann et al., 1995; Lohmann & Lohmann, 2006; Normandeau et al., 2011).

High-energy lasers were not proposed for use in the 2015 MITT Final EIS/OEIS. As discussed in Section 3.0.4.3.2.2 (High-Energy Lasers), high-energy laser weapons testing involves the use of directed energy as a weapon against small surface vessels and airborne targets. These weapons systems are deployed from a surface ship to create small but critical failures in potential targets and used at short ranges from the target.

Marine invertebrates could be exposed to a laser only if the beam missed the target. Should the laser strike the sea surface, individual invertebrates at or near the surface, such as jellyfish, floating eggs, and larvae could potentially be exposed. The potential for exposure to a high-energy laser beam decreases rapidly as water depth increases and varies with time of day, as many zooplankton species migrate away from the surface during the day. Most marine invertebrates are not susceptible to laser exposure because they occur beneath the sea surface.

#### 3.8.2.3.1 Impacts from In-Water Electromagnetic Devices Under Alternative 1

Under Alternative 1, the number of proposed training and testing activities involving the use of in-water electromagnetic devices would decrease in comparison to the 2015 MITT Final EIS/OEIS (Table 3.0-9). The activities would occur in the same locations and in a similar manner as were analyzed previously.

Therefore, impacts on marine invertebrates under Alternative 1 from in-water electromagnetic devices would be negligible.

*Pursuant to the ESA, the use of in-water electromagnetic devices associated with training and testing activities, as described under Alternative 1, would have no effect on ESA-listed coral species.*

#### 3.8.2.3.2 Impacts from In-Water Electromagnetic Devices Under Alternative 2

Under Alternative 2, the number of proposed training and testing activities involving the use of in-water electromagnetic devices would decrease in comparison to the 2015 MITT Final EIS/OEIS (Table 3.0-9). The activities would occur in the same locations and in a similar manner as were analyzed previously and above for Alternative 1.

Therefore, impacts on marine invertebrates under Alternative 2 from in-water electromagnetic devices would be negligible.

*Pursuant to the ESA, the use of in-water electromagnetic devices associated with training and testing activities, as described under Alternative 2, would have no effect on ESA-listed coral species.*

#### 3.8.2.3.3 Impacts from In-Water Electromagnetic Devices Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Energy stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer in-water electromagnetic stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for energy impacts on individual invertebrates, but would not measurably improve the status of invertebrate populations or subpopulations.

#### 3.8.2.3.4 Impacts from High-Energy Lasers Under Alternative 1

No high-energy lasers are proposed for training activities under Alternative 1. Under Alternative 1, the number of proposed testing events involving the use of high-energy lasers would be 54 (Table 3.0-10); this is a new substressor that was not analyzed in the 2015 MITT Final EIS/OEIS.

The primary concern for high-energy weapons testing is the potential for a marine invertebrate to be struck by a high-energy laser beam at or near the water's surface, which could result in injury or death, resulting from traumatic burns from the beam. Invertebrates that do not occur at or near the sea surface would not be exposed due to the attenuation of laser energy with depth. Surface invertebrates such as squid, jellyfish, and zooplankton (which may include invertebrate larvae) exposed to high-energy lasers could be injured or killed, but the probability is low based on the relatively low number of events, very localized potential impact area of the laser beam, and the temporary duration of potential impact (seconds). Activities involving high-energy lasers 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 because of the relatively small number of individuals that could be impacted. The impact of high-energy lasers on marine invertebrates would be inconsequential because (1) it is highly unlikely that a high-energy laser would miss its target, (2) it is highly unlikely that the laser would miss in such a way that the laser beam would strike a marine invertebrate, and (3) it is highly unlikely that the marine invertebrate would be at or near the surface, just as two equally unlikely events take place.

*Pursuant to the ESA, the use of high-energy lasers associated with testing activities, as described under Alternative 1, would have no effect on ESA-listed coral species.*

#### 3.8.2.3.5 Impacts from High-Energy Lasers Under Alternative 2

As shown in Table 3.0-10, 60 testing events involving the use of high-energy lasers are proposed under Alternative 2, which is a slight increase from the number proposed under Alternative 1. Therefore, the impacts would be the same as described under Alternative 1.

*Pursuant to the ESA, the use of high-energy lasers associated with testing activities, as described under Alternative 2, would have no effect on ESA-listed coral species.*

#### 3.8.2.3.6 Impacts from High-Energy Lasers Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Energy stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer high-energy laser stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for energy impacts on individual invertebrates, but would not measurably improve the status of invertebrate populations or subpopulations.

### 3.8.2.4 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. While the number of training and testing events would change under this SEIS/OEIS, the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.8.3.3 (Physical Disturbance and Strike Stressors) remains valid. The changes in training and testing activities are not substantial and would not result in an overall change to existing environmental conditions or an increase in the level or intensity of physical disturbance and strike stressors within the Study Area.

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.

As stated in the 2015 MITT Final EIS/OEIS, activities involving vessels and in-water devices are not intended to contact the seafloor. This would include amphibious and expeditionary events such as Amphibious Assaults, Amphibious Raids, Personnel Insertion/Extraction, and Underwater Surveys, which are proposed to continue in this SEIS/OEIS. These activities could occur at beaches at Unai Babui, Unai Chulu, and Unai Dankulo on Tinian and could also occur at Dry Dock Island in Apra Harbor at Dadi Beach on Guam. Benthic invertebrates of the reef crest or flat, such as crabs, clams, and polychaete worms, within the disturbed area could be displaced, injured, or killed during amphibious operations. As is current practice, coral and other hard bottom habitats would continue to be avoided to the greatest extent practical under the Proposed Action (see Section 2.3.3, Standard Operating Procedures and Chapter 5 - Mitigation). However, combat swimmers and Marines may be required to walk through nearshore areas during these activities. For example, as the boat approaches a beach, Marines may be required to exit the boat, stand up, and walk through the shallow water habitats.

As discussed in Section 5.4.1 (Mitigation Areas for Seafloor Resources), the Navy will implement mitigation to avoid or reduce impacts from precision anchoring and military expended materials on seafloor resources in mitigation areas throughout the Study Area. For example, the Navy will not conduct explosive mine countermeasure and neutralization activities within a specified distance of shallow-water coral reefs, live hard bottom, artificial reefs, and shipwrecks (except at designated nearshore training areas, where these resources will be avoided to the maximum extent practicable). The mitigation will consequently also help avoid or reduce potential impacts on invertebrates that inhabit these areas.

#### 3.8.2.4.1 Impacts from Physical Disturbance and Strike Stressors Under Alternative 1

Under Alternative 1, the combined number of proposed training and testing activities involving vessels and in-water devices (Table 3.0-12 and Table 3.0-13) would decrease slightly from those presented in the 2015 MITT Final EIS/OEIS. Military expended materials and munitions (Tables 3.0-14 through 3.0-17) combined would increase, and seafloor devices (Table 3.0-18) would decrease slightly from the number in the 2015 MITT Final EIS/OEIS. Increases in some physical disturbance and strike stressors, such as military expended materials, could increase the level of impact on some marine invertebrates. However, these changes do not appreciably change the analysis or impact conclusions presented in the 2015 MITT Final EIS/OEIS because the impact analysis was based on the probability of an impact on a resource.

As stated in the 2015 MITT Final EIS/OEIS, the impact of physical disturbance and strike stressors on marine invertebrates is likely to cause injury or mortality to individuals, such as corals on nearshore reefs, but impacts on populations would be negligible because (1) the area exposed to the stressor is extremely small (localized) relative to most marine invertebrates’ ranges, and (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one event. Activities involving vessel and in-water devices, military expended material, and seafloor 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. However, the combined consequences of all physical disturbance and strike stressors could degrade habitat quality at some locations. As stated above, combat swimmers and Marines may be required to walk through nearshore areas and reefs during these activities, potentially causing damage to coral species. As stated in the 2015 MITT Final EIS/OEIS and above, these activities could cause injury or mortality to individuals, but impacts on marine invertebrate populations, including ESA-listed corals, are unlikely.

Therefore, under Alternative 1, impacts on marine invertebrates from the use of vessels and in-water devices, military expended materials, and seafloor devices would be negligible.

*Pursuant to the ESA, the use of vessels and in-water devices, military expended materials, and seafloor devices during training and testing activities, as described under Alternative 1, may affect ESA-listed coral species.*

#### 3.8.2.4.2 Impacts from Physical Disturbance and Strike Stressors Under Alternative 2

Under Alternative 2, the combined number of proposed training and testing activities involving vessels and in-water devices would decrease slightly from those presented in the 2015 MITT Final EIS/OEIS (Table 3.0-12 and Table 3.0-13). Military expended materials (Tables 3.0-14 through 3.0-17) combined would increase, and seafloor devices (Table 3.0-18) would decrease slightly from the numbers in the 2015 MITT Final EIS/OEIS. Increases in some physical disturbance and strike stressors such as military expended materials could increase the impact risk on marine invertebrates, but do not appreciably change the analysis or impact conclusions presented in the 2015 MITT Final EIS/OEIS. Impacts on marine invertebrates would be inconsequential for the same reasons detailed above and there would be no appreciable change in the impact conclusions for physical disturbance and strike stressors, as presented in the 2015 MITT Final EIS/OEIS and summarized above under Alternative 1.

Therefore, under Alternative 2, impacts on marine invertebrates from the use of vessels and in-water devices, military expended materials, and seafloor devices would be negligible.

*Pursuant to the ESA, the use of vessels and in-water devices, military expended materials, and seafloor devices during training and testing activities, as described under Alternative 2, may affect ESA-listed coral species.*

#### 3.8.2.4.3 Impacts from Physical Disturbance and Strike Stressors Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Physical disturbance and strike stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer physical disturbance and strike stressors within the marine environment where Navy activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for physical disturbance and strike impacts on individual invertebrates, but would not measurably improve the status of invertebrate populations or subpopulations.

### 3.8.2.5 Entanglement Stressors

Entanglement stressors that may impact marine invertebrates include (1) fiber optic cables and guidance wires, and (2) decelerators/parachutes. While the number of training and testing events would change under this supplement, the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.8.3.4 (Entanglement Stressors) remains valid.

#### 3.8.2.5.1 Impacts from Entanglement Stressors Under Alternative 1

Under Alternative 1, the number of fiber optic cables (Table 3.0-20), guidance wires (Table 3.0-21), and decelerators/parachutes (Table 3.0-22) that would be expended during training and testing activities would decrease compared to the number of activities proposed in the 2015 MITT Final EIS/OEIS. Decreases in the number of training and testing events would potentially decrease the level of entanglement stressors in the Study Area.

As stated in the 2015 MITT Final EIS/OEIS, the impact of fiber optic cables, guidance wires, and decelerators/parachutes on marine invertebrates is not likely to cause injury or mortality to individuals, and impacts would be negligible because (1) the area exposed to the stressor is extremely small (localized) 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) marine invertebrates are not particularly susceptible to entanglement stressors. Activities involving cables, guidance wires, and 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.

Therefore, impacts on marine invertebrates from entanglement stressors such as wires and cables and decelerators/parachutes under Alternative 1 would be negligible.

*Pursuant to the ESA, the use of fiber optic cables and guidance wires, and* decelerators/parachutes *during training and testing activities, as described under Alternative 1, may affect ESA-listed coral species.*

#### 3.8.2.5.2 Impacts from Entanglement Stressors Under Alternative 2

Under Alternative 2, the number of fiber optic cables (Table 3.0-20) decrease, guidance wires (Table 3.0-21) increase, and decelerators/parachutes (Table 3.0-22) decrease compared to the number of activities proposed in the 2015 MITT Final EIS/OEIS and would increase or stay the same compared to Alternative 1. However, as stated above for Alternative 1, training and testing activities involving fiber optic cables, guidance wires, and 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 for the same reasons detailed above for Alternative 1.

Therefore, impacts on marine invertebrates from entanglement stressors such as wires and cables and decelerators/parachutes under Alternative 2 would be negligible.

*Pursuant to the ESA, the use of fiber optic cables and guidance wires, and* decelerators/parachutes *during training and testing activities, as described under Alternative 2, may affect ESA-listed coral species.*

#### 3.8.2.5.3 Impacts from Entanglement Stressors Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Entanglement stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer entanglement stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for entanglement impacts on individual invertebrates, but would not measurably improve the status of invertebrate populations or subpopulations.

### 3.8.2.6 Ingestion Stressors

Types of materials that could become ingestion stressors during training and testing activities in the Study Area include 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. While the number of training and testing events would change under this SEIS/OEIS, the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.8.3.5 (Ingestion Stressors) remains valid.

Expended materials could be ingested by marine invertebrates 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 (i.e., corals) and bottom-feeding animals (seastars and sea cucumbers). Marine invertebrates are universally present in the water and the seafloor, with many individuals being 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 degrade into smaller fragments.

#### 3.8.2.6.1 Impacts from Ingestion Stressors Under Alternative 1

Under Alternative 1, the combined number of ingestion stressors would increase compared to the number in the 2015 MITT Final EIS/OEIS (see Tables 3.0-14 through 3.0-17, Table 3.0-23, and Table 3.0-24). However, increases in the number of ingestion stressors do not appreciably change the impact analysis or conclusions presented in the 2015 MITT Final EIS/OEIS.

As stated in the 2015 MITT Final EIS/OEIS, 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 increase in military expended materials, primarily from small-caliber projectiles, would not represent an ingestion risk for marine invertebrates. Only a small fraction of military expended materials would be of ingestible size, or become ingestible after degradation; while those may impact individual marine invertebrates, such as ESA-listed corals, they are unlikely to impact populations. Therefore, impacts on marine invertebrates from ingestion of military expended materials under Alternative 1 would be negligible.

*Pursuant to the ESA, the use of military expended materials of ingestible size during training and testing activities, as described under Alternative 1, may affect ESA-listed coral species.*

#### 3.8.2.6.2 Impacts from Ingestion Stressors Under Alternative 2

Under Alternative 2, the combined number of ingestion would increase compared to the number in the 2015 MITT Final EIS/OEIS and as compared to Alternative 1 (see Tables 3.0-14 through 3.0-17, Table 3.0-23, and Table 3.0-24). However, these increases do not appreciably change the impact analysis or conclusions presented in the 2015 MITT Final EIS/OEIS and those summarized above under Alternative 1.

Therefore, impacts on marine invertebrates from ingestion of military expended materials under Alternative 2 would be negligible.

*Pursuant to the ESA, the use of military expended materials of ingestible size during training and testing activities, as described under Alternative 2, may affect ESA-listed coral species.*

#### 3.8.2.6.3 Impacts from Ingestion Stressors Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Ingestion stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer ingestion stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for ingestion impacts on individual invertebrates, but would not measurably improve the status of invertebrate populations or subpopulations.

### 3.8.2.7 Secondary Stressors

Potential impacts on marine invertebrates exposed to stressors could occur indirectly through sediments and water quality. Stressors from Navy training and testing activities could pose secondary or indirect impacts on marine invertebrates via habitat, sediment, or water quality. Components of these stressors that could pose indirect impacts include (1) explosives and byproducts; (2) metals; (3) chemicals; and (4) other materials such as targets, chaff, and plastics.

While the number of training and testing events would change under this SEIS/OEIS, the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.8.3.6 (Secondary Stressors) remains valid. As stated in the 2015 MITT Final EIS/OEIS, indirect impacts of explosives and unexploded ordnance on marine invertebrates via water are likely to be negligible and not detectable for two reasons. First, most explosives and explosive degradation products have very low solubility in sea water. 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 byproducts, 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 chemical byproducts. While marine invertebrates may be adversely impacted by the indirect effects of degrading explosives via water (Rosen & Lotufo, 2007; 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 (1–6 ft. [0.3–1.8 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 negligible. 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.

Erosion as a result of training activities at FDM may contribute to deposition of soils into the nearshore areas of FDM, causing increased turbidity. However, cliff face vertical targets used as part of Naval surface fire support training have been moved to reduce erosion and potential impacts to the cliff face, as well as biological resources. Turbidity can impact corals and invertebrate communities on hard-bottom areas by reducing the amount of light that reaches these organisms and by clogging siphons for filter-feeding organisms. Reef-building corals are sensitive to water clarity because they host symbiotic algae that require sunlight to live. Encrusting organisms residing on hard bottom can be impacted by persistent silting from increased turbidity. However, the impacts of explosive byproducts on sediment and water quality would be indirect, short term, local, and negative. Explosive ordnance could loosen soil on FDM, and runoff from surface drainage areas containing soil and explosive byproducts could subsequently enter nearshore waters. Impacts on marine invertebrates from erosion or sedimentation could occur.

As stated in the 2015 MITT Final EIS/OEIS, 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 negligible and not detectable. Given these conditions, the possibility of population-level impacts on marine invertebrates is likely to be negligible and not detectable. In addition, 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 negligible and not detectable. Population-level impacts on marine invertebrates would be negligible and not detectable.

In addition, as stated in the 2015 MITT Final EIS/OEIS, plastics could impact marine invertebrates via sediment. 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. Because plastics retain many of their chemical properties as they are physically degraded into microplastic particles (Singh & 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 relatively few military expended material contains plastics. Therefore, population-level impacts on marine invertebrates attributable to Navy-expended materials are likely to be negligible and not detectable.

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

### 3.8.3 Public Scoping Comments

The public raised a number of issues during the scoping period in regard to marine invertebrates. The issues are summarized in the list below.

- **Sonar disrupting larval recruitment.** As described in the 2015 MITT Final EIS/OEIS, corals throughout the Study Area may be exposed to non-impulse sounds generated by sonar and other transducers, vessels, and aircraft during training and testing activities. 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 coral species are known to exist. Sound from training and testing activities is intermittent or transient, or both, and would not occur close enough to reefs to interfere with larval perception of reef noise. The Navy also looked at impacts on the individual polyp or medusae from the use of sonar in relation to the overall number, or population, of coral medusae or polyps. In addition, as described above in Section 3.8.1.1 (Invertebrate Hearing and Vocalization), invertebrate species detect sounds through particle motion, which diminishes rapidly from the sound source. Most activities using sonar or other transducers would be conducted in deep-water, offshore areas of the Study Area and would not affect invertebrates. Furthermore, invertebrate species have their best hearing sensitivity below 1 kHz and would not be capable of detecting the majority of sonars and other transducers used in the Study Area.

- **Impacts from precision anchoring activities.** As described in Section 3.7.3.2.3 (Impacts from Seafloor Devices) of the 2015 MITT Final EIS/OEIS, precision anchoring would typically occur within predetermined shallow water anchorage locations near ports where the seafloor consists of unconsolidated sediments and lacks marine vegetation. These areas do not contain coral reefs. Additional mitigation measures for shallow water coral reefs used to avoid or reduce impacts from precision anchoring are presented in Chapter 5 (Mitigation).
- **Persistence of chemicals in ordnance when debris becomes encased in coral.** As described in Section 3.8.3.3.2.1 (Military Expended Materials that are Ordnance) of the 2015 MITT Final EIS/OEIS, the physical and chemical properties of the surrounding water from an ordnance strike 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. In addition, Section 3.8.3.6 (Secondary Impacts) in the 2015 MITT Final EIS/OEIS determined that the impacts on sedentary invertebrate beds and reefs from the use of metal, chemical, and other material byproducts, and secondary physical disturbances during training and testing activities would be minimal and short term within the Study Area.
- **Secondary impacts on ESA species, including coral reefs from training activities on FDM.** The 2015 MITT Final EIS/OEIS analyzed potential impacts on marine resources, including ESA-listed coral species, using the best available data. Similarly, the Navy conducted an extensive review of recent literature, including government technical documents and reports, and online scientific journal databases to add any new information to this document. This information supports the conclusions from the 2015 MITT Final EIS/OEIS that secondary impacts on coral reefs from explosives and explosive byproducts could occur, while impacts on marine invertebrates from erosion or sedimentation are not anticipated. In addition, indirect impacts from metals and other chemicals in the marine environment are likely to be negligible and not detectable.
- **Direct impacts on coral reefs, coral spawning periods, and other invertebrates from sedimentation/erosion around FDM.** As detailed in Section 3.1 (Sediments and Water Quality), recent multi-year dive studies were conducted by Smith and Marx (2016) at FDM. These surveys found that coral fauna at FDM are healthy and robust and the nearshore physical environment and basic habitat types at FDM remained unchanged over the 13 years (1999–2012). These conclusions are based on (1) a limited amount of physical damage, (2) very low levels of partial mortality and disease (less than 1 percent of all species observed), (3) absence of excessive mucus production, (4) good coral recruitment, (5) complete recovery by 2012 of the 2007 bleaching event, and (6) a limited number of macrobioeroders and an absence of invasive crown of thorns starfish (*Acanthaster planci*). These factors suggest that sedimentation that may result from military use of FDM is not sufficient as to adversely impact water quality and coral communities.
- **Direct and cumulative impacts from military expended materials as marine debris.** The 2015 MITT Final EIS/OEIS and this SEIS/OEIS analyzed potential direct and cumulative impacts of military expended materials on marine invertebrates through physical disturbance and strike, entanglement, and ingestion. The majority of these materials are expended in open ocean areas where impacts on biological communities, such as coral reefs, would be minimized.

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# REFERENCES

Anthony, K. R. N. (2016). Coral Reefs Under Climate Change and Ocean Acidification: Challenges and Opportunities for Management and Policy. *Annual Review of Environment and Resources, 41*, 598–581.

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* (NOAA Technical Memorandum NMFS-PIFSC-27). Honolulu, HI: National Marine Fisheries Service, Pacific Islands Fisheries Science Center.

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

Burke, L., and J. Maidens. (2004). *Reefs at Risk in the Caribbean*. Washington, DC: 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*. San Juan, PR: Caribbean Fishery Management Council.

Caribbean Fishery Management Council. (2016). *Amendments to the U.S. Caribbean Reef Fish, Spiny Lobster, and Corals and Reef Associated Plants and Invertebrates Fishery Management Plans: Timing of Accountability Measure-Based Closures*. San Juan, PR: Caribbean Fishery Management Council.

Carilli, J., S. H. Smith, D. E. Marx, Jr., L. Bolick, and D. Fenner. (2018). *Farallon de Medinilla 2017 Species Level Coral Reef Survey Report*. Pearl Harbor, HI: U.S. Navy Pacific Fleet.

Corinaldesi, C., F. Marcellini, E. Nepote, E. Damiani, and R. Danovaro. (2018). Impact of inorganic UV filters contained in sunscreen products on tropical stony corals (*Acropora* spp.). *Science of the Total Environment, 2018*, 1279–1285.

Derraik, J. G. B. (2002). The pollution of the marine environment by plastic debris: A review. *Marine Pollution Bulletin, 44*, 842–852.

Downs, C. A., E. Kramarsky-Winter, R. Segal, J. Fauth, S. Knutson, O. Bronstein, F. R. Ciner, R. Jeger, Y. Lichtenfeld, C. M. Woodley, P. Pennington, K. Cadenas, A. Kushmaro, and Y. Loya. (2016). Toxicopathological Effects of the Sunscreen UV Filter, Oxybenzone (Benzophenone-3), on Coral Planulae and Cultured Primary Cells and Its Environmental Contamination in Hawaii and the U.S. Virgin Islands. *Archives of Environmental Contamination and Toxicology, 2016*(70), 265–288.

Drury, C., D. Manzello, and D. Lirman. (2017). Genotype and local environment dynamically influence growth, disturbance response and survivorship in the threatened coral, *Acropora cervicornis*. *PLoS ONE, 12*(3), 21.

Edmonds, N. J., C. J. Firmin, D. Goldsmith, R. C. Faulkner, and D. T. Wood. (2016). A review of crustacean sensitivity to high amplitude underwater noise: Data needs for effective risk assessment in relation to UK commercial species. *Marine Pollution Bulletin, 108*, 5–11.

Ennis, R. S., M. E. Brandt, K. E. W. Grimes, and T. B. Smith. (2016). Coral reef health response to chronic and acute changes in water quality in St. Thomas, United States Virgin Islands. *Marine Pollution Bulletin, 111*(1–2), 418–427.

Gailani, J. Z., T. C. Lackey, D. B. J. King, D. Bryant, S. C. Kim, and D. J. Shafer. (2016). Predicting dredging-associated effects to coral reefs in Apra Harbor, Guam - Part 1: Sediment exposure modeling. *Journal of Environmental Management, 168*, 16–26.

Galloway, S. B., A. W. Bruckner, and C. M. Woodley. (2009). *Coral Health and Disease in the Pacific: Vision for Action*. Silver Spring, MD: National Oceanic and Atmospheric Administration.

Harvey, C. (2016). 'I cried... right into my mask': Scientists say Guam's reefs have bleached four years straight. *The Washington Post*. Retrieved from https://www.washingtonpost.com/news/energy-environment/wp/2016/08/03/i-cried-right-into-my-mask-these-coral-reefs-have-seen-a-devastating-four-years-of-bleaching/?noredirect=on&utm_term=.17d2d85b6b40.

Hawkins, A., and A. N. Popper (2017). A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. *ICES Journal of Marine Science, 74*(3), 635–651.

Hughes, T. P., A. H. Baird, D. R. Bellwood, M. Card, S. R. Connolly, C. Folke, R. Grosberg, O. Hoegh-Guldberg, J. B. C. Jackson, J. Kleypas, J. M. Lough, P. A. Marshall, M. Nystrom, S. R. Palumbi, J. M. Pandolfi, B. Rosen, and J. Roughgarden. (2003). Climate change, human impacts, and the resilience of coral reefs. *Science, 301*(5635), 929–933.

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. *Science, 293*, 629–638.

Ladd, M. C., A. A. Shantz, E. Bartels, and D. E. Burkepile. (2017). Thermal stress reveals a genotype-specific tradeoff between growth and tissue loss in restored *Acropora cervicornis*. *Marine Ecology Progess Series, 572*, 129–139.

Lohmann, K. J., N. D. Pentcheff, G. A. Nevitt, G. D. Stetten, R. K. Zimmer-Faust, H. E. Jarrard, and L. C. Boles. (1995). Magnetic orientation of spiny lobsters in the ocean: Experiments with undersea coil systems. *The Journal of Experimental Biology, 198*(10), 2041–2048.

Lohmann, K. J., and C. M. F. Lohmann. (2006). Sea turtles, lobsters, and oceanic magnetic maps. *Marine and Freshwater Behaviour and Physiology, 39*(1), 49–64.

Lusher, A. L., C. O'Donnell, R. Officer, and I. O'Connor. (2016). Microplastic interactions with North Atlantic mesopelagic fish. *ICES Journal of Marine Science, 73*(4), 1214–1225.

Lybolt, M. (2015). *Listed Coral Sighting (Guam)*. Stuart, FL: Tetra Tech, Inc.

Meadows, D. W. (2016). *Petition to List the Tridacninae Giant Clams (Excluding Tridacna rosewateri) as Threatened or Endangered Under the Endangered Species Act*. Ellicott City, MD: Giant Clam Petition.

Moribe, J., S. Hanser, and R. Spaulding (2016). [Personal communication regarding the observation of *Acropora globiceps* near Dadi Beach, Naval Base Guam via email between J. Moribe (National Marine Fisheries Service, Protected Resources Division, Pacific Islands Regional Office), Dr. S. Hanser (Naval Facilities Engineering Command Pacific), and R. Spaulding (Cardno)].

National Marine Fisheries Service. (2010). Marine Invertebrates and Plants. Silver Spring, MD: National Oceanic and Atmospheric Administration, Office of Protected Resources.

National Oceanic and Atmospheric Administration. (2010). *Deep-Sea Corals*. Silver Spring, MD: National Oceanic and Atmospheric Administration Ocean Explorer. Retrieved from https://oceanexplorer.noaa.gov/edu/themes/deep-sea-corals/welcome.html.

National Oceanic and Atmospheric Administration. (2017). *Coral Bleaching and Disease*. Retrieved from https://www.pifsc.noaa.gov/cred/coral_bleaching_and_disease.php.

Nelson, D. S., J. McManus, R. H. Richmond, D. B. J. King, J. Z. Gailani, T. C. Lackey, and D. Bryant. (2016). Predicting dredging-associated effects to coral reefs in Apra Harbor, Guam - Part 2: Potential coral effects. *Journal of Environmental Management, 168*, 111–122.

Normandeau, E., T. Tricas, and A. Gill. (2011). *Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species*. Camarillo, CA: U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific Outer Continental Shelf Region.

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

Porter, J. W., P. Dustan, W. C. Jaap, K. L. Patterson, V. Kosmynin, O. W. Meier, M. E. Patterson, and M. Parsons. (2001). Patterns of spread of coral disease in the Florida Keys. *Hydrobiologia, 460*, 1–24.

Raymundo, L. J., M. C. D. Malay, and A. N. Williams. (2016). *Final Report: Research on Stony Coral Health and Community Structure.* Mangilao, GU: University of Guam Marine Laboratory.

Raymundo, L. J., D. Burdick, V. A. Lapacek, R. J. Miller, and V. Brown. (2017). Anomalous temperatures and extreme tides: Guam staghorn *Acropora* succumb to a double threat. *Marine Ecology Progess Series, 564*, 47–55.

Risk, M. (2009). Editorial: The reef crisis and the reef science crisis: Nitrogen isotopic ratios as an objective indicator of stress. *Marine Pollution Bulletin, 58*(6), 787–788.

Roberts, L., S. Cheesman, M. Elliott, and T. Breithaupt. (2016). Sensitivity of *Pagurus bernhardus* (L.) to substrate-borne vibration and anthropogenic noise. *Journal of Experimental Marine Biology and Ecology, 474*, 185–194.

Rosen, G., and G. Lotufo. (2007). Toxicity of explosive compounds to the marine mussel, *Mytilus galloprovincialis*, in aqueous exposures. *Ecotoxicology and Environmental Safety, 68*(2), 228–236.

Rosen, G., and G. R. Lotufo. (2010). Fate and effects of composition B in multispecies marine exposures. *Environmental Toxicology and Chemistry, 29*(6), 1330–1337.

Singh, B., and N. Sharma. (2008). Mechanistic implications of plastic degradation. *Polymer Degradation and Stability, 93*(3), 561–584.

Smith, S. H., and D. E. Marx, Jr. (2009). *Assessment of Near Shore Marine Resources at Farallon De Medinilla: 2006, 2007 and 2008*. Capitol Hill, Commonwealth of the Northern Mariana Islands: Pacific Division, Naval Facilities Engineering Command.

Smith, S. H., J. Marx, D. E., and L. H. Shannon. (2013). *Calendar Year 2012 Assessment of Near Shore Marine Resources at Farallon de Medinilla, Commonwealth of the Northern Mariana Islands*. Port Hueneme, CA: U.S. Department of the Navy.

Smith, S. H., and D. E. Marx, Jr. (2016). De-facto marine protection from a Navy bombing range: Farallon de Medinilla, Mariana Archipelago, 1997 to 2012. *Marine Pollution Bulletin, 102*(1), 187–198.

van Hooidonk, R., J. A. Maynard, J. Tamelander, J. Gove, G. Ahmadia, L. Raymundo, G. Williams, S. F. Heron, and S. Planes. (2016). Local-scale projections of coral reef futures and implications of the Paris Agreement. *Scientific Reports, 6*(39666), 8.

Vermeij, M. J. A., K. L. Marhaver, C. M. Huijbers, I. Nagelkerken, and S. D. Simpson. (2010). Coral larvae move toward reef sounds. *PLoS ONE, 5*(5), e10660.

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

# 3.9 Fishes

# Supplemental Environmental Impact Statement/

# Overseas Environmental Impact Statement

# Mariana Islands Training and Testing

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# 3.9 Fishes

## 3.9.1 Affected Environment

The purpose of this section is to supplement the analysis of impacts on fishes presented in the 2015 Mariana Islands Training and Testing (MITT) Final Environmental Impact Statement/ Overseas Environmental Impact Statement (EIS/OEIS) with new information relevant to proposed changes in training and testing activities conducted at sea and on Farallon de Medinilla. New information made available since the publication of the 2015 MITT Final EIS/OEIS is included below to better understand potential stressors and impacts on fishes resulting from training and testing activities. Comments received from the public during scoping related to fishes are addressed in Section 3.9.3 (Public Scoping Comments).

### 3.9.1.1 Hearing and Vocalization

A summary of fish hearing and vocalizations is described in the 2015 MITT Final EIS/OEIS. Due to the availability of new literature, including revised sound exposure criteria, the information provided below will supplement the 2015 MITT Final EIS/OEIS for fishes.

All fishes have two sensory systems that can detect sound in the water: the inner ear, which functions similarly to the inner ear in other vertebrates, and the lateral line, which consists of a series of receptors along the body of a fish (Popper, 2008). The lateral line system is sensitive to external particle motion arising from sources within a few body lengths of the animal. The lateral line detects particle motion at low frequencies from below 1 hertz (Hz) up to at least 400 Hz (Coombs & Montgomery, 1999; Hastings & Popper, 2005; Higgs & Radford, 2013; Webb et al., 2008). Generally, the inner ears of fish contain three dense otoliths (i.e., small calcareous bodies) that sit atop many delicate mechanoelectric hair cells within the inner ear of fishes, similar to the hair cells found in the mammalian ear. Sound waves in water tend to pass through the fish's body, which has a composition similar to water, and vibrate the otoliths. This causes a relative motion between the dense otoliths and the surrounding tissues, causing a deflection of the hair cells, which is sensed by the nervous system.

Although a propagating sound wave contains pressure and particle motion components, particle motion is most significant at low frequencies (up to at least 400 Hz) and is most detectible at high sound pressures or very close to a sound source. The inner ears of fishes are directly sensitive to acoustic particle motion rather than acoustic pressure (acoustic particle motion and acoustic pressure are discussed in Appendix H, Acoustic and Explosive Concepts). Historically, studies that have investigated hearing in, and effects to, fishes have been carried out with sound pressure metrics. Although particle motion may be the more relevant exposure metric for many fish species, there is little data available that actually measures it due to a lack in standard measurement methodology and experience with particle motion detectors (Hawkins et al., 2015; Martin et al., 2016). In these instances, particle motion can be estimated from pressure measurements (Nedelec et al., 2016a).

Some fishes possess additional morphological adaptations or specializations that can enhance their sensitivity to sound pressure, such as a gas-filled swim bladder (Astrup, 1999; Popper & Fay, 2010). The swim bladder can enhance sound detection by converting acoustic pressure into localized particle motion, which may then be detected by the inner ear (Radford et al., 2012). Fishes with a swim bladder generally have better sensitivity and can detect higher frequencies than fishes without a swim bladder (Popper & Fay, 2010; Popper et al., 2014). In addition, structures such as gas-filled bubbles near the ear or swim bladder, or even connections between the swim bladder and the inner ear, also increase sensitivity and allow for high-frequency hearing capabilities and better sound pressure detection.

Although many researchers have investigated hearing and vocalizations in fish species (Ladich & Fay, 2013; Popper et al., 2014), hearing capability data only exist for just over 100 of the currently known 34,000 marine and freshwater fish species (Eschmeyer & Fong, 2017). Therefore, fish hearing groups are defined by species that possess a similar continuum of anatomical features, which result in varying degrees of hearing sensitivity (Popper & Fay, 2010). Categories and descriptions of hearing sensitivities are further defined in this document (modified from Popper et al., 2014) as the following:

- Fishes without a swim bladder—hearing capabilities are limited to particle motion detection at frequencies well below 1 kilohertz (kHz).
- Fishes with a swim bladder not involved in hearing—species lack notable anatomical specializations and primarily detect particle motion at frequencies below 1 kHz.
- Fishes with a swim bladder involved in hearing—species can detect frequencies below 1 kHz and possess anatomical specializations to enhance hearing, and are capable of sound pressure detection up to a few kHz.
- Fishes with a swim bladder and high-frequency hearing—species can detect frequencies below 1 kHz and possess anatomical specializations, and are capable of sound pressure detection at frequencies up to 10 kHz to over 100 kHz.

Data suggest that most species of marine fish either lack a swim bladder (e.g., sharks and flatfishes) or have a swim bladder not involved in hearing and can only detect sounds below 1 kHz. Some marine fishes (clupeiforms) with a swim bladder involved in hearing are able to detect sounds to about 4 kHz (Colleye et al., 2016; Mann et al., 2001; Mann et al., 1997). One subfamily of clupeids (i.e., Alosinae) can detect high- and very high-frequency sounds (i.e., frequencies from 10 to 100 kHz, and frequencies above 100 kHz, respectively), although auditory thresholds at these higher frequencies are elevated and the range of best hearing is still in the low-frequency range (below 1 kHz) similar to other fishes. Mann et al. (1997; 1998) theorize that this subfamily may have evolved the ability to hear relatively high sound levels at these higher frequencies in order to detect echolocations of nearby foraging dolphins. For fishes that have not had their hearing tested, such as deep sea fishes, the suspected hearing capabilities are based on the structure of the ear, the relationship between the ear and the swim bladder, and other potential adaptations such as the presence of highly developed areas of the brain related to inner ear and lateral line functions (Buran et al., 2005; Deng et al., 2011, 2013). It is believed that most fishes have their best hearing sensitivity from 100 to 400 Hz (Popper, 2003).

Endangered Species Act (ESA)-listed species within the MITT Study Area include the scalloped hammerhead shark (*Sphyrna lewini*), the oceanic whitetip shark (*Carcharhinus longimanus*), and the giant manta ray (*Manta birostris*). As discussed above, most marine fishes investigated to date lack hearing capabilities greater than 1,000 Hz. Rays and sharks are cartilaginous fishes (i.e., elasmobranchs) lacking a swim bladder. Available data suggest these species can detect sounds from 20 to 1,000 Hz, with best sensitivity at lower ranges (Casper et al., 2003; Casper & Mann, 2006; Casper & Mann, 2009; Myrberg, 2001).

Some fishes are known to produce sound. Bony fishes can produce sounds in a number of ways and use them for a number of behavioral functions (Ladich, 2008, 2014). Over 30 families of fishes are known to use vocalizations in aggressive interactions, and over 20 families are known to use vocalizations in mating (Ladich, 2008). Sounds generated by fishes as a means of communication are generally 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, of the family sciaenidae, can produce drumming sounds ranging from 128 to 135 decibels (dB) referenced to 1 micropascal (dB re 1 µPa). Female midshipman fish apparently detect and locate the "hums" (approximately 90–400 Hz) of vocalizing males during the breeding season (McIver et al., 2014; Sisneros & Bass, 2003). Sciaenids produce a variety of sounds, including calls produced by males on breeding grounds (Ramcharitar et al., 2001), and a "drumming" call produced during chorusing that suggests a seasonal pattern to reproductive-related function (McCauley & Cato, 2000). Other sounds produced by chorusing reef fishes include "popping," "banging," and "trumpet" sounds; altogether, these choruses produce sound levels 35 dB above background levels, at peak frequencies between 250 and 1,200 Hz, and source levels between 144 and 157 dB re 1 µPa (McCauley & Cato, 2000).

Additional research using visual surveys (such as baited underwater video) and passive acoustic monitoring continue to reveal new sounds produced by fishes, both in the marine and freshwater environments, and allow for specific behaviors to be paired with those sounds (Radford et al., 2018; Rountree et al., 2018; Rowell et al., 2018).

#### 3.9.1.2 General Threats

A summary of the major threats to fish species within the Study Area is described in the 2015 MITT Final EIS/OEIS. Overfishing and associated factors, such as bycatch, fisheries-induced evolution, and intrinsic vulnerability to overfishing were described. Pollution, including the effect of oceanic circulation patterns scattering coastal pollution throughout the open ocean, was described. The effects of organic and inorganic pollutants to fishes, including bioaccumulation of pollutants, behavioral and physiological changes, or genetic damage, were described, as well as entanglement in abandoned commercial and recreational fishing gear. Other human-caused stressors on fishes described were the introduction of non-native species, climate change, aquaculture, energy production, vessel movement, and underwater noise. Neither the extent or any other threats have changed since it was last described in the 2015 MITT Final EIS/OEIS. Therefore, the information and analysis presented in the 2015 MITT Final EIS/OEIS remains valid.

#### 3.9.1.3 Endangered Species Act Species

The scalloped hammerhead shark (*Sphyrna lewini*), oceanic whitetip shark (*Carcharhinus longimanus*), and giant manta ray (*Manta birostris*) are the only ESA-listed fish species in the Study Area (Table 3.9-1). Two species of concern, the humphead wrasse (*Cheilinus undulates)* and bumphead parrotfish (*Bolbometopon muricatum*), also occur in the Study Area (Table 3.9-1). The National Marine Fisheries Service (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. All the species listed in Table 3.9-1 are declining because of impacts from fishing (including night spear fishing, bycatch, and illegal fishing activities) and habitat degradation.

**Table 3.9-1: Endangered Species Act Listed and Special Status Fish Species in the Mariana Islands Study Area**

| Species Name and Regulatory Status | | | Presence in Study Area | |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | **Endangered Species Act Status** | **Open Ocean/ Transit Corridor** | **Coastal Ocean** |
| Scalloped hammerhead shark (Indo-West Pacific Distinct Population Segment) | *Sphyrna lewini* | Threatened | Yes | Yes |
| Oceanic whitetip shark | *Carcharhinus longimanus* | Threatened | Yes | Yes |
| Giant manta ray | *Manta birostris* | Threatened | Yes | Yes |
| Humphead wrasse | *Cheilinus undulatus* | Species of Concern | No | Yes |
| Bumphead parrotfish | *Bolbometopon muricatum* | Species of Concern | No | Yes |

#### 3.9.1.3.1 Scalloped Hammerhead Shark (*Sphyrna lewini*)

A literature review found that the information on the scalloped hammerhead shark in the Study Area has not substantially changed from what is included in the 2015 MITT Final EIS/OEIS. Therefore, the information presented in the 2015 MITT Final EIS/OEIS remains valid.

##### 3.9.1.3.1.1 Status and Management

In 2013, NMFS determined that two distinct population segments, the Central and Southwest Atlantic and Indo-West Pacific, warrant listing as threatened. The Indo-West Pacific distinct population segment is the only one located within the Study Area. Following a review of recent literature, the status and management of this species has not changed since the publication of the 2015 MITT Final EIS/OEIS. As such, the information and analysis presented in the 2015 MITT Final EIS/OEIS remains valid. No critical habitat has been designated for this species.

##### 3.9.1.3.1.2 Habitat and Geographic Range

The habitat and geographic range of scalloped hammerhead sharks is described in the 2015 MITT Final EIS/OEIS. Following a review of recent literature, information related to habitat and the geographic range of this species has not changed since the publication of the 2015 MITT Final EIS/OEIS. As such, the information and analysis presented in the 2015 MITT Final EIS/OEIS remains valid.

##### 3.9.1.3.1.3 Population and Abundance

As indicated in the 2015 MITT Final EIS/OEIS, information on population and abundance of scalloped hammerhead sharks is limited. Following a review of recent literature, information related to population and abundance estimates for this species has not changed since the publication of the 2015 MITT Final EIS/OEIS. As such, the information and analysis presented in the 2015 MITT Final EIS/OEIS remains valid.

#### 3.9.1.3.1.4 Predator and Prey Interactions

A new study by Brown et al. (2016) found that juvenile scalloped hammerhead sharks in the Rewa River estuary on Fiji consumed primarily estuarine and marine prawns, stomatopoda (mantis shrimps), estuarine eels, and various bony fish, with prawns being found in half of the stomachs sampled, which is consistent with other available information. However, this new information does not appreciably change the information and analysis that was presented in the 2015 MITT Final EIS/OEIS.

#### 3.9.1.3.1.5 Species-Specific Threats

Primary threats to scalloped hammerhead sharks are from direct take, especially by the foreign commercial shark fin fishery (National Marine Fisheries Service, 2011), as described in the 2015 MITT Final EIS/OEIS. Following a review of recent literature, information on threats to this species has not changed since the publication of the 2015 MITT Final EIS/OEIS. As such, the information and analysis presented in the 2015 MITT Final EIS/OEIS remains valid.

### 3.9.1.3.2 Oceanic Whitetip Shark (*Carcharhinus longimanus*)

#### 3.9.1.3.2.1 Status and Management

Since the publication of the 2015 MITT Final EIS/OEIS, NMFS proposed on December 29, 2016 to list the oceanic whitetip shark as a threatened species under the ESA (81 Federal Register [FR] 96304). On January 30, 2018, NMFS published the Final Rule listing this species as threatened and concluded that critical habitat is not determinable because data sufficient to perform the required analyses are lacking (83 FR 4153). Because this species was proposed as threatened, and subsequently listed as threatened under the ESA after the publication of the 2015 MITT Final EIS/OEIS, the impact analysis included in Section 3.9.2 (Environmental Consequences) is new.

#### 3.9.1.3.2.2 Habitat and Geographic Range

Oceanic whitetip sharks are found worldwide in warm tropical and subtropical waters between 30° North and 35° South latitude near the surface of the water column (Young et al., 2016). Oceanic whitetips occur throughout the Central Pacific. This species has a clear preference for open ocean waters, with abundances decreasing with greater proximity to continental shelves. Preferring warm waters near or over 20°Celsius (68°Fahrenheit), and offshore areas, the oceanic whitetip shark is known to undertake seasonal movements to higher latitudes in the summer (National Oceanic and Atmospheric Administration, 2016a) and may regularly survey extreme environments (deep depths, low temperatures) as a foraging strategy (Young et al., 2016).

#### 3.9.1.3.2.3 Population and Abundance

Population trend information is not clear or available. Information shows that the population has declined and there is evidence of decreasing average weights of the sharks. Unstandardized nominal catch data from the Inter-American Tropical Tuna Commission in the eastern Pacific tropical tuna purse seine fisheries show trends of decreasing catch (Inter-American Tropical Tuna Commission, 2015). In addition, Rice & Harvey (2012) found catch, catch per unit effort, and size composition data for oceanic whitetip sharks in the western and central Pacific all show consistent declines.

#### 3.9.1.3.2.4 Predator and Prey Interactions

Oceanic whitetip sharks are large, often reaching a maximum length of 345 centimeters (cm) (Ebert et al., 2015), can live up to nine years (Joung et al., 2016), and are one of the major apex predators in the tropical open ocean waters. This species feeds on fishes, stingrays, sea turtles, birds, and cephalopods, and has no known predators.

#### 3.9.1.3.2.5 Species-Specific Threats

Threats include pelagic longline and drift net fisheries bycatch, targeted fisheries (for the shark fin trade), and destruction or modification of its habitat and range (Baum et al., 2015; Defenders of Wildlife, 2015a). Legal and illegal fishing activities have caused significant population declines for the oceanic whitetip shark caught as bycatch in tuna and swordfish longlines throughout its range.

### 3.9.1.3.3 Giant Manta Ray (*Manta birostris*)

#### 3.9.1.3.3.1 Status and Management

Since the publication of the 2015 MITT Final EIS/OEIS, NMFS proposed on January 12, 2017 to list the giant manta ray as a threatened species under ESA (82 FR 3694). Based on the best scientific and commercial information available, including the status review report (Miller & Klimovich, 2016), and after taking into account efforts being made to protect these species, NMFS determined that the giant manta ray is likely to become an endangered species within the foreseeable future throughout a significant portion of its range. On January 22, 2018, NMFS published the Final Rule listing this species as threatened and concluded that critical habitat was not determinable because data sufficient to perform the required analyses are lacking (83 FR 2916). Because this species was proposed as threatened and subsequently listed as threatened under the ESA after the publication of the 2015 MITT Final EIS/OEIS, the impact analysis presented below in Section 3.9.2 (Environmental Consequences) is new.

#### 3.9.1.3.3.2 Habitat and Geographic Range

Giant manta rays are visitors to productive coastlines with regular upwelling, including oceanic island shores, and offshore pinnacles and seamounts. They utilize sandy bottom habitat and seagrass beds, as well as shallow reefs, and the ocean surface both inshore and offshore. The species ranges globally and is distributed in tropical, subtropical, and temperate waters. They migrate seasonally usually more than 1,000 kilometers (km) (621.4 miles), however not likely across ocean basins (National Oceanic and Atmospheric Administration, 2016b).

#### 3.9.1.3.3.3 Population and Abundance

No stock assessments exist for the giant manta ray. Most estimates of subpopulations are based on anecdotal observations by divers and fishermen, with current populations estimated between 100 and 1,500 individuals (Miller & Klimovich, 2016). In general, giant manta ray populations have declined, except in areas where they are specifically protected, such as the Hawaiian Islands (National Oceanic and Atmospheric Administration, 2016b). Giant manta rays reach maturity at age 10 and have one pup every two to three years (National Oceanic and Atmospheric Administration, 2016b).

#### 3.9.1.3.3.4 Predator and Prey Interactions

Manta rays prey exclusively on plankton (Defenders of Wildlife, 2015b). The gill plates of the giant manta ray filters the water as they swim, straining out any plankton that is larger than a grain of sand (Defenders of Wildlife, 2015b).

#### 3.9.1.3.3.5 Species-Specific Threats

Threats to giant manta rays include fisheries and bycatch, destruction or modification of habitat, and disease and predation. The international market highly values the gill plates of the giant manta ray for use in traditional medicines. They also trade their cartilage and skins and consume the manta ray meat or use it for local bait. Bycatch occurs in purse seine, gillnet, and trawl fisheries as well (National Oceanic and Atmospheric Administration, 2016b). Fisheries exist outside the Study Area in Indonesia, Sri Lanka, India, Peru, Mexico, China, Mozambique, and Ghana (Food and Agriculture Organization of the United Nations, 2013). Other potential threats include degradation of coral reefs, interaction with marine debris, marine pollution, and boat strikes (Food and Agriculture Organization of the United Nations, 2013).

### 3.9.1.4 Federally Managed Species

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) (see Section 3.0.1.1, Federal Statutes, in the 2015 MITT Final EIS/OEIS) established eight fishery management councils that share authority with NMFS to manage and conserve the fisheries in federal waters. 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. Sections 3.3 (Marine Habitats), 3.7 (Marine Vegetation), and 3.8 (Marine Invertebrates) analyze impacts on habitats within the Study Area.

The Mariana Archipelago Fishery Ecosystem Plan (FEP), which includes fishery management measures for Guam and the Commonwealth of the Northern Mariana Islands, was approved in 2009 and codified in 2010. The Western Pacific Regional Fishery Management Council is currently working on an update to the FEP (Western Pacific Regional Fishery Management Council, 2016). Federally managed fish species listed in the 2015 MITT Final EIS/OEIS and in Table 3.9-2 have not changed since the publication of the EIS/OEIS and the information and analysis presented in the 2015 MITT Final EIS/OEIS remains valid.

The 2015 NMFS stock assessment report for the bottomfish fishery in Guam and the Commonwealth of the Northern Mariana Islands (CNMI) concluded that the fishery was not overfished through 2013, and modeled projections predicted that the fishery was very unlikely to become overfished by 2017 (Yau et al., 2016). However, coral reef fisheries, which support most traditional fishing in the Study Area, have declined over the past 30 years (Weijerman et al., 2016). However, the catch from the non-commercial reef fish fishery in the CNMI, which supports most traditional fishing, has historically been underestimated, yet has clearly been in decline since the late 1970s (Cuetos-Bueno & Houk, 2014). Detailed information on overfished stocks is presented in Section 3.12.1.2 (Commercial and Recreational Fishing).

**Table 3.9-2: Federally Managed Fish Species within the Mariana Islands Study Area for Each Fishery Management Unit in the FEP**

| 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* |
| 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* |

**Table 3.9-2: Federally Managed Fish Species within the Mariana Islands Study Area for Each Fishery Management Unit in the FEP (continued)**

| **Western Pacific Regional Fishery Management Council** | |
|---|---|
| **Marianas Coral Reef Ecosystem Management Unit (continued)** | |
| **Common Name** | **Scientific Name** |
| 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* |
| Mackerel scad | *Decapterus macarellus* |
| Mimic surgeonfish | *Acanthurus pyroferus* |
| Multi-barred goatfish | *Parupeneus multifaciatus* |
| Napoleon wrasse | *Cheilinus undulates* |

**Table 3.9-2: Federally Managed Fish Species within the Mariana Islands Study Area for Each Fishery Management Unit in the FEP (continued)**

| Western Pacific Regional Fishery Management Council | |
|---|---|
| **Marianas Coral Reef Ecosystem Management Unit (continued)** | |
| **Common Name** | **Scientific Name** |
| 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 3.9-2: Federally Managed Fish Species within the Mariana Islands Study Area for Each Fishery Management Unit in the FEP (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* |
| Yellowmargin 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 | *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* |

#### 3.9.1.5 Taxonomic Group Descriptions

A literature review found that the information on the taxonomic groups of fishes in the Study Area has not substantially changed from what is included in the 2015 MITT Final EIS/OEIS. Therefore, the information presented in the 2015 MITT Final EIS/OEIS remains valid.

### 3.9.2 Environmental Consequences

In the Proposed Action for this Supplemental EIS (SEIS)/OEIS, there have been some modifications to the quantity and type of acoustic and explosive stressors under the two action alternatives. There are also additional species listed under the ESA that are considered. In addition, within the stressor framework presented in the 2015 MITT Final EIS/OEIS, high-energy lasers are being analyzed as a new energy stressor, as detailed in Section 3.0.4.3.2.2 (High-Energy Lasers).

The 2015 MITT Final EIS/OEIS considered training and testing activities that currently occur in the Study Area and considered all potential stressors related to fishes. The potential impacts on fishes in the Study Area from Navy training and testing activities is presented in detail for ESA-listed and federally managed species, as well as generally for taxonomic groups.

The stressors vary in intensity, frequency, duration, and location within the Study Area. The stressors applicable to fishes in the Study Area are the same stressors analyzed in the 2015 MITT Final EIS/OEIS and include:

- **Acoustic** (sonar and other transducers, vessel noise, aircraft noise, and weapon noise)
- **Explosives** (in-air explosions and in-water explosions)
- **Energy** (in-water electromagnetic devices and high-energy lasers)
- **Physical disturbance and strikes** (vessels, in-water devices, military expended materials, and seafloor devices)
- **Entanglement** (wires and cables, decelerators/parachutes)
- **Ingestion** (military expended materials – munitions, military expended materials other than munitions)
- **Secondary** (impacts associated with sediments and water quality)

This section evaluates how and to what degree potential impacts on fishes from stressors described in Section 3.0 (Introduction) may have changed since the analysis presented in the 2015 MITT Final EIS/OEIS was completed. Table 2.5-1 and Table 2.5-2 in Chapter 2 (Description of Proposed Action and Alternatives) list the proposed training and testing activities and include the number of times each activity would be conducted annually and the locations within the Study Area where the activity would typically occur under each alternative. The tables also present the same information for activities described in the 2015 MITT Final EIS/OEIS so that the proposed levels of training and testing under this SEIS/OEIS can be easily compared.

The Navy conducted a review of federal and state regulations and standards relevant to fishes and reviewed scientific literature published since 2015 for new information on fishes that could update the analysis presented in the 2015 MITT Final EIS/OEIS. The analysis presented in this section also considers standard operating procedures, which are discussed in Section 2.3.3 (Standard Operating Procedures) of this SEIS/OEIS, and mitigation measures that are described in Chapter 5 (Mitigation). The Navy would implement these measures to avoid or reduce potential impacts on fishes from stressors associated with the proposed training and testing activities. Mitigation for ESA-listed fishes will be coordinated with NMFS through the ESA consultation process.

#### 3.9.2.1 Acoustic Stressors

The analysis of effects to fishes follows the concepts outlined in Section 3.0.4.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities). This section begins with a summary of relevant data regarding acoustic impacts on fishes in Section 3.9.2.1.1 (Background). This is followed by an analysis of estimated impacts on fishes due to specific Navy acoustic stressors (sonar and other transducers, vessel noise, aircraft noise, and weapon noise). Additional explanations of the acoustic terms and sound energy concepts used in this section are found in Appendix H (Acoustic and Explosive Concepts).

The Navy will rely on the 2015 MITT Final EIS/OEIS analysis for the analysis of vessel noise and weapon noise, as there has been no substantive or otherwise meaningful change in the action, although new applicable and emergent science in regard to these sub-stressors is presented in the sections that follow. Due to available new literature, adjusted sound exposure criteria, and new acoustic effects modeling, the analysis provided in Section 3.9.2.1.2 (Impacts from Sonar and Other Transducers) and Section 3.9.2.1.4 (Impacts from Aircraft Noise) of this SEIS/OEIS supplants the 2015 MITT Final EIS/OEIS for fishes, and changes estimated impacts for some species since the 2015 MITT Final EIS/OEIS.

##### 3.9.2.1.1 Background

Effects of human-generated sound on fishes have been examined in numerous publications (Hastings & Popper, 2005; Hawkins et al., 2015; Lindseth & Lobel, 2018; Mann, 2016; National Research Council, 1994, 2003; Neenan et al., 2016; Popper et al., 2004; Popper, 2003, 2008; Popper & Hastings, 2009b; Popper et al., 2014; Popper et al., 2016; Popper & Hawkins, 2018). The potential impacts from Navy activities are based on the analysis of available literature related to each type of effect. In addition, a Working Group organized under the American National Standards Institute-Accredited Standards Committee S3, Subcommittee 1, Animal Bioacoustics, developed sound exposure guidelines for fish and sea turtles (Popper et al., 2014), hereafter referred to as the *ANSI Sound Exposure Guideline* technical report. Where applicable, thresholds and relative risk factors presented in the *ANSI Sound Exposure Guideline* technical report were used to assist in the analysis of effects on fishes from Navy activities.

There are limited studies of fish responses to aircraft and weapon noise. Based on the general characteristics of these sound types, for stressors where data is lacking (such as aircraft noise), studies of the effects of similar non-impulsive/continuous noise sources (such as sonar or vessel noise) are used to inform the analysis of fish responses. Similarly, studies of the effects from impulsive sources (such as air guns or pile driving) are used to inform fish responses to other impulsive sources (such as weapon noise). Where data from sonar and vessel noise exposures are also limited, other non-impulsive sources such as white noise may be presented as a proxy source to better understand potential reactions from fish. Additional information on the acoustic characteristics of these sources can be found in Appendix H (Acoustic and Explosive Concepts).

###### 3.9.2.1.1.1 Injury

Injury refers to the direct effects on the tissues or organs of a fish. Moderate- to low-level noise from vessels, aircraft, and weapons use are described in Section 3.0.4.1 (Acoustic Stressors) and lacks the amplitude and energy to cause any direct injury. Section 3.0.4.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities) provides additional information on injury and the framework used to analyze this potential impact.

**Injury Due to Impulsive Sound Sources**

Impulsive sounds, such as those produced by seismic air guns and impact pile driving, may cause injury or mortality in fishes. Mortality and potential damage to the cells of the lateral line have been observed in fish larvae, fry, and embryos after exposure to single shots from a seismic air gun within close proximity to the sound source (0.1 to 6 meters [m]) (Booman et al., 1996; Cox et al., 2012). However, exposure of adult fish to a single shot from an air gun array (four air guns) within similar ranges (6 m), has not resulted in any signs of mortality within seven days after exposure (Popper et al., 2016). Although injuries occurred in adult fishes, they were similar to injuries seen in control subjects (i.e., fishes that were not exposed to the air gun) so there is little evidence that the air gun exposure solely contributed to the observed effects.

Injuries, such as ruptured swim bladders, hematomas, and hemorrhaging of other gas-filled organs, have been reported in fish exposed to a large number of simulated impact pile driving strikes with cumulative sound exposure levels up to 219 decibels referenced to 1 micropascal squared seconds (dB re 1 $\mu Pa^2$-s) under highly controlled settings where fish were unable to avoid the source (Casper et al., 2012b; Casper et al., 2013a; Casper et al., 2013b; Halvorsen et al., 2011; Halvorsen et al., 2012a; Halvorsen et al., 2012b). However, it is important to note that these studies exposed fish to 900 or more strikes as the studies goal was largely to evaluate the equal energy hypothesis, which suggests that the effects of a large single pulse of energy is equivalent to the effects of energy received from many smaller pulses (as discussed in Smith & Gilley, 2008). Halvorsen et al. (2011) and Casper et al. (2017) found that the equal energy hypothesis does not apply to effects of pile driving; rather, metrics relevant to injury could include, but not be limited to, cumulative sound exposure level, single strike sound exposure level, and number of strikes (Halvorsen et al., 2011). Furthermore, Casper et al. (2017) found the amount of energy in each pile strike and the number of strikes determines the severity of the exposure and the injuries that may be observed. For example, hybrid striped bass (white bass *Morone chrysops* x striped bass *Morone saxaltilis*) exposed to fewer strikes with higher single strike sound exposure values resulted in a higher number of, and more severe, injuries than bass exposed to an equivalent cumulative sound exposure level that contained more strikes with lower single strike sound exposure values. This is important to consider when comparing data from pile driving studies to potential effects from an explosion. Although single strike peak sound pressure levels were measured during these experiments (at average levels of 207 dB re 1 µPa), the injuries were only observed during exposures to multiple strikes, therefore, it is anticipated that a peak value much higher than the measured values would be required to lead to injury in fishes exposed to a single strike, or, for comparison, to a single explosion.

These studies included species both with and without swim bladders. The majority of fish that exhibited injuries were those with swim bladders. Lake sturgeon (*Acipenser fulyescens*), a physostomous fish, was found to be less susceptible to injury from impulsive sources than Nile tilapia (*Oreochromis niloticus*) or hybrid striped bass, physoclistous fishes (Casper et al., 2017; Halvorsen et al., 2012a). As reported by Halvorsen et al. (2012a), the difference in results is likely due to the type of swim bladder in each fish. Physostomous fishes have an open duct connecting the swim bladder to their esophagus and may be able to quickly adjust the amount of gas in their body by gulping or releasing air. Physoclistous fishes do not have this duct; instead, gas pressure in the swim bladder is regulated by special tissues or glands. There were no mortalities reported during these experiments, and in the studies where recovery was observed, the majority of exposure related injuries healed within a few days in a laboratory setting. In many of these controlled studies, neutral buoyancy was determined in the fishes prior to exposure to the simulated pile driving. However, fishes with similar physiology to those described in these studies that are exposed to actual pile driving activities may show varying levels of injury depending on their state of buoyancy.

Debusschere et al. (2014) largely confirmed the results discussed in the paragraph above with caged juvenile European sea bass (*Dicentrarchus labrax*) exposed to actual pile driving operations. No differences in mortality were found between control and experimental groups at similar levels tested in the experiments described in the paragraph above (sound exposure levels up to 215–222 dB re 1 $\mu Pa^2$-s), and many of the same types of injuries occurred. Fishes with injuries from impulsive sources such as these may not survive in the wild due to harsher conditions and risk of predation.

Other potential effects from exposure to impulsive sound sources include potential bubble formation and neurotrauma. It is speculated that high sound pressure levels may also cause bubbles to form from micronuclei in the blood stream or other tissues of animals, possibly causing embolism damage (Hastings & Popper, 2005). Fishes 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 take place in the eyes of fish due to potentially high gas saturation within the eye tissues (Popper & Hastings, 2009b). Additional research is necessary to verify if these speculations apply to exposures to non-impulsive sources such as sonars. These phenomena have not been well studied in fishes and are difficult to recreate under real-world conditions.

As summarized in the *ANSI Sound Exposure Guideli*ne technical report (Popper et al., 2014), exposure to high intensity and long duration impact pile driving or air gun shots did not cause mortality, and fishes typically recovered from injuries in controlled laboratory settings. Species tested to date can be used as viable surrogates for investigating injury in other species exposed to similar sources (Popper et al., 2014).

**Injury due to Sonar and Other Transducers**

Non-impulsive sound sources (e.g., sonar, acoustic modems, and sonobuoys) have not been known to cause direct injury or mortality to fish under conditions that would be found in the wild (Halvorsen et al., 2012a; Kane et al., 2010; Popper et al., 2007). Potential direct injuries (e.g., barotrauma, hemorrhage or rupture of organs or tissue) from non-impulsive sound sources, such as sonar, are unlikely because of slow rise times,[1] lack of a strong shock wave such as that associated with an explosive, and relatively low peak pressures. General categories and characteristics of Navy sonar systems are described in Section 3.0.4.1.1 (Sonar and Other Transducers).

The effects of mid-frequency sonar-like signals (1.5–6.5 kHz) on larval and juvenile Atlantic herring (*Clupea harengus*), Atlantic cod (*Gadus morhura*), saithe (*Pollachius virens*), and spotted wolffish (*Anarhichas minor*) were examined by Jørgensen et al. (2005). Researchers investigated potential effects on survival, development, and behavior in this study. Among fish kept in tanks and observed for one to four weeks after sound exposure, no significant differences in mortality or growth-related parameters between exposed and unexposed groups were observed. Examination of organs and tissues from selected herring experiments did not reveal obvious differences between unexposed and exposed

[1] Rise time: the amount of time for a signal to change from static pressure (the ambient pressure without the added sound) to high pressure. Rise times for non-impulsive sound typically have relatively gradual increases in pressure, while impulsive sound has near-instantaneous rise to a high peak pressure. For more detail, see Appendix H (Acoustic and Explosive Concepts).

groups. However, two (out of 42) of the herring groups exposed to sound pressure levels of 189 dB re 1 µPa and 179 dB re 1 µPa had a post-exposure mortality of 19 and 30 percent, respectively. It is not clear if this increased mortality was due to the received level or to other unknown factors, such as exposure to the resonance frequency of the swim bladder. Jørgensen et al. (2005) estimated a resonant frequency of 1.8 kHz for herring and saithe ranging in size from 6.3 to 7.0 cm, respectively, which lies within the range of frequencies used during sound exposures and therefore may explain some of the noted mortalities.

Individual juvenile fish with a swim bladder resonance in the frequency range of the operational sonars may be more susceptible to injury or mortality. Past research has demonstrated that fish species, size, and depth influences resonant frequency (Løvik & Hovem, 1979; McCartney & Stubbs, 1971). At resonance, the swim bladder, which can amplify vibrations that reach the fishes hearing organs, may absorb much of the acoustic energy in the impinging sound wave. It is suspected that the resulting oscillations may cause mortality, harm the auditory organs or the swim bladder (Jørgensen et al., 2005; Kvadsheim & Sevaldsen, 2005). However, damage to the swim bladder and to tissues surrounding the swim bladder was not observed in fishes exposed to sonar at their presumed swim bladder resonant frequency (Jørgensen et al., 2005). The physiological effect of sonars on adult fish is expected to be less than for juvenile fish because adult fish are in a more robust stage of development, the swim bladder resonant frequencies would be lower than that of mid-frequency active sonar, and adult fish have more ability to move from an unpleasant stimulus (Kvadsheim & Sevaldsen, 2005). Lower frequencies (i.e., generally below 1 kHz) are expected to produce swim bladder resonance in adult fishes from about 10 to 100 cm (McCartney & Stubbs, 1971). Fish, especially larval and small juveniles, are more susceptible to injury from swim bladder resonance when exposed to continuous signals within the resonant frequency range.

Hastings (1995) found “acoustic stunning” (loss of consciousness) in blue gouramis (*Trichogaster trichopterus*), a freshwater species, following an eight-minute continuous exposure to a 150 Hz pure tone with a 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 (1991) also found that goldfish (*Carassius auratus*), also a freshwater species, exposed to a 250 Hz continuous wave sound with peak pressures of 204 dB re 1 µPa for two hours, and blue gourami exposed to a 150 Hz continuous wave sound at a sound pressure level of 198 dB re 1 µPa for 0.5 hours did not survive. These studies are examples of the highest-known levels tested on fish and for relatively long durations. Stunning and mortality due to exposure to non-impulsive sound exposure has not been observed in other studies.

Three freshwater species of fish, the rainbow trout (*Oncorhynchus mykiss*), channel catfish (*Ictalurus punctatus*), and the hybrid sunfish (*Lepomis* sp.), were exposed to both low- and mid-frequency sonar (Kane et al., 2010; Popper et al., 2007). Low-frequency exposures with received sound pressure levels of 193 dB re 1 µPa occurred for either 324 or 648 seconds. Mid-frequency exposures with received sound pressure levels of 210 dB re 1 µPa occurred for 15 seconds. No fish mortality resulted from either experiment, and during necropsy after test exposures, both studies found that none of the subjects showed signs of tissue damage related to exposure (Kane et al., 2010; Popper et al., 2007).

As summarized in the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014), although fish have been injured and killed due to intense, long-duration non-impulsive sound exposures, fish exposed under more realistic conditions have shown no signs of injury. Those species tested to date can be used as viable surrogates for estimating injury in other species exposed to similar sources.

#### 3.9.2.1.1.2 Hearing Loss

Researchers have examined the effects on hearing in fishes from sonar-like signals, tones, and different non-impulsive noise sources. Section 3.0.4.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities) provides additional information on hearing loss and the framework used to analyze this potential impact.

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, permanent loss of hair cells, or damage to auditory nerve fibers (Liberman, 2016), and can occur over a small range of frequencies related to the sound exposure. However, the sensory hair cells of the inner ear in fishes are regularly replaced over time when they are damaged, unlike in mammals where sensory hair cells loss is permanent (Lombarte et al., 1993; Popper et al., 2014; Smith et al., 2006). Consequently, PTS has not been known to occur in fishes, and 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 (Popper et al., 2005; Popper et al., 2014; Smith et al., 2006). Although available data for some terrestrial mammals have shown signs of nerve damage after severe threshold shifts (e.g., Kujawa & Liberman, 2009; Lin et al., 2011), it is not known if damage to auditory nerve fibers could also occur in fishes and whether fibers would recover during this process. 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.

**Hearing Loss due to Impulsive Sound Sources**

Popper et al. (2005) examined the effects of a seismic air gun array on a fish with a swim bladder that is involved in hearing, the lake chub (*Couesius plumbeus*), and two species that have a swim bladder that is not involved in hearing, the northern pike (*Esox lucius*) and the broad whitefish (*Coregonus nasus*), a salmonid. In this study, the lowest received cumulative sound exposure level (5 shots with a mean sound pressure level of 177 dB re 1 µPa) at which effects were noted was 186 dB re 1 $\mu Pa^2$-s. The results showed temporary hearing loss for both lake chub and northern pike to both 5 and 20 air gun shots, but not for the broad whitefish. Hearing loss was approximately 20 to 25 dB at some frequencies for both species, and full recovery of hearing took place within 18 hours after sound exposure. Examination of the sensory surfaces of the ears after allotted recovery times (one hour for five shot exposures, and up to 18 hours for 20 shot exposures) showed no damage to sensory hair cells in any of the fish from these exposures (Song et al., 2008).

McCauley et al. (2003) and McCauley and Kent (2012) showed loss of a small percent of sensory hair cells in the inner ear of caged fish exposed to a towed air gun array simulating a passing seismic vessel. Pink snapper (*Pargus auratus*), a species that has a swim bladder that is not involved in hearing, were exposed to multiple air gun shots for up to 1.5 hours (McCauley et al., 2003) where the maximum received sound exposure levels exceeded 180 dB re 1 $\mu Pa^2$-s. 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. Gold band snapper (*Pristipomoides multidens*) and sea perch (*Lutjanis kasmira*), both fishes with a swim bladder involved in hearing, were also exposed to a towed air gun array simulating a passing seismic vessel (McCauley & Kent, 2012). Although received levels for these exposures have not been published, hair cell damage increased as the range of the exposure (i.e., range to the source) decreased. Again, the amount of damage was considered small in each case (McCauley & Kent, 2012). 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 and only a small portion were affected by the sound (Lombarte & Popper, 1994; Popper & Hoxter, 1984). The question remains as to why McCauley and Kent (2012) found damage to sensory hair cells while Popper et al. (2005) did not; however, there are many differences between the studies, including species and the precise sound source characteristics.

Hastings et al. (2008) exposed a fish with a swim bladder that is involved in hearing, the pinecone soldierfish (*Myripristis murdjan*), and three species that have a swim bladder that is not involved in hearing, the blue green damselfish (*Chromis viridis*), the saber squirrelfish (*Sargocentron spiniferum*), and the bluestripe seaperch (*Lutjanus kasmira*), to an air gun array. Fish in cages were exposed to multiple air gun shots with a cumulative sound exposure level of 190 dB re 1 $\mu Pa^2$-s. The authors found no hearing loss in any fish examined up to 12 hours after the exposures.

In an investigation of another impulsive source, Casper et al. (2013b) found that some fishes may actually be more susceptible to barotrauma (e.g., swim bladder ruptures, herniations, and hematomas) than hearing effects when exposed to simulated impact pile driving. Hybrid striped bass (white bass [*Morone chrysops*] x striped bass [*Morone saxatilis*]) and Mozambique tilapia (*Oreochromis mossambicus*), two species with a swim bladder not involved in hearing, were exposed to sound exposure levels between 213 and 216 dB re 1 $\mu Pa^2$-s. The subjects exhibited barotrauma, and although researchers began to observe signs of inner ear hair cell loss, these effects were small compared to the other non-auditory injuries incurred. Researchers speculated that injury might occur prior to signs of hearing loss or TTS. These sound exposure levels may present the lowest threshold at which hearing effects may begin to occur. Overall, PTS has not been known to occur in fishes tested to date. 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 (Popper et al., 2005; Popper et al., 2014; Smith et al., 2006). The lowest sound exposure level at which TTS has been observed in fishes with a swim bladder involved in hearing is 186 dB re 1 $\mu Pa^2$-s. As reviewed in the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014), fishes without a swim bladder, or fishes with a swim bladder that is not involved in hearing, would be less susceptible to hearing loss (i.e., TTS) than fishes with swim bladders involved in hearing, even at higher levels and longer durations.

**<u>Hearing Loss due to Sonar and Other Transducers</u>**

Several studies have examined the effects of the sound exposures from low-frequency sonar on fish hearing (i.e., Halvorsen et al., 2013; Kane et al., 2010; Popper et al., 2007). Hearing was measured both immediately post exposure and for up to several days thereafter (Halvorsen et al., 2013; Kane et al., 2010; Popper et al., 2007). Maximum received sound pressure levels were 193 dB re 1 μPa for 324 or 648 seconds (a cumulative sound exposure level of 218 or 220 dB re 1 $\mu Pa^2$-s, respectively) at frequencies ranging from 170 to 320 Hz (Kane et al., 2010; Popper et al., 2007), and 195 dB re 1 μPa for 324 seconds (a cumulative sound exposure level of 215 dB re 1 $\mu Pa^2$-s) in a follow-on study (Halvorsen et al., 2013). Two species with a swim bladder not involved in hearing, the largemouth bass (*Micropterus salmoides*) and yellow perch (*Perca flavescens*), showed no loss in hearing sensitivity from sound exposure immediately after the test or 24 hours later. Channel catfish, a fish with a swim bladder involved in hearing, and some specimens of rainbow trout, a fish with a swim bladder not involved in hearing, showed a threshold shift (up to 10–20 dB of hearing loss) immediately after exposure to the low-frequency sonar when compared to baseline and control animals. Small thresholds shifts were detected for up to 24 hours after the experiment in some channel catfish. Although some rainbow trout showed signs of hearing loss, another group showed no hearing loss. The different results between rainbow trout test groups are difficult to understand, but may be due to development 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 sonar. Examination of the inner ears of the fish during necropsy revealed no differences from the control groups in ciliary bundles or other features indicative of hearing loss. The maximum time fish were held post exposure before sacrifice was 96 hours (Kane et al., 2010).

The same investigators examined the potential effects of mid-frequency active sonar on fish hearing and the inner ear (Halvorsen et al., 2012c; Kane et al., 2010). The maximum received sound pressure level was 210 dB re 1 µPa at a frequency of 2.8 to 3.8 kHz for a total duration of 15 seconds (cumulative sound exposure level of 220 dB re 1 $\mu Pa^2$-s). Out of the species tested (rainbow trout and channel catfish), only one test group of channel catfish showed any hearing loss after exposure to mid-frequency active sonar. The investigators tested catfish during two different seasons and found that the group tested in October experienced TTS, which recovered within 24 hours, but fish tested in December showed no effect. It was speculated that the difference in hearing loss between catfish groups might have been due to the difference in water temperature during the testing period or due to differences between the two stocks of fish (Halvorsen et al., 2012c). Any effects on hearing in channel catfish due to sound exposure appeared to be short-term and non-permanent (Halvorsen et al., 2012c; Kane et al., 2010).

Some studies have suggested that there may be some loss of sensory hair cells due to high-intensity sources, indicating a loss in hearing sensitivity; however, none of those studies concurrently investigated the subjects' actual hearing range after exposure to these sources. Enger (1981) found loss of ciliary bundles of the sensory cells in the inner ears of Atlantic cod following one to five 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 goldfish, a freshwater species with a swim bladder that is involved in hearing. Goldfish were exposed to 250 Hz and 500 Hz continuous tones with maximum peak sound pressure 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*) observed one to four days following a one-hour exposure to a pure tone at 300 Hz with a sound pressure level of 180 dB re 1 µPa, but no damage to the lateral line was observed. Both studies found a relatively small percentage of total hair cell loss from hearing organs despite long duration exposures. Effects from long-duration noise exposure studies are generally informative; however, they are not necessarily a direct comparison to intermittent short-duration sounds generated during Navy activities involving sonar and other transducers.

As noted in the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014), some fish species with a swim bladder that is involved in hearing may be more susceptible to TTS from high-intensity non-impulsive sound sources, such as sonar and other transducers, depending on the duration and frequency content of the exposure. Fishes with a swim bladder involved in hearing and fishes with high-frequency hearing may exhibit TTS from exposure to low- and mid-frequency sonar, specifically at cumulative sound exposure levels above 215 dB re 1 $\mu Pa^2$-s. Fishes without a swim bladder and fishes with a swim bladder that is not involved in hearing would be unlikely to detect mid-frequency or other higher-frequency sonars and would likely require a much higher sound exposure level to exhibit the same effect from exposure to low-frequency active sonar.

**Hearing Loss due to Vessel Noise**

Little data exist on the effects of vessel noise on hearing in fishes. However, TTS has been observed in fishes exposed to elevated background noise and other non-impulsive sources (e.g., white noise). Caged studies on pressure-sensitive fishes (i.e., fishes with a swim bladder involved in hearing and those with high-frequency hearing) show some hearing loss after several days or weeks of exposure to increased background sounds, although the hearing loss seems to recover (e.g., Scholik & Yan, 2002a; Smith et al., 2004b; Smith et al., 2006). Smith et al. (2004b; 2006) exposed goldfish, to noise with a sound pressure level of 170 dB re 1 µPa and found a clear relationship between the amount of hearing loss and the duration of exposure until maximum hearing loss occurred at about 24 hours of exposure. A 10-minute exposure resulted in 5 dB of TTS, whereas a three-week exposure resulted in a 28 dB TTS that took over two weeks to return to pre-exposure baseline levels (Smith et al., 2004b). Recovery times were not measured by investigators for shorter exposure durations. It is important to note that these exposures were continuous and subjects were unable to avoid the sound source for the duration of the experiment.

Scholik and Yan (2001) demonstrated TTS in fathead minnows (*Pimephales promelas*), another pressure sensitive species with similar hearing capabilities as the goldfish, after a 24-hour exposure to white noise (0.3 to 2.0 kHz) at 142 dB re 1 µPa, that did not recover 14 days post-exposure. This is the longest threshold shift documented to have occurred in a fish species, with the actual duration of the threshold shift being unknown, but exceeding 14 days. However, the same authors found that the bluegill sunfish (*Lepomis macrochirus*), a species that primarily detects particle motion and lacks specializations for hearing, did not show statistically significant elevations in auditory thresholds when exposed to the same stimulus (Scholik & Yan, 2002b). This demonstrates that fishes with a swim bladder involved in hearing and those with high-frequency hearing may be more sensitive to hearing loss than fishes without a swim bladder or those with a swim bladder not involved in hearing. Studies such as these should be treated with caution in comparison to exposures in a natural environment, largely due to the confined nature of the controlled setting where fishes are unable to avoid the sound source (e.g., fishes held stationary in a tub), and due to the long, continuous durations of the exposures themselves (sometimes days to weeks). Fishes exposed to vessel noise in their natural environment, even in areas with higher levels of vessel movement, would only be exposed for a short duration (seconds or minutes) as vessels are transient and pass by.

As summarized in the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014), some fish species with a swim bladder that is involved in hearing may be more susceptible to TTS from long duration continuous noise, such as broadband[2] white noise, depending on the duration of the exposure (thresholds are proposed based on continuous exposure of 12 hours). However, it is not likely that TTS would occur in fishes with a swim bladder not involved in hearing or in fishes without a swim bladder.

#### 3.9.2.1.1.3 Masking

Masking refers to the presence of a noise that interferes with a fish's ability to hear biologically important sounds, including those produced by prey, predators, or other fishes. Masking occurs in all vertebrate groups and can effectively limit the distance over which an animal can communicate and

[2] A sound or signal that contains energy across multiple frequencies.

detect biologically relevant sounds. Human-generated continuous sounds (e.g., some sonar, vessel or aircraft noise, and vibratory pile driving) have the potential to mask sounds that are biologically important to fishes. Researchers have studied masking in fishes using continuous masking noise, but masking due to intermittent, short-duty cycle sounds has not been studied. Section 3.0.4.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities) provides additional information on masking and the framework used to analyze this potential impact.

Masking is likely to occur in most fishes due to varying levels of ambient or natural noise in the environment such as wave action, precipitation, or other animal vocalizations (Popper et al., 2014). Ambient noise during higher sea states in the ocean has resulted in elevated thresholds in several fish species (Chapman & Hawkins, 1973; Ramcharitar & Popper, 2004). Although the overall intensity or loudness of ambient or human-generated noise may result in masking effects in fishes, masking may be most problematic when human-generated signals or ambient noise levels overlap the frequencies of biologically important signals (Buerkle, 1968, 1969; Popper et al., 2014; Tavolga, 1974).

Wysocki and Ladich (2005) investigated the influence of continuous white noise exposure on the auditory sensitivity of two freshwater fish with notable hearing specializations for sound pressure detection, the goldfish and the lined Raphael catfish (*Platydoras costatus*), and a freshwater fish without notable specializations, the pumpkinseed sunfish (*Lepomis gibbosus*). For the goldfish and catfish, baseline thresholds were lower than masked thresholds. Continuous white noise with a sound pressure level of approximately 130 dB re 1 µPa at 1 m resulted in an elevated threshold of 23–44 dB within the subjects' region of best sensitivity between 500 and 1,000 Hz. There was less evidence of masking in the sunfish during the same exposures, with only a shift of 11 dB. Wysocki and Ladich (2005) suggest that ambient sound regimes may limit acoustic communication and orientation, especially in animals with notable hearing specializations for sound pressure detection.

Masking could lead to potential fitness costs depending on the severity of the reaction (Radford et al., 2014; Slabbekoorn et al., 2010). For example, masking could result in changes in predator-prey relationships, potentially inhibiting a fish's ability to detect predators and therefore increase its risk of predation (Astrup, 1999; Mann et al., 1998; Simpson et al., 2015; Simpson et al., 2016). Masking may also limit the distance over which fish can communicate or detect important signals (Alves et al., 2016; Codarin et al., 2009; Ramcharitar et al., 2001; Ramcharitar et al., 2006), including sounds emitted from a reef for navigating larvae (Higgs, 2005; Neenan et al., 2016). If the masking signal is brief (a few seconds or less), biologically important signals may still be detected, resulting in little effect to the individual. If the signal is longer in duration (minutes or hours) or overlaps with important frequencies for a particular species, more severe consequences may occur such as the inability to attract a mate and reproduce. Holt and Johnston (2014) were the first to demonstrate the Lombard effect in one species of fish, a potentially compensatory behavior where an animal increases the source level of its vocalizations in response to elevated noise levels. The Lombard effect is currently understood to be a reflex that may be unnoticeable to the animal or may lead to increased energy expenditure during communication.

The *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014) highlights a lack of data that exists for masking by sonar but suggests that the narrow bandwidth and intermittent nature of most sonar signals would result in only a limited probability of any masking effects. In addition, most sonars (mid-, high-, and very high-frequency) are above the hearing range of most marine fish species, eliminating the possibility of masking for these species. In most cases, the probability of masking would further decrease with increasing distance from the sound source.

In addition, no data are available on masking by impulsive signals (e.g., impact pile driving and air guns) (Popper et al., 2014). Impulsive sounds are typically brief, lasting only fractions of a second, where masking could occur only during that brief duration of sound. Biological sounds can typically be detected between pulses within close distances to the source unless those biological sounds are similar to the masking noise, such as impulsive or drumming vocalizations made by some fishes (e.g., cod or haddock). Masking could also indirectly occur because of repetitive impulsive signals where the repetitive sounds and reverberations over distance may create a more continuous noise exposure.

Although there is evidence of masking because of exposure to vessel noise, the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014) does not present numeric thresholds for this effect. Instead, relative risk factors are considered, and it is assumed the probability of masking occurring is higher at near to moderate distances from the source (up to hundreds of meters) but decreases with increasing distance (Popper et al., 2014).

#### 3.9.2.1.1.4 Physiological Stress

Section 3.0.4.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities) provides additional information on physiological stress and the framework used to analyze this potential impact. A fish must first be able to detect a sound above its hearing threshold and above the ambient noise level before a physiological stress reaction can occur. The initial response to a 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 and animals, only a limited number of studies have measured biochemical responses by fishes to acoustic stressors (e.g., Goetz et al., 2015; Madaro et al., 2015; Remage-Healey et al., 2006; Smith et al., 2004a; Wysocki et al., 2006; Wysocki et al., 2007), and the results have varied. Researchers have studied physiological stress in fishes using predator vocalizations, non-impulsive or continuous, and impulsive noise exposures.

A stress response that has been observed in fishes is the production of cortisol (a stress hormone) when exposed to sounds such as boat noise, tones, or predator vocalizations. Nichols et al. (2015) found that giant kelpfish (*Heterostichus rostratus*) had increased levels of cortisol with increased sound level and intermittency of boat noise playbacks. Cod exposed to a short-duration upsweep (a tone that sweeps upward across multiple frequencies) across 100–1,000 Hz had increases in cortisol levels, which returned to normal within one hour post-exposure (Sierra-Flores et al., 2015). Remage-Healey et al. (2006) found elevated cortisol levels in Gulf toadfish (*Opsanus beta*) exposed to low-frequency bottlenose dolphin sounds. The researchers observed none of these effects in toadfish exposed to low-frequency snapping shrimp “pops.”

A sudden increase in sound pressure level (i.e., presentation of a sound source) or an increase in overall background noise levels can increase hormone levels and alter other metabolic rates indicative of a stress response, such as increased ventilation and oxygen consumption (Pickering, 1981; Popper & Hastings, 2009a; Radford et al., 2016; Simpson et al., 2015; Simpson et al., 2016; Smith et al., 2004a, 2004b; Spiga et al., 2017). Similarly, reef fish embryos exposed to boat noise have shown increases in heart rate, another indication of a physiological stress response (Jain-Schlaepfer et al., 2018). It has been shown in some species that chronic or long-term (days or weeks) exposures of continuous man-made sounds can lead to a reduction in embryo viability (Sierra-Flores et al., 2015) and slowed growth rates (Nedelec et al., 2015).

However, not all species tested to date show these reactions. Smith et al. (2004a) found no increase in corticosteroid, a class of stress hormones, in goldfish exposed to a continuous, band-limited noise (0.1–10 kHz) with a sound pressure level of 170 dB re 1 µPa for one month. Wysocki et al. (2007) exposed rainbow trout to continuous band-limited noise with a sound pressure level of about 150 dB re 1 µPa for nine months with no observed stress effects. Growth rates and effects on the trout's immune systems were not significantly different from control animals held at a sound pressure level of 110 dB re 1 µPa.

Fishes may have physiological stress reactions to sounds that they can hear. Generally, stress responses are more likely to occur in the presence of potentially threatening sound sources, such as predator vocalizations, or during the sudden onset of impulsive signals rather than from non-impulsive or continuous sources such as vessel noise or sonar. Stress responses are typically brief (a few seconds to minutes) if the exposure is short or if fishes habituate or learn to tolerate the noise that is being presented. Exposure to chronic noise sources can lead to more severe impacts such as reduced growth rates, which may lead to reduced survivability for an individual. It is assumed that any physiological response (e.g., hearing loss or injury) or significant behavioral response is also associated with a stress response.

#### 3.9.2.1.1.5 Behavioral Reactions

Section 3.0.4.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities) provides additional information on behavioral reactions and the framework used to analyze this potential impact. Behavioral reactions in fishes have been observed due to a number of different types of sound sources. The majority of research has been performed using air guns (including large-scale seismic surveys), sonar, and vessel noise. Fewer observations have been made on behavioral reactions to impact pile driving noise, although fish are likely to show similar behavioral reactions to any impulsive noise within or outside the zone for hearing loss and injury.

As with masking, a fish must first be able to detect a sound above its hearing threshold and above the ambient noise level before a behavioral reaction can potentially occur. Most fishes can only detect low-frequency sounds, with the exception of a few species that can detect some mid and high frequencies (above 1 kHz).

Studies of fishes have identified the following basic behavioral reactions to sound: alteration of natural behaviors (e.g., startle or alarm), and avoidance (LGL Ltd Environmental Research Associates et al., 2008; McCauley et al., 2000; Pearson et al., 1992). In the context of this SEIS/OEIS, and to remain consistent with available behavioral reaction literature, the terms "startle" and "alarm" and "response" or "reactions" will be used synonymously.

In addition, observed 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. However, there is evidence that some fish may habituate to repeated exposures or learn to tolerate noise that is not seemingly unthreatening (e.g., Bruintjes et al., 2016; Nedelec et al., 2016b; Radford et al., 2016).

Behavioral reactions often times vary depending on the type of exposure or the sound source present. Changes in sound intensity may be more important to a fishes' behavior than the maximum sound level. Sounds that fluctuate in level or have intermittent pulse rates tend to elicit stronger responses from fish than even stronger sounds with a continuous level (Neo et al., 2014; Schwarz & Greer, 1984). Interpreting behavioral responses can be difficult due to species-specific behavioral tendencies, motivational state (e.g., feeding or mating), an individual's previous experience, and whether or not the fish are able to avoid the source (e.g., caged versus free-swimming subjects). Results from caged studies may not provide a clear understanding of how free-swimming fishes may react to the same or similar sound exposures (Hawkins et al., 2015).

**Behavioral Reactions due to Impulsive Sound Sources**

It is assumed that most species would react similarly to impulsive sources (i.e., air guns and impact pile driving). These reactions include startle or alarm responses and increased swim speeds at the onset of impulsive sounds (Fewtrell & McCauley, 2012; Pearson et al., 1992; Roberts et al., 2016a; Spiga et al., 2017). Data on behavioral reactions in fishes exposed to impulsive sound sources is mostly limited to studies using caged fishes and the use of seismic air guns (Løkkeborg et al., 2012). Several species of rockfish (*Sebastes* species) in a caged environment exhibited startle or alarm reactions to seismic air gun pulses between peak-to-peak sound pressure levels of 180 dB re 1 µPa and 205 dB re 1 µPa (Pearson et al., 1992). More subtle behavioral changes were noted at lower sound pressure levels, including decreased swim speeds. At the presentation of the sound, some species of rockfish settled to the bottom of the experimental enclosure and reduced swim speed. Trevally (*Pseudocaranx dentex*) and pink snapper (*Pagrus auratus*) also exhibited alert responses as well as changes in swim depth, speed, and schooling behaviors when exposed to air gun noise (Fewtrell & McCauley, 2012). Both trevally and pink snapper swam faster and closer to the bottom of the cage at the onset of the exposure. However, trevally swam in tightly cohesive groups at the bottom of the test cages while pink snapper exhibited much looser group cohesion. These behavioral responses were seen during sound exposure levels as low as 147 up to 161 dB re 1 $µPa^2$-s but habituation occurred in all cases, either within a few minutes or within 30 minutes after the final air gun shot (Fewtrell & McCauley, 2012; Pearson et al., 1992).

Some studies have shown a lack of behavioral reactions to air gun noise. Herring exposed to an approaching air gun survey (from 27 to 2 km over six hours), resulting in single pulse sound exposure levels of 125–155 dB re 1 $µPa^2$-s, did not react by changing direction or swim speed (Pena et al., 2013). Although these levels are similar to those tested in other studies which exhibited responses (Fewtrell & McCauley, 2012), the distance of the exposure to the test enclosure, the slow onset of the sound source, and a strong motivation for feeding may have affected the observed response (Pena et al., 2013). In another study, Wardle et al. (2001) observed marine fish on an inshore reef before, during, and after an air gun survey at varying distances. The air guns were calibrated at a peak level of 210 dB re 1 µPa at 16 m and 195 dB re 1 µPa at 109 m from the source. Other than observed startle responses and small changes in the position of pollack, when the air gun was located within close proximity to the test site (within 10 m), they found no substantial or permanent changes in the behavior of the fish on the reef throughout the course of the study. Behavioral responses to impulsive sources are more likely to occur within near and intermediate (tens to hundreds of meters) distances from the source as opposed to far distances (thousands of meters) (Popper et al., 2014).

Unlike the previous studies, Slotte et al. (2004) used fishing sonar (38 kHz echo sounder) to monitor behavior and depth of blue whiting (*Micromesistius poutassou*) and Norwegian spring herring (*Claupea harengus L.*) spawning schools exposed to air gun signals. They reported that fishes in the area of the air guns appeared to go to greater depths after the air gun exposure compared to their vertical position prior to the air gun usage. Moreover, the abundance of animals 30–50 km away from the air guns increased during seismic activity, suggesting that migrating fish left the zone of seismic activity and did not re-enter the area until the activity ceased. It is unlikely that either species was able to detect the fishing sonar, however, it should be noted that these behavior patterns may have also been influenced by other factors such as motivation for feeding, migration, or other environmental factors (e.g., temperature, salinity, etc.) (Slotte et al., 2004).

Alterations in natural behavior patterns due to exposure to pile driving noise have not been studied as thoroughly, but reactions noted thus far are similar to those seen in response to seismic surveys. These changes in behavior include startle responses, changes in depth (in both caged and free-swimming subjects), increased swim speeds, changes in ventilation rates, changes in attention and anti-predator behaviors, and directional avoidance (e.g., Hawkins et al., 2014; Mueller-Blenkle et al., 2010; Neo et al., 2015; Roberts et al., 2016a; Spiga et al., 2017). The severity of response varied greatly by species and received sound pressure level of the exposure. For example, some minor behavioral reactions such as startle responses were observed during caged studies with a sound pressure level as low as 140 dB re 1 µPa (Neo et al., 2014). However, only some free-swimming fishes avoided pile driving noise at even higher sound pressure levels between 152 and 157 dB re 1 µPa (Iafrate et al., 2016). In addition, Roberts et al. (2016a) observed that although multiple species of free swimming fish responded to simulated pile driving recordings, not all responded consistently and in some cases, only one fish would respond while the others continued feeding from a baited remote underwater video, and others responded to different strikes. The repetition rate of pulses during an exposure may also have an effect on what behaviors were noted and how quickly these behaviors recovered as opposed to the overall sound pressure or exposure level (Neo et al., 2014). Neo et al. (2014) observed slower recovery times in fishes exposed to intermittent sounds (similar to pile driving) compared to continuous exposures.

As summarized in the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014), species may react differently to the same sound source depending on a number of variables, such as the animal's life stage or behavioral state (e.g., feeding, mating). Without specific data, it is assumed that fishes react similarly to all impulsive sounds outside the zone for hearing loss and injury. Observations of fish reactions to large-scale air gun surveys are informative, but not necessarily directly applicable to analyzing impacts from the short-term, intermittent use of all impulsive sources. It is assumed that fish have a high probability of reacting to an impulsive sound source within near and intermediate distances (tens to hundreds of meters), and a decreasing probability of reaction at increasing distances (Popper et al., 2014).

**Behavioral Reactions due to Sonar and Other Transducers**

Behavioral reactions to sonar have been studied both in caged and free-swimming fish although results can oftentimes be difficult to interpret depending on the species tested and the study environment. Jørgensen et al. (2005) showed that caged cod and spotted wolf fish (*Anarhichas minor*) lacked any response to simulated sonar between 1 and 8 kHz. However, within the same study, reactions were seen in juvenile herring. It is likely that the sonar signals were inaudible to the cod and wolf fish, species that lack notable hearing specializations, but audible to herring, which do possess hearing capabilities in the frequency ranges tested.

Doksæter et al. (2009; 2012) and Sivle et al. (2012; 2014) studied the reactions of both wild and captive Atlantic herring to the Royal Netherlands Navy's experimental mid-frequency active sonar ranging from 1 to 7 kHz. The behavior of the fish was monitored in each study either using upward-looking echosounders (for wild herring) or audio and video monitoring systems (for captive herring). The source levels used within each study varied across all studies and exposures with a maximum received sound pressure level of 181 dB re 1 µPa and maximum cumulative sound exposure level of 184 dB re 1 $\mu Pa^2s$. No avoidance or escape reactions were observed when herring were exposed to any sonar sources. Instead, significant reactions were noted at lower received sound levels of different non-sonar sound types. For example, dive responses (i.e., escape reactions) were observed when herring were exposed to killer whale feeding sounds at received sound pressure levels of approximately 150 dB re 1 µPa (Sivle et al., 2012). Startle responses were seen when the cages for captive herring were hit with a wooden stick and with the ignition of an outboard boat engine at a distance of one meter from the test pen (Doksaeter et al., 2012). It is possible that the herring were not disturbed by the sonar, were more motivated to continue other behaviors such as feeding, or did not associate the sound as a threatening stimulus. Based on these results (Doksaeter et al., 2009; Doksaeter et al., 2012; Sivle et al., 2012), Sivle et al. (2014) created a model in order to report on the possible population-level effects on Atlantic herring from active naval sonar. The authors concluded that the use of naval sonar poses little risk to populations of herring regardless of season, even when the herring populations are aggregated and directly exposed to sonar.

There is evidence that elasmobranchs (cartilaginous fish including sharks and rays) also respond to human-generated sounds. Myrberg and colleagues did experiments in which they played back sounds (e.g., pulsed tones below 1 kHz) and attracted a number of different shark species to the sound source (e.g., Casper et al., 2012a; Myrberg et al., 1976; Myrberg et al., 1969; Myrberg et al., 1972; Nelson & Johnson, 1972). The results of these studies showed that sharks were attracted to irregularly pulsed 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 to continuous signals or higher frequencies that they presumably cannot hear (Casper & Mann, 2006; Casper & Mann, 2009).

Only a few species of fishes can detect sonars above 1 kHz (see Section 3.9.1.1, Hearing and Vocalization), meaning that most fishes would not detect most mid-, high-, or very high-frequency Navy sonars. The few marine species that can detect above 1 kHz and have some hearing specializations may be able to better detect the sound and would therefore be more likely to react. However, researchers have found little reaction by adult fish in the wild to sonars within the animals' hearing range (Doksaeter et al., 2009; Doksaeter et al., 2012; Sivle et al., 2012). The *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014) suggests that fish able to hear sonars would have a low probability of reacting to the source within near or intermediate distances (within tens to hundreds of meters) and a decreasing probability of reacting at increasing distances.

**Behavioral Reactions due to Vessel Noise**

Vessel traffic also contributes to the amount of noise in the ocean and has the potential to affect fishes. Several studies have demonstrated and reviewed avoidance responses by fishes (e.g., herring and cod) to the low-frequency sounds of vessels (De Robertis & Handegard, 2013; Engås et al., 1995; Handegard et al., 2003). Misund (1997) found that fish that were ahead of a ship and showed avoidance reactions did so at ranges of 50–150 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.

As mentioned in Section 3.9.2.1.1.5 (Behavioral Reactions), behavioral reactions are quite variable and depend on a number of factors such as (but not limited to) the type of fish, its life history stage, behavior, time of day, location, the type of vessel, and the sound propagation characteristics of the water column (Popper et al., 2014; Schwarz & Greer, 1984). Reactions to playbacks of continuous noise or passing vessels generally include basic startle and avoidance responses, as well as evidence of distraction and increased decision-making errors. Other specific examples of observed responses include increased group cohesion, increased distractions or evidence of modified attention, changes in vertical distribution in the water column, changes in swim speeds, as well as changes in feeding efficacy such as reduced foraging attempts and increased mistakes (i.e., lowered discrimination between food and nonfood items) (e.g., Bracciali et al., 2012; De Robertis & Handegard, 2013; Handegard et al., 2015; Nedelec et al., 2015; Nedelec et al., 2017a; Neo et al., 2015; Payne et al., 2015; Purser & Radford, 2011; Roberts et al., 2016a; Sabet et al., 2016; Simpson et al., 2015; Simpson et al., 2016; Voellmy et al., 2014a; Voellmy et al., 2014b).

Behavioral responses may also be dependent on the type of vessel that fish are exposed to. For example, juvenile damselfish (*Pomacentrus wardi*) exposed to sound from a two-stroke engine resulted in startle responses, reduction in boldness (increased time spent hiding, less time exhibiting exploratory behaviors) and space use (maximum distance ventured from shelter), as well as more conservative reactions to visual stimuli analogous to a potential predator. However, damselfish exposed to sound from a four stroke engine generally displayed similar responses as control fish exposed to ambient noise (e.g., little or no change in boldness) (McCormick et al., 2018).

Vessel noise has also led to changes in anti-predator responses, but these responses vary by species. During exposures to vessel noise, juvenile Ambon damselfish (*Pomacentrus amboinensis*) and European eels showed slower reaction times and lacked startle responses to predatory attacks, and subsequently showed signs of distraction and increased their risk of predation during both simulated and actual predation experiments (Simpson et al., 2015; Simpson et al., 2016). Spiny chromis (*Acanthochromis polyacanthus*) exposed to chronic boat noise playbacks for up to 12 consecutive days spent less time feeding and interacting with offspring, and increased defensive acts. In addition, offspring survival rates were also lower at nests exposed to chronic boat noise playbacks versus those exposed to ambient playbacks (Nedelec et al., 2017b). This suggests that chronic or long-term exposures could have more severe consequences than brief exposures.

In contrast, larval Atlantic cod showed a stronger anti-predator response and were more difficult to capture during simulated predator attacks (Nedelec et al., 2015). There are also observations of a general lack of response to shipping and pile driving playback noise by grey mullet (*Chelon labrosus*) and two-spotted gobys (*Gobiusculus flavescens*) (Roberts et al., 2016b). Mensinger et al. (2018) found that Australian snapper (*Pagrus auratus*) located in a protected area showed no change in feeding behavior or avoidance during boat passes, whereas snapper in areas where fishing occurs startled and ceased feeding behaviors during boat presence. This supports that location and past experience also have an influence on whether fishes react.

Although behavioral responses such as those listed above were often noted during the onset of most sound presentations, most behaviors did not last long and animals quickly returned to baseline behavior patterns. In fact, in one study, when given the chance to move from a noisy tank (with sound pressure levels reaching 120–140 dB re 1 µPa) to a quieter tank (sound pressure levels of 110 dB re 1 µPa), there was no evidence of avoidance. The fish did not seem to prefer the quieter environment and continued to swim between the two tanks comparable to control sessions (Neo et al., 2015). However, many of these reactions are difficult to extrapolate to real world conditions due to the captive environment in which testing occurred.

Most fish species should be able to detect vessel noise due to its low-frequency content and their hearing capabilities (see Section 3.9.1.1, Hearing and Vocalization). The *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014) suggests that fishes have a moderate to high probability of reacting to nearby vessel noise (i.e., within tens of meters) with decreasing probability of reactions with increasing distance from the source (hundreds or more meters).

#### 3.9.2.1.1.6 Long-Term Consequences

Section 3.0.4.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities) provides additional information on potential pathways for long-term consequences. Mortality removes an individual fish from the population, while injury reduces the fitness of an individual. Few studies have been conducted on any long-term consequences from repeated hearing loss, stress, or behavioral reactions in fishes due to exposure to loud sounds (Hawkins et al., 2015; Popper & Hastings, 2009a; Popper et al., 2014). Repeated exposures of an individual to multiple sound-producing activities over a season, year, or life stage could cause reactions with costs that can accumulate over time to cause long-term consequences for the individual. These long-term consequences may affect the survivability of the individual, or if impacting enough individuals may have population-level effects, including alteration from migration paths, avoidance of important habitat, or even cessation of foraging or reproductive behavior (Hawkins et al., 2015). Conversely, some animals habituate to or become tolerant of repeated exposures over time, learning to ignore a stimulus that in the past has not accompanied any overt threat. In fact, Sivle et al. (2016) predicted that exposures to sonar at the maximum levels tested would only result in short-term disturbance and would not likely affect the overall population in sensitive fishes such as Atlantic herring (a species which does not occur in the MITT Study Area).

#### 3.9.2.1.2 Impacts from Sonar and Other Transducers

The overall use of sonar and other transducers for training and testing would be similar to what is currently conducted (see Table 2.5-1 and Table 3.0-2 for details). Although individual activities may vary some from those previously analyzed, and some new systems using new technologies would be tested under Alternative 1 and 2, the overall determinations presented in the 2015 MITT Final EIS/OEIS remain valid.

Sonar and other transducers proposed for use are transient in most locations because activities that involve sonar and other transducers take place at different locations and many platforms are generally moving throughout the Study Area. A few activities involving sonar and other transducers occur in inshore waters (within bays and estuaries), including at pierside locations where they reoccur. Sonar and other transducers emit sound waves into the water to detect objects, safely navigate, and communicate. General categories and characteristics of these systems and the number of hours these sonars would be operated are described in Section 3.0.4.1.1 (Sonar and Other Transducers). The activities analyzed in this SEIS/OEIS that use sonar and other transducers are described in Appendix A (Training and Testing Activities Descriptions).

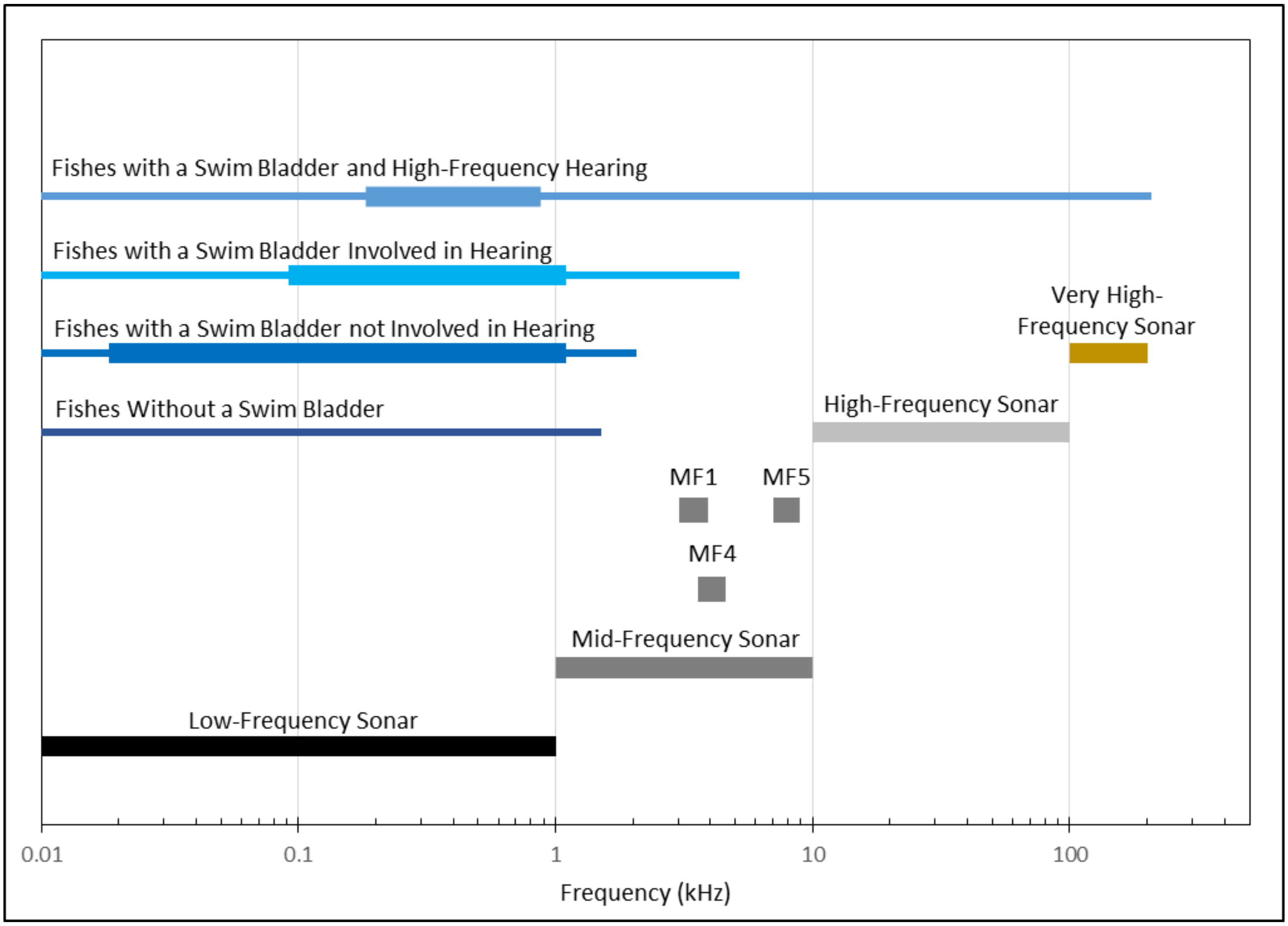
As described under Section 3.9.2.1.1.1 (Injury – Injury due to Sonar and Other Transducers), direct injury from sonar and other transducers is highly unlikely because injury has not been documented in fish exposed to sonar (Halvorsen et al., 2012c; Halvorsen et al., 2013; Popper et al., 2007) and therefore is not considered further in this analysis.

Fishes are not equally sensitive to noise at all frequencies. Fishes must first be able to hear a sound in order to be affected by it. As discussed in Section 3.9.1.1 (Hearing and Vocalization), many marine fish species tested to date hear primarily below 1 kHz. For the purposes of this analysis, fish species were grouped into one of four fish hearing groups based on either their known hearing ranges (i.e., audiograms) or physiological features that may be linked to overall hearing capabilities (i.e., swim bladder with connection to, or in close proximity to, the inner ear). Figure 3.9-1 provides a summary of hearing threshold data from available literature (e.g., Casper & Mann, 2006; Deng et al., 2013; Kéver et al., 2014; Mann et al., 2001; Ramcharitar et al., 2006) to demonstrate the maximum potential range of frequency detection for each hearing group.

Due to data limitations, these estimated hearing ranges may be overly conservative in that they may extend beyond what some species within a given fish hearing group may actually detect. For example, although most sharks are sensitive to lower frequencies, well below 1 kHz, the bull shark has been tested and can detect frequencies up to 1.5 kHz (Kritzler & Wood, 1961; Myrberg, 2001) and therefore represents the uppermost known limit of frequency detection for this hearing group. These upper bounds of each fish hearing groups' frequency range are outside of the range of best sensitivity for the majority of fishes within that group. As a result, fishes within each group would only be able to detect those upper frequencies at close distances to the source, and from sources with relatively high source levels. Figure 3.9-1 is not intended as a composite audiogram but rather displays the basic overlap in potential frequency content for each hearing group with Navy defined sonar classes (i.e., low-, mid-, high- and very high-frequency) as discussed under Section 3.0.4.1.1 (Sonar and Other Transducers – Classification of Sonar and Other Transducers).

Systems within the low-frequency sonar class present the greatest potential for overlap with fish hearing. Some mid-frequency sonars and other transducers may also overlap some species' hearing ranges, but to a lesser extent than low-frequency sonars. For example, the only hearing groups that have the potential to be able to detect mid-frequency sources within bins MF1, MF4, and MF5 are fishes with a swim bladder involved in hearing and with high-frequency hearing. It is anticipated that most fishes would not hear or be affected by mid-frequency Navy sonars or other transducers with operating frequencies greater than about 1–4 kHz. Only a few fish species (i.e., fish with a swim bladder and high-frequency hearing specializations) can detect and therefore be potentially affected by high- and very high-frequency sonars and other transducers.

The most probable impacts from exposure to sonar and other transducers are TTS (for more detail see Section 3.9.2.1.1.2, Hearing Loss), masking (for more detail see Section 3.9.2.1.1.3, Masking), physiological stress (for more detail see Section 3.9.2.1.1.4, Physiological Stress), and behavioral reactions (for more detail see Section 3.9.2.1.1.5, Behavioral Reactions). Analysis of these effects are provided below.




Notes: Thin blue lines represent the estimated minimum and maximum range of frequency detection for each group. All hearing groups are assumed to hear down to 0.01 kHz regardless of available data. Thicker portions of each blue line represent the estimated minimum and maximum range of best sensitivity for that group. Currently, no data are available to estimate the range of best sensitivity for fishes without a swim bladder. Although each sonar class is represented graphically by the horizontal black, grey and brown bars, not all sources within each class would operate at all the displayed frequencies. Example mid-frequency sources are provided to further demonstrate this. kHz = kilohertz, MF1 = 3.5 kHz, MF4 = 4 kHz, MF5 = 8 kHz.

**Figure 3.9-1: Fish Hearing Group and Navy Sonar Bin Frequency Ranges**

#### 3.9.2.1.2.1 Methods for Analyzing Impacts from Sonar and Other Transducers

The Navy performed a quantitative analysis to estimate the range to TTS for fishes exposed to sonar and other transducers used during Navy training and testing activities. Inputs to the quantitative analysis included sound propagation modeling in the Navy Acoustic Effects Model to the sound exposure criteria and thresholds presented below. Although ranges to effect are predicted, density data for fish species within the Study Area are not available; therefore, it is not possible to estimate the total number of individuals that may be affected by sound produced by sonar and other transducers.

Criteria and thresholds to estimate impacts from sonar and other transducers are presented below in Table 3.9-3. Thresholds for hearing loss are typically reported in cumulative sound exposure level so as to account for the duration of the exposure. Therefore, thresholds reported in the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014) that were presented in other metrics were converted to sound exposure level based on the signal duration reported in the original studies (see Halvorsen et al., 2012c; Halvorsen et al., 2013; Kane et al., 2010; Popper et al., 2007). General research findings from these studies can be reviewed in Section 3.9.2.1.1.2 (Hearing Loss).

### Table 3.9-3: Sound Exposure Criteria for TTS from Sonar

| *Fish Hearing Group* | *TTS from Low-Frequency Sonar ($SEL_{cum}$)* | *TTS from Mid-Frequency Sonar ($SEL_{cum}$)* |
|---|---|---|
| Fishes without a swim bladder | NC | NC |
| Fishes with a swim bladder not involved in hearing | > 210 | NC |
| Fishes with a swim bladder involved in hearing | 210 | 220 |
| Fishes with a swim bladder and high-frequency hearing | 210 | 220 |

Notes: TTS = Temporary Threshold Shift, $SEL_{cum}$ = Cumulative sound exposure level (decibel referenced to 1 micropascal squared seconds [dB re 1 μPa$^2$-s]), NC = effects from exposure to sonar is considered to be unlikely, therefore no criteria are reported, “>” indicates that the given effect would occur above the reported threshold.

For mid-frequency sonars, fishes with a swim bladder involved in hearing have shown signs of hearing loss because of mid-frequency sonar exposure at a maximum received sound pressure level of 210 dB re 1 μPa for a total duration of 15 seconds. To account for the total duration of the exposure, the threshold for TTS is a cumulative sound exposure level of 220 dB re 1 μPa$^2$-s (Halvorsen et al., 2012c; Kane et al., 2010). The same threshold is used for fishes with a swim bladder and high-frequency hearing as a conservative measure, although fishes in this hearing group have not been tested for the same impact. TTS has not been observed in fishes with a swim bladder that is not involved in hearing exposed to mid-frequency sonar. Fishes within this hearing group do not sense pressure well and typically cannot hear at frequencies above 1 kHz (Halvorsen et al., 2012c; Popper et al., 2014). Therefore, no criteria were proposed for fishes with a swim bladder that is not involved in hearing from exposure to mid-frequency sonars, as it is considered unlikely for TTS to occur. Fishes without a swim bladder are even less susceptible to noise exposure; therefore, TTS is unlikely to occur, and no criteria are proposed for this group either.

For low-frequency sonar, as described in Section 3.9.2.1.1.2 (Hearing Loss), exposure of fishes with a swim bladder has resulted in TTS (Halvorsen et al., 2013; Kane et al., 2010; Popper et al., 2007). Specifically, fishes with a swim bladder not involved in hearing showed signs of hearing loss after exposure to a maximum received sound pressure level of 193 dB re 1 μPa for 324 and 648 seconds (cumulative sound exposure level of 218 and 220 dB re 1 μPa$^2$-s, respectively) (Kane et al., 2010; Popper et al., 2007). In addition, exposure of fishes with a swim bladder involved in hearing to low-frequency sonar at a sound pressure level of 195 dB re 1 μPa for 324 seconds (cumulative sound exposure level of 215 dB re 1 μPa$^2$-s) resulted in TTS (Halvorsen et al., 2013). Although the results were variable, it can be assumed that TTS may occur in fishes within the same hearing groups at similar exposure levels. As a conservative measure, the threshold for TTS from exposure to low-frequency sonar for all fish hearing groups with a swim bladder was rounded down to a cumulative sound exposure level of 210 dB re 1 μPa$^2$-s.

Criteria for high- and very-high-frequency sonar were not available in the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014); however, only species with a swim bladder involved in hearing and with high-frequency specializations, such as shad, could potentially be affected. The majority of fish species within the Study Area are unlikely to be able to detect these sounds. There is little data available on hearing loss from exposure of fishes to these high-frequency sonars. Due to the lack of available data, and as a conservative measure, effects to these hearing groups from high-frequency sonars would utilize the lowest threshold available for other hearing groups (a cumulative sound exposure level of 210 dB re 1 μPa$^2$-s), but effects would largely be analyzed qualitatively.

#### 3.9.2.1.2.2 Impact Ranges for Sonar and Other Transducers

The following section provides ranges to specific effects from sonar and other transducers. Ranges are calculated using criteria from Table 3.9-4 and the Navy Acoustic Effects Model. Only ranges to TTS were predicted based on available data. Sonar durations of 1, 30, 60 and 120 seconds were used to calculate the ranges below. However, despite the variation in exposure duration, ranges were almost identical across these durations and therefore were combined and summarized by bin in the table below. General source levels, durations, and other characteristics of these systems are described in Section 3.0.4.1.1 (Sonar and Other Transducers).

### Table 3.9-4: Ranges to Temporary Threshold Shift from Four Representative Sonar Bins

| *Fish Hearing Group* | *Range to Effects (meters)* | | | |
|---|---|---|---|---|
| | *Sonar Bin LF4 Low-frequency* | *Sonar Bin MF1 Hull-mounted surface ship sonars (e.g., AN/SQS-53C and AN/SQS-61)* | *Sonar Bin MF4 Helicopter-deployed dipping sonars (e.g., AN/AQS-22)* | *Sonar Bin MF5 Active acoustic sonobuoys (e.g., DICASS)* |
| Fishes without a swim bladder | NR | NR | NR | NR |
| Fishes with a swim bladder not involved in hearing | 0 | NR | NR | NR |
| Fishes with a swim bladder involved in hearing | 0 | 7 (5–10) | 0 | 0 |
| Fishes with a swim bladder and high-frequency hearing | 0 | 7 (5–10) | 0 | 0 |

Notes: Ranges to TTS represent modeled predictions in different areas and seasons within the Study Area. The average range to TTS is provided as well as the minimum to the maximum range to TTS in parenthesis. Where only one number is provided the average, minimum, and maximum ranges to TTS are the same.
LF = low-frequency, MF = mid-frequency, NR = no criteria are available and therefore no range to effects are estimated.

#### 3.9.2.1.2.3 Impacts from Sonar and Other Transducers Under Alternative 1

Sonar and other transducers emit sound waves into the water to detect objects, safely navigate, and communicate. Use of sonar and other transducers would typically be transient and temporary. General categories and characteristics of sonar systems and the number of hours these sonars would be operated during training and testing activities under Alternative 1 are described in Section 3.0.4.1.1

(Sonar and Other Transducers). Activities using sonars and other transducers would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Training and Testing Activities Descriptions).

Under Alternative 1, training and testing activities including low-frequency sonars within most marine species hearing range (<2 kHz) would take place throughout the Study Area. Unit-level training and major training exercises would fluctuate each year to account for the natural variation of training cycles and deployment schedules. Some unit-level training would be conducted using synthetic means (e.g., simulators) or would be completed through other training exercises. Low-frequency sources are operated more frequently during testing activities than during training activities. Therefore, although the general impacts from sonar and other transducers during testing would be similar in severity to those described during training, there may be slightly more impacts during testing activities as all marine fishes can detect low-frequency sources.

Only a few species of shad within the Clupeidae family, subfamily Alosinae, are known to be able to detect high-frequency sonar and other transducers (greater than 10 kHz) and are considered a part of the fish hearing group for species with a swim bladder that have high-frequency hearing. However, these species are not present in the MITT Study Area. Other marine fishes would probably not detect these sounds and therefore would not experience masking, physiological stress, or behavioral disturbance from exposure to high or very high-frequency sonar and other transducers.

Most marine fish species are not expected to detect sounds in the mid-frequency range (above a few kHz) of most operational sonars. The fish species that are known to detect mid-frequencies (i.e., those with swim bladders including some sciaenids [drum], most clupeids [herring, shad], and potentially deep-water fish such as myctophids [lanternfish]) do not have their best sensitivities in the range of the operational sonars (see Figure 3.9-1). Thus, fishes 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. Fishes with a swim bladder involved in hearing and with high-frequency hearing are more susceptible to hearing loss due to exposure to mid-frequency sonars. However, as shown in Table 3.9-4, the maximum estimated range to TTS for these fish hearing groups is equal to or less than 10 m for only the most powerful sonar bins. Fishes within these hearing groups would have to be very close to the source and the source levels would have to be relatively high in order to experience this effect.

Most mid-frequency active sonars used in the Study Area would not have the potential to substantially mask key environmental sounds or produce sustained physiological stress or behavioral reactions due to the limited time of exposure due to the moving sound sources and variable duty cycles. However, it is important to note that some mid-frequency sonars have a high duty cycle or are operated continuously. This may increase the risk of masking but only for important biological sounds that overlap with the frequency of the sonar being operated. Furthermore, although some species may be able to produce sound at higher frequencies (greater than 1 kHz), vocal marine fishes, such as sciaenids, largely communicate below the range of mid-frequency levels used by most sonars. Any such effects would be temporary and infrequent as a vessel operating mid-frequency sonar transits an area. As such, mid-frequency sonar use is unlikely to impact individuals. Long-term consequences for fish populations due to exposure to mid-frequency sonar and other transducers are not expected.

All marine fish species can likely detect low-frequency sonars and other transducers. However, low-frequency active sonar use is rare and most low-frequency active operations are typically conducted in deeper, offshore areas. The majority of fish species, including those that are the most highly vocal, exist on the continental shelf and within nearshore, estuarine areas. However, some species may still be present in areas where low-frequency sonar and other transducers are used, including some coastal areas. Most low-frequency sonar sources do not have a high enough source level to cause TTS, as shown in Table 3.9-4. Although highly unlikely, if TTS did occur, it may reduce the detection of biologically significant sounds but would likely recover within a few minutes to days.

The majority of fish species exposed to sonar and other transducers within near (tens of meters) to far (thousands of meters) distances of the source would be more likely to experience; mild physiological stress; brief periods of masking; behavioral reactions such as startle or avoidance responses, although risk would be low even close to the source; or no reaction. However, based on the information provided in the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014), the relative risk of these effects at any distance are expected to be low. Due to the transient nature of most sonar operations, overall effects would be localized and infrequent, only lasting a few seconds or minutes. Based on the low level and short duration of potential exposure to low-frequency sonar and other transducers, long-term consequences for fish populations are not expected.

As discussed previously in Section 3.9.1.1 (Hearing and Vocalization) and as shown in Figure 3.9-1, all ESA-listed fish species that occur in the Study Area are capable of detecting sound produced by low-frequency sonars and other transducers. However, scalloped hammerhead sharks, giant manta rays and oceanic whitetip sharks do not have a swim bladder and cannot detect frequencies above 1 kHz therefore impacts from mid-, high- or very high-frequency sonar and other transducers are not expected for any ESA-listed species.

All ESA-listed species that occur in the Study Area may be exposed to low-frequency sonar or other transducers associated with training and testing activities. The Indo-West Pacific Distinct Population Segment of scalloped hammerhead could occur in nearshore waters, such as bays and estuaries, but is also known to occur in offshore portions of the Study Area. The giant manta ray and oceanic whitetip shark would most likely be exposed to low-frequency sonar in offshore areas throughout the Study Area.

Overall, impacts on ESA-listed species that encounter sonar or other transducers within their hearing range would be similar to those discussed above for impacts on fishes in general. As described above, most low-frequency sonar sources do not have a high enough source level to cause TTS and TTS would not be anticipated in fishes without a swim bladder. ESA-listed species within the Study Area would be more likely to experience masking, physiological stress, and behavioral reactions, although risk would be low even close to the source. These impacts would be short-term (seconds to minutes) for individuals and long-term consequences for populations would not be expected. Multiple exposures for individuals within a short period (seconds to minutes) are unlikely due to the transient nature of most sonar activities. Although some shark species have shown attraction to irregularly pulsed low-frequency sounds (below several hundred Hz), they are not known to be attracted to continuous signals or higher frequencies that they presumably cannot hear (Casper & Mann, 2006; Casper & Mann, 2009; Casper et al., 2012a).

*Pursuant to the ESA, the use of sonar and other transducers during training and testing activities, as described under Alternative 1, may affect ESA-listed Indo-West Pacific Distinct Population Segment scalloped hammerhead sharks, oceanic whitetip sharks and giant manta rays.*

##### 3.9.2.1.2.4 Impacts from Sonar and Other Transducers Under Alternative 2

Sonar and other transducers emit sound waves into the water to detect objects, safely navigate, and communicate. Use of sonar and other transducers would typically be transient and temporary. General categories and characteristics of sonar systems and the number of hours these sonars would be operated during training and testing activities under Alternative 2 are described in Section 3.0.4.1.1 (Sonar and Other Transducers). Activities using sonars and other transducers would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Training and Testing Activities Descriptions).

Under Alternative 2, training and testing activities could occur throughout the Study Area. Training activities include the same type and tempo of training activities as Alternative 1 but also considers additional Fleet exercises (e.g., Valiant Shield type event) every year. Alternative 2 reflects the maximum number of training events that could occur within a given year, and assumes that the maximum number of Fleet exercises would occur every year. However, the types and tempo of testing activities would be the same as those conducted under Alternative 1.

Compared to training and testing activities that use sonar and other transducers that were previously analyzed in the 2015 MITT Final EIS/OEIS under Alternative 2, some training and testing activities would increase, decrease, or stay the same from those currently conducted (see Table 2.5-1 and Table 2.5-2 for details).

Impacts on fishes due to sonar and other transducers are expected to be limited to minor behavioral responses, short-term physiological stress, and brief periods of masking (seconds to minutes at most) for individuals; long-term consequences for individuals and therefore populations would not be expected. Predicted impacts on ESA-listed fish species would not be discernible from those described above in Section 3.9.2.1.2.3 (Impacts from Sonar and Other Transducers under Alternative 1).

*Pursuant to the ESA, the use of sonar and other transducers during training and testing activities, as described under Alternative 2, may affect ESA-listed Indo-West Pacific Distinct Population Segment scalloped hammerhead sharks, oceanic whitetip sharks and giant manta rays.*

##### 3.9.2.1.2.5 Impacts from Sonar and Other Transducers Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Acoustic stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer sonar and other transducers within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for acoustic impacts on individual fishes, but would not measurably improve the status of fish populations or subpopulations, including those listed under ESA and those federally managed under the MSA.

#### 3.9.2.1.3 Impacts from Vessel Noise

Fishes may be exposed to noise from vessel movement. A detailed description of the acoustic characteristics and typical sound levels of vessel noise are in Section 3.0.4.1.2 (Vessel Noise). Vessel movements involve transits to and from ports to various locations within the Study Area, including commercial ship traffic as well as recreational vessels in addition to U.S. Navy vessels. Many ongoing and proposed training and testing activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels). Activities may vary slightly from those previously analyzed in the 2015 MITT Final EIS/OEIS, but the overall determinations presented remain valid. Increases and decreases shown in Table 2.5-1 and Table 2.5-2 for proposed activities under Alternative 1 and 2 do not appreciably change the impact conclusions presented in the 2015 MITT Final EIS/OEIS.

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Acoustic stressors, as described above, would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in less vessel noise within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for acoustic impacts on individual fishes, but would not measurably improve the status of fish populations or subpopulations, including those listed under ESA and those federally managed under the MSA.

*Pursuant to the ESA, sound produced by vessel movement during training and testing activities, as described under Alternative 1 and Alternative 2, may affect ESA-listed Indo-West Pacific Distinct Population Segment scalloped hammerhead sharks, oceanic whitetip sharks and giant manta rays.*

#### 3.9.2.1.4 Impacts from Aircraft Noise

Fishes that occur near or at the water's surface may be exposed to aircraft noise, although this is considered to be unlikely. Fixed, rotary-wing, and tilt-rotor aircraft are used during a variety of training and testing activities throughout the Study Area. Tilt-rotor impacts would be similar to fixed-wing or rotary-wing (i.e., helicopter) impacts depending which mode the aircraft is in. Most of these sounds would be concentrated around airbases and fixed ranges within the range complex. Aircraft noise could also occur in the waters immediately surrounding aircraft carriers at sea during takeoff and landing. Aircraft produce extensive airborne noise from either turbofan or turbojet engines. An infrequent type of aircraft noise is the sonic boom, produced when the aircraft exceeds the speed of sound. Rotary-wing aircraft (helicopters) produce low-frequency sound and vibration (Pepper et al., 2003). A detailed description of aircraft noise as a stressor is in Section 3.0.4.1.3 (Aircraft Noise).

Activities may vary slightly from those previously analyzed in the 2015 MITT Final EIS/OEIS. The analysis of impacts from aircraft noise in this Supplemental EIS/OEIS supplants the 2015 MITT Final EIS/OEIS for fishes, and changes estimated impacts for some species since the 2015 MITT Final EIS/OEIS.

##### 3.9.2.1.4.1 Methods for Analyzing Impacts from Aircraft Noise

The amount of sound entering the ocean from aircraft would be very limited in duration, sound level, and affected area. Due to the low level of sound that could enter the water from aircraft activities, hearing loss is not further considered as a potential effect. Potential impacts considered are masking of other biologically relevant sounds, physiological stress, and changes in behavior. Reactions by fishes to these specific stressors have not been recorded; however, fishes would be expected to react to aircraft noise as they would react to other transient sounds (e.g., sonar or vessel noise).

For this analysis, the Navy assumes that some fish at or near the water surface may exhibit startle reactions to certain aircraft noise if aircraft altitude is low. This could mean a hovering helicopter, for which the sight of the aircraft and water turbulence could also cause a response, or a low-flying or super-sonic aircraft generating enough noise to be briefly detectable underwater or at the air-water interface. Because any fixed-wing aircraft noise would be brief, the risk of masking any sounds relevant to fishes is very low. The *ANSI Sound Exposure Guidelines* for fishes did not consider this acoustic stressor (Popper et al., 2014).

#### 3.9.2.1.4.2 Impacts from Aircraft Noise Under Alternative 1

Fishes may be exposed to aircraft-generated noise throughout the Study Area. Characteristics of aircraft noise and the number of training and testing events that include aircraft under Alternative 1 are shown in Section 3.0.4.1.3 (Aircraft Noise). Activities with aircraft would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Training and Testing Activities Descriptions). Aircraft training and testing activities would usually occur adjacent to Navy airfields, installations, and in special use airspace within the Study Area and transit corridor.

Under Alternative 1, activities may vary slightly from those previously analyzed in the 2015 MITT Final EIS/OEIS. Increases and decreases shown in Table 2.5-1 and Table 2.5-2 for proposed activities under Alternative 1 and 2.

In most cases, exposure of fishes to fixed-wing aircraft presence and noise would be brief as the aircraft quickly passes overhead. Fishes would have to be at or near the surface at the time of an overflight to be exposed to appreciable sound levels. Due to the low sound levels in water, it is unlikely that fishes would respond to most fixed-wing aircraft or transiting helicopters. Because most overflight exposure would be brief and aircraft noise would be at low received levels, only startle reactions, if any, are expected in response to low altitude flights. Similarly, the brief duration of most overflight exposures would limit any potential for masking of relevant sounds.

Daytime and nighttime activities involving helicopters may occur for extended periods of time, up to a couple of hours in some areas. During these activities, helicopters would typically transit throughout an area but could also hover over the water. Longer event durations and periods of time where helicopters hover may increase the potential for behavioral reactions, startle reactions, masking, and physiological stress. Low-altitude flights of helicopters during some activities, which often occur under 100 feet (ft.) altitude, may elicit a stronger startle response due to the proximity of a helicopter to the water; the slower airspeed and longer exposure duration; and the downdraft created by a helicopter's rotor.

If fish were to respond to aircraft noise, only short-term behavioral or physiological reactions (e.g., avoidance and increased heart rate) would be expected. Therefore, long-term consequences for individuals would be unlikely and long-term consequences for populations are not expected.

All ESA-listed species that occur in the Study Area are likely capable of detecting aircraft noise as discussed previously in Section 3.9.1.1 (Hearing and Vocalization) and could be exposed to aircraft noise throughout the Study Area. However, due to the small area within which sound could potentially enter the water and the extremely brief window the sound could be present, exposures of fishes to aircraft noise would be extremely rare and in the event that they did occur, would be very brief (seconds).

*Pursuant to the ESA, sound produced by aircraft movement during training and testing activities, as described under Alternative 1, may affect ESA-listed Indo-West Pacific Distinct Population Segment scalloped hammerhead sharks, oceanic whitetip sharks and giant manta rays.*

#### 3.9.2.1.4.3 Impacts from Aircraft Noise Under Alternative 2

Characteristics of aircraft noise and the number of training and testing events that include aircraft under Alternative 2 are shown in Section 3.0.4.1.3 (Aircraft Noise). Activities with aircraft would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Training and Testing Activities Descriptions). Aircraft training and testing activities would usually occur adjacent to Navy airfields, installations, and in special use airspace within the Study Area and transit corridor.

Under Alternative 2, activities may vary slightly from those previously analyzed in the 2015 MITT Final EIS/OEIS. Increases and decreases shown in Table 2.5-1 and Table 2.5-2 for proposed activities under Alternative 1 and 2.

Activities under Alternative 2 include a minor increase in the number of events that involve aircraft as compared to Alternative 1; however, the training locations, types of aircraft, and severity of predicted impacts would not be discernible from those described above in Section 3.9.2.1.4.2 (Impacts from Aircraft Noise Under Alternative 1).

*Pursuant to the ESA, sound produced by aircraft movement during training and testing activities, as described under Alternative 2, may affect ESA-listed Indo-West Pacific Distinct Population Segment scalloped hammerhead sharks, oceanic whitetip sharks and giant manta rays.*

#### 3.9.2.1.4.4 Impacts from Aircraft Noise Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Acoustic stressors, as described above, would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in less acoustic stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for acoustic impacts on individual fishes, but would not measurably improve the status of fish populations or subpopulations, including those listed under ESA and those federally managed under the MSA.

### 3.9.2.1.5 Impacts from Weapon Noise

Fishes may be exposed to sounds caused by the firing of weapons, objects in flight, and impact of non-explosive munitions on the water's surface, which are described in Section 3.0.4.1.4 (Weapon Noise). In general, these are impulsive sounds generated in close vicinity to or at the water surface, with the exception of items that are launched underwater. The firing of a weapon may have several components of associated noise. Firing of guns could include sound generated in air by firing a gun (muzzle blast) and a crack sound due to a low amplitude shock wave generated by a supersonic projectile flying through the air. Most in-air sound would be reflected at the air-water interface. Underwater sounds would be strongest just below the surface and directly under the firing point. Any sound that enters the water only does so within a narrow cone below the firing point or path of the projectile. Vibration from the blast propagating through a ship’s hull, the sound generated by the impact of an object with the water surface, and the sound generated by launching an object underwater are other sources of impulsive sound in the water. Sound due to missile and target launches is typically at a maximum at initiation of the booster rocket and rapidly fades as the missile or target travels downrange. Reactions by fishes to these specific stressors have not been recorded however, fishes would be expected to react to weapon noise as they would react to other transient sounds (e.g., sonar or vessel noise).

Activities may vary slightly from those previously analyzed in the 2015 MITT Final EIS/OEIS, but the overall determinations presented remain valid. Increases and decreases shown in Table 2.5-1 and Table 2.5-2 for activities proposed under Alternative 1 and 2 do not appreciably change the impact conclusions presented in the 2015 MITT Final EIS/OEIS.

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Acoustic stressors, as described above, would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in less acoustic stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for acoustic impacts on individual fishes, but would not measurably improve the status of fish populations or subpopulations, including those listed under ESA and those federally managed under the MSA.

*Pursuant to the ESA, sound produced by weapon noise during training and testing activities, as described under Alternative 1 and Alternative 2, may affect ESA-listed Indo-West Pacific Distinct Population Segment scalloped hammerhead sharks, oceanic whitetip sharks and giant manta rays.*

#### 3.9.2.2 Explosive Stressors

Explosions in the water or near the water surface can introduce loud, impulsive, broadband sounds into the marine environment. But, unlike other acoustic stressors, explosives release energy at a high rate producing a shock wave that can be injurious and even deadly. Therefore, explosive impacts on fishes are discussed separately from other acoustic stressors, even though the analysis of explosive impacts will rely on data for fish impacts due to impulsive sound exposure where appropriate.

Explosives are usually described by their net explosive weight, which accounts for the weight and type of explosive material. Additional explanation of the acoustic and explosive terms and sound energy concepts used in this section is found in Appendix H (Acoustic and Explosive Concepts).

This section begins with a summary of relevant data regarding explosive impacts on fishes in Section 3.9.2.2.1 (Background). The ways in which an explosive exposure could result in immediate effects or lead to long-term consequences for an animal are explained in Section 3.0.4.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors), and this section follows that framework.

Although air guns and pile driving are not used during MITT training and testing activities, the analysis of some explosive impacts will in part rely on data from fishes exposed to impulsive sources where appropriate. Impulsive sources are further discussed below when applicable data are available for comparison purposes. In addition, there are limited studies of fish responses to weapon noise. For the purposes of this analysis, studies of the effects from air guns, pile driving, and explosives are used to inform fish responses to other impulsive sources (i.e., weapon noise).

Due to the availability of new literature, adjusted sound exposure criteria, and new acoustic effects modeling, the analysis provided in Section 3.9.2.2.2 (Impacts from Explosives) of this SEIS/OEIS supplants the 2015 MITT Final EIS/OEIS for fishes.

#### 3.9.2.2.1 Background

The effects of explosions on fishes have been studied and reviewed by numerous authors (Keevin & Hempen, 1997; O'Keeffe, 1984; O'Keeffe & Young, 1984; Popper et al., 2014). A summary of the literature related to each type of effect forms the basis for analyzing the potential effects from Navy activities. The sections below include a survey and synthesis of best-available science published in peer-reviewed journals, technical reports, and other scientific sources pertinent to impacts on fishes potentially resulting from Navy training and testing activities. Fishes could be exposed to a range of impacts depending on the explosive source and context of the exposure. In addition to acoustic impacts including temporary or permanent hearing loss, auditory masking, physiological stress, or changes in behavior, potential impacts from an explosive exposure can include non-lethal injury and mortality.

##### 3.9.2.2.1.1 Injury

Injury refers to the direct effects on the tissues or organs of a fish. The blast wave from an in-water explosion is lethal to fishes at close range, causing massive organ and tissue damage (Keevin & 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, depth, physical condition of the fish, and perhaps most importantly, the presence of a swim bladder (Keevin & Hempen, 1997; Wright, 1982; Yelverton et al., 1975; Yelverton & Richmond, 1981). At the same distance from the source, larger fishes 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 fishes oriented sideways to the blast suffer the greatest impact (Edds-Walton & Finneran, 2006; O'Keeffe, 1984; O'Keeffe & Young, 1984; Wiley et al., 1981; Yelverton et al., 1975). Species with a swim bladder are much more susceptible to blast injury from explosives than fishes without them (Gaspin, 1975; Gaspin et al., 1976; Goertner et al., 1994).

If a fish is close to an explosive detonation, the exposure to rapidly changing high pressure levels can cause barotrauma. Barotrauma is injury due to a sudden difference in pressure between an air space inside the body and the surrounding water and tissues. Rapid compression followed by rapid expansion of airspaces, such as the swim bladder, can damage surrounding tissues and result in the rupture of the airspace itself. The swim bladder is the primary site of damage from explosives (Wright, 1982; Yelverton et al., 1975). Gas-filled swim bladders resonate at different frequencies than surrounding tissue and can be torn by rapid oscillation between high- and low-pressure waves (Goertner, 1978). Swim bladders are a characteristic of most bony fishes with the notable exception of flatfishes (e.g., halibut). Sharks and rays are examples of fishes without a swim bladder. Small airspaces, such as micro-bubbles that may be present in gill structures, could also be susceptible to oscillation when exposed to the rapid pressure increases caused by an explosion. This may have caused the bleeding observed on gill structures of some fish exposed to explosions (Goertner et al., 1994). Sudden very high pressures can also cause damage at tissue interfaces due to the way pressure waves travel differently through tissues with different densities. Rapidly oscillating pressure waves might rupture the kidney, liver, spleen, and sinus and cause venous hemorrhaging (Keevin & Hempen, 1997).

Several studies have exposed fish to explosives and examined various metrics in relation to injury susceptibility. Sverdrup (1994) exposed Atlantic salmon (1–1.5 kilograms [2–3 pounds]) in a laboratory setting to repeated shock pressures of around 2 MPa (300 psi) without any immediate or delayed mortality after a week. Hubbs and Rechnitzer (1952) showed that fish with swim bladders exposed to explosive shock fronts (the near-instantaneous rise to peak pressure) were more susceptible to injury when several feet below the water surface than near the bottom. When near the surface, the fish began to exhibit injuries around peak pressure exposures of 40 to 70 psi. However, near the bottom (all water depths were less than 100 ft.) fish exposed to pressures over twice as high exhibited no sign of injury. Yelverton et al. (1975) similarly found that peak pressure was not correlated to injury susceptibility; instead, injury susceptibility of swim bladder fish at shallow depths (10 ft. or less) was correlated to the metric of positive impulse (Pa-s), which takes into account both the positive peak pressure, the duration of the positive pressure exposure, and the fish mass, with smaller fish being more susceptible.

Gaspin et al. (1976) exposed multiple species of fish with a swim bladder, placed at varying depths, to explosive blasts of varying size and depth. Goertner (1978) and Wiley (1981) developed a swim bladder oscillation model, which showed that the severity of injury observed in those tests could be correlated to the extent of swim bladder expansion and contraction predicted to have been induced by exposure to the explosive blasts. Per this model, the degree of swim bladder oscillation is affected by ambient pressure (i.e., depth of fish), peak pressure of the explosive, duration of the pressure exposure, and exposure to surface rarefaction (negative pressure) waves. The maximum potential for injury is predicted to occur where the surface reflected rarefaction (negative) pressure wave arrives coincident with the moment of maximum compression of the swim bladder caused by exposure to the direct positive blast pressure wave, resulting in a subsequent maximum expansion of the swim bladder. Goertner (1978) and Wiley et al. (1981) found that their swim bladder oscillation model explained the injury data in the Yelverton et al. (1975) exposure study, and their impulse parameter was applicable only to fishes at shallow enough depths to experience less than one swim bladder oscillation before being exposed to the following surface rarefaction wave.

O’Keeffe (1984) provides calculations and contour plots that allow estimation of the range to potential effects of in-water explosions on fish possessing swim bladders using the damage prediction model developed by Goertner (1978). O’Keeffe’s (1984) parameters include the charge weight, depth of burst, and the size and depth of the fish, but the estimated ranges do not take into account unique propagation environments that could reduce or increase the range to effect. The 10 percent mortality ranges are shown below in Table 3.9-7. In contrast to fishes with swim bladders, fishes without swim bladders have been shown to be more resilient to explosives (Gaspin, 1975; Gaspin et al., 1976; Goertner et al., 1994). For example, some small (average 116 mm length; approximately 1 ounce [oz.]) hogchokers (*Trinectes maculatus*) exposed less than 5 ft. from a 10-pound pentolite charge immediately survived the exposure with slight to moderate injuries, and only a small number of fish were immediately killed; however, most of the fish at this close range did suffer moderate to severe injuries, typically of the gills or around the otolithic structures (Goertner et al., 1994).

Table 3.9-5 is the maximum horizontal range predicted by O'Keeffe (1984) for 10 percent of fish suffering injuries that are expected to not be survivable (e.g., damaged swim bladder or severe hemorrhaging). Fish at greater depths and near the surface are predicted to be less likely to be injured because geometries of the exposures would limit the amplitude of swim bladder oscillations.

**Table 3.9-5: Range to 10 Percent Mortality from In-water Explosions for Fishes with a Swim Bladder**

| *Weight of Pentolite (lb.) [NEW, lb.][1]* | *Depth of Explosion (ft.) [m]* | *10% Mortality Maximum Range (ft.) [m]* | | |
|---|---|---|---|---|
| | | *1 oz. Fish* | *1 lb. Fish* | *30 lb. Fish* |
| 10 [13] | 10 [3] | 530 [162] | 315 [96] | 165 [50] |
| | 50 [15] | 705 [214] | 425 [130] | 260 [79] |
| | 200 [61] | 905 [276] | 505 [154] | 290 [88] |
| 100 [130] | 10 [3] | 985 [300] | 600 [183] | 330 [101] |
| | 50 [15] | 1,235 [376] | 865 [264] | 590 [180] |
| | 200 [61] | 1,340 [408] | 1,225 [373] | 725 [221] |
| 1,000 [1,300] | 10 [3] | 1,465 [447] | 1,130 [344] | 630 [192] |
| | 50 [15] | 2,255 [687] | 1,655 [504] | 1,130 [344] |
| | 200 [61] | 2,870 [875] | 2,390 [728] | 1,555 [474] |
| 10,000 [13,000] | 10 [3] | 2,490 [759] | 1,920 [585] | 1,155 [352] |
| | 50 [15] | 4,090 [1,247] | 2,885 [879] | 2,350 [716] |
| | 200 [61] | 5,555 [1,693] | 4,153 [1,266] | 3,090 [942] |

[1] Explosive weights of pentolite converted to net explosive weight using the peak pressure parameters in Swisdak (1978).
Notes: ft. = feet, lb. = pounds, m = meters, NEW = net explosive weight, oz. = ounce
Source: Data from O'Keeffe (1984)

In contrast to fishes with swim bladders, fishes without swim bladders have been shown to be more resilient to explosives (Gaspin, 1975; Gaspin et al., 1976; Goertner et al., 1994). For example, some small (average 116 mm length; approximately 1 oz.) hogchokers (*Trinectes maculatus*) exposed less than 5 ft. from a 10 pound pentolite charge immediately survived the exposure with slight to moderate injuries, and only a small number of fish were immediately killed; however, most of the fish at this close range did suffer moderate to severe injuries, typically of the gills or around the otolithic structures (Goertner et al., 1994).

Studies that have documented caged fishes killed during planned underwater explosions indicate that most fish that die do so within one to four hours, and almost all die within a day (Yelverton et al., 1975). Mortality in free-swimming (uncaged) fishes may be higher due to increased susceptibility to predation. Fitch and Young (1948) found that the type of free-swimming fish killed changed when blasting was repeated at the same 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.

Fitch and Young (1948) also investigated whether a significant portion of fish killed would have sunk and not been observed at the surface. Comparisons of the numbers of fish observed dead at the surface and at the bottom in the same affected area after an explosion showed that fish found dead on the bottom comprised less than 10 percent of the total observed mortality. Gitschlag et al. (2000) conducted a more detailed study of both floating fishes and those that were sinking or lying on the bottom after explosive removal of nine oil platforms in the northern Gulf of Mexico. Results were highly variable. They found that 3–87 percent (46 percent average) of the red snapper killed during a blast might float to the surface. Currents, winds, and predation by seabirds or other fishes may be some of the reasons that the magnitude of fish mortality may not have been accurately captured.

There have been few studies of the impact of underwater explosives on early life stages of fish (eggs, larvae, juveniles). Fitch and Young (1948) reported mortality of larval anchovies exposed to underwater blasts off California. Nix and Chapman (1985) found that anchovy and smelt larvae died following the detonation of buried charges. Similar to adult fishes, the presence of a swim bladder contributes to shock wave-induced internal damage in larval and juvenile fish (Settle et al., 2002). Explosive shock wave injury to internal organs of larval pinfish and spot exposed at shallow depths was documented by Settle et al. (2002) and Govoni et al. (2003; 2008) at impulse levels similar to those predicted by Yelverton et al. (1975) for very small fish. Settle et al. (2002) provide the lowest measured received level that injuries have been observed in larval fish. Researchers (Faulkner et al., 2006; Faulkner et al., 2008; Jensen, 2003) have suggested that egg mortality may be correlated with peak particle velocity exposure (i.e., the localized movement or shaking of water particles, as opposed to the velocity of the blast wave), although sufficient data from direct explosive exposures is not available (2003; 2008).

Rapid pressure changes could cause mechanical damage to sensitive ear structures due to differential movements of the otolithic structures. Bleeding near otolithic structures was the most commonly observed injury in non-swim bladder fish exposed to a close explosive charge (Goertner et al., 1994).

Although effects from explosives have been examined, results from other impulsive sound exposure studies, such as those for seismic air or water guns and impact pile driving (acoustic stressors), may also be useful in interpreting effects where data are lacking for explosive sources (see discussion below Section 3.9.2.1.1.1, Injury).

As summarized by the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014), exposure to explosive energy poses the greatest potential threat for injury and mortality in marine fishes. Fishes with a swim bladder are more susceptible to injury than fishes without a swim bladder. The susceptibility also probably varies with size and depth of both the detonation and the fish. Fish larvae or juvenile fish may be more susceptible to injury from exposure to explosives.

#### 3.9.2.2.1.2 Hearing Loss

There are no direct measurements of hearing loss in fishes due to exposure to explosive sources. The sound resulting from an explosive detonation is considered an impulsive sound and shares important qualities (i.e., short duration and fast rise time) with other impulsive sounds such as those produced by air guns. PTS in fish has not been known to occur in species tested to date and 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 (Popper et al., 2005; Popper et al., 2014; Smith et al., 2006).

As reviewed in Popper et al. (2014), fishes without a swim bladder, or fishes with a swim bladder not involved in hearing, would be less susceptible to hearing loss (i.e., TTS), even at higher level exposures. Fish with a swim bladder involved in hearing may be susceptible to TTS within very close ranges to an explosive. General research findings regarding TTS in fishes as well as findings specific to exposure to other impulsive sound sources are discussed in Section 3.9.2.1.1.2 (Hearing Loss).

#### 3.9.2.2.1.3 Masking

Masking refers to the presence of a noise that interferes with a fish's ability to hear biologically important sounds, including those produced by prey, predators, or other fish in the same species (Myrberg, 1980; Popper et al., 2003). This can take place whenever the noise level heard by a fish exceeds the level of a biologically relevant sound. As discussed in Section 3.0.4.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities), masking only occurs in the presence of the masking noise and does not persist after the cessation of the noise. Masking may lead to a change in vocalizations or a change in behavior (e.g., cessation of foraging, leaving an area).

There are no direct observations of masking in fishes due to exposure to explosives. The *ANSI Sound Exposure Guideline* technical report (2014) highlights a lack of data that exist for masking by explosives but suggests that the intermittent nature of explosions would result in very limited probability of any masking effects, and if masking were to occur it would only occur during the duration of the sound. General research findings regarding masking in fishes due to exposure to sound are discussed in detail in Section 3.9.2.1.1.3 (Masking). Potential masking from explosives is likely to be similar to masking studied for other impulsive sounds such as air guns.

#### 3.9.2.2.1.4 Physiological Stress

Fishes naturally experience stress within their environment and as part of their life histories. The stress response is a suite of physiological changes that are meant to help an organism mitigate the impact of a stressor. However, if the magnitude and duration of the stress response is too great or too long, then it can have negative consequences to the organism (e.g., decreased immune function, decreased reproduction). Section 3.0.4.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors) provides additional information on physiological stress and the framework used to analyze this potential impact.

Research on physiological stress in fishes due to exposure to explosive sources is limited. Sverdrup et al. (1994) studied levels of stress hormones in Atlantic salmon after exposure to multiple detonations in a laboratory setting. Increases in cortisol and adrenaline were observed following the exposure, with adrenaline values returning to within normal range within 24 hours. General research findings regarding physiological stress in fishes due to exposure to acoustic sources are discussed in detail in Section 3.9.2.1.1.4 (Physiological Stress). Generally, stress responses are more likely to occur in the presence of potentially threatening sound sources such as predator vocalizations or the sudden onset of impulsive signals. Stress responses may be brief (a few seconds to minutes) if the exposure is short or if fishes habituate or learn to tolerate the noise. It is assumed that any physiological response (e.g., hearing loss or injury) or significant behavioral response is also associated with a stress response.

#### 3.9.2.2.1.5 Behavioral Reactions

As discussed in Section 3.0.4.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors), any stimuli in the environment can cause a behavioral response in fishes, including sound and energy produced by explosions. Behavioral reactions of fishes to explosions have not been recorded. Behavioral reactions from explosive sounds are likely to be similar to reactions studied for other impulsive sounds such as those produced by air guns. Impulsive signals, particularly at close range, have a rapid rise time and higher instantaneous peak pressure than other signal types, making them more likely to cause startle or avoidance responses. General research findings regarding behavioral reactions from fishes due to exposure to impulsive sounds, such as those associated with explosions, are discussed in detail in Section 3.9.2.1.1.5 (Behavioral Reactions).

As summarized by the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014), species may react differently to the same sound source depending on a number of variables, such as the animal's life stage or behavioral state (e.g., feeding, mating). Without data that are more specific it is assumed that fishes with similar hearing capabilities react similarly to all impulsive sounds outside or within the zone for hearing loss and injury. Observations of fish reactions to large-scale air gun surveys are informative, but not necessarily directly applicable to analyzing impacts from the short-term, intermittent use of all impulsive sources. Fish have a higher probability of reacting when closer to an impulsive sound source (within tens of meters), and a decreasing probability of reaction at increasing distances (Popper et al., 2014).

#### 3.9.2.2.1.6 Long-Term Consequences

Long-term consequences to a population are determined by examining changes in the population growth rate. For additional information on the determination of long-term consequences, see Section 3.0.4.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors). Physical effects from explosive sources that could lead to a reduction in the population growth rate include mortality or injury, which could remove animals from the reproductive pool, and permanent hearing impairment or chronic masking, which could affect navigation, foraging, predator avoidance, or communication. The long-term consequences due to individual behavioral reactions, masking, and short-term instances of physiological stress are especially difficult to predict because individual experience over time can create complex contingencies, especially for fish species that live for multiple seasons or years. For example, a lost reproductive opportunity could be a measurable cost to the individual; however, short-term costs may be recouped during the life of an otherwise healthy individual. These factors are taken into consideration when assessing risk of long-term consequences.

#### 3.9.2.2.2 Impacts from Explosives

Fishes could be exposed to energy and sound from in-water and in-air explosions associated with proposed activities. General categories and characteristics of explosives and the numbers and sizes of detonations proposed are described in Section 3.0.4.2 (Explosive Stressors). The activities analyzed in this SEIS/OEIS that use explosives are also described in Appendix A (Training and Testing Activities Descriptions).

As discussed above, sound and energy from in-water explosions are capable of causing mortality, injury, hearing loss, masking, physiological stress, or a behavioral response, depending on the level and duration of exposure. The death of an animal would eliminate future reproductive potential, which is considered in the analysis of potential long-term consequences to the population. Exposures that result in non-auditory injuries may limit an animal's ability to find food, communicate with other animals, or interpret the surrounding environment. Impairment of these abilities can decrease an individual's chance of survival or affect its ability to reproduce. Temporary threshold shift can also impair an animal's abilities, although the individual may recover quickly with little significant effect.

The overall use of explosives for training and testing activities would be similar to what is currently conducted and several new testing activities would occur (see Table 2.5-1 and Table 2.5-2 for details). Although individual activities may vary some from those previously analyzed, the overall determinations presented in the 2015 MITT Final EIS/OEIS remain valid.

#### 3.9.2.2.2.1 Methods for Analyzing Impacts from Explosives

The Navy performed a quantitative analysis to estimate ranges to effect for fishes exposed to underwater explosives during Navy training and testing activities. Inputs to the quantitative analysis included sound propagation modeling in the Navy Acoustic Effects Model to the sound exposure criteria and thresholds presented below. Density data for fish species within the Study Area are not currently available; therefore, it is not possible to estimate the total number of individuals that may be affected by explosive activities.

**<u>Criteria and Thresholds used to Estimate Impacts on Fishes from Explosives</u>**

**Mortality and Injury from Explosives**

Criteria and thresholds to estimate impacts from sound and energy produced by explosive activities are presented in Table 3.9-6. In order to estimate the longest range at which a fish may be killed or mortally injured, the Navy based the threshold for mortal injury on the lowest pressure that caused mortalities in the study by Hubbs and Rechnitzer (1952), consistent with the recommendation in the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014). As described in Section 3.9.2.2.1.1 (Injury), this threshold likely overestimates the potential for mortal injury. The potential for mortal injury has been shown to be correlated to fish size, depth, and geometry of exposure, which are not accounted for by using a peak pressure threshold. However, until fish mortality models are developed that can reasonably consider these factors across multiple environments, use of the peak pressure threshold allows for a conservative estimate of maximum impact ranges.

Due to the lack of detailed data for onset of injury in fishes exposed to explosives, thresholds from impact pile driving exposures (Halvorsen et al., 2011; Halvorsen et al., 2012a; Halvorsen et al., 2012b) were used as a proxy for the analysis in the Atlantic Fleet Training and Testing EIS/OEIS. Upon re-evaluation, it was decided that pile driving thresholds are too conservative and not appropriate to use in the analysis of explosive effects on fishes. Therefore, injury criteria have been revised as follows.

Thresholds for the onset of injury from exposure to explosions are not currently available and recommendations in the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014) only provide qualitative criteria for consideration. Therefore, available data from existing explosive studies were reviewed to provide a conservative estimate for a threshold to the onset of injury (Gaspin, 1975; Gaspin et al., 1976; Hubbs & Rechnitzer, 1952; Settle et al., 2002; Yelverton et al., 1975). It is important to note that some of the available literature is not peer-reviewed and may have some caveats to consider when reviewing the data (e.g., issues with controls, limited details on injuries observed, etc.) but this information may still provide a better understanding of where injurious effects would begin to occur specific to explosive activities. The lowest threshold at which injuries were observed in each study were recorded and compared for consideration in selecting criteria. As a conservative measure, the absolute lowest peak sound pressure level recorded that resulted in injury, observed in exposures of larval fishes to explosions (Settle et al., 2002), was selected to represent the threshold to injury.

**Table 3.9-6: Sound Exposure Criteria for Mortality and Injury from Explosives**

| *Fish Hearing Group* | *Onset of Mortality* | *Onset of Injury* |
|---|---|---|
| | $SPL_{peak}$ | $SPL_{peak}$ |
| Fishes without a swim bladder | 229 | 220 |
| Fishes with a swim bladder not involved in hearing | 229 | 220 |
| Fishes with a swim bladder involved in hearing | 229 | 220 |
| Fishes with a swim bladder and high-frequency hearing | 229 | 220 |

Note: $SP_{Lpeak}$ = Peak sound pressure level.

The injury threshold is consistent across all fish, regardless of hearing groups, due to the lack of rigorous data for multiple species. It is important to note that these thresholds may be overly conservative as there is evidence that fishes exposed to higher thresholds than the those in Table 3.9-6 have shown no signs of injury (depending on variables such as the weight of the fish, size of the explosion, and depth of the cage). It is likely that adult fishes and fishes without a swim bladder would be less susceptible to injury than more sensitive hearing groups and larval species.

The number of fish killed by an in-water explosion would depend on the population density near the blast, as well as factors discussed throughout Section 3.9.2.2.1.1 (Injury) 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 menhaden, herring, or other schooling fish, a large number of fish could be killed. However, the probability of this occurring is low based on the patchy distribution of dense schooling fish. Stunning from pressure waves could also temporarily immobilize fish, making them more susceptible to predation.

Fragments produced by exploding munitions at or near the surface may present a high-speed strike hazard for an animal at or near the surface. In water, however, fragmentation velocities decrease rapidly due to drag (Swisdak & Montanaro, 1992). Because blast waves propagate efficiently through water, the range to injury from the blast wave would likely extend beyond the range of fragmentation risk.

**Hearing Loss from Explosives**

Criteria and thresholds to estimate TTS from sound produced by explosive activities are presented below in Table 3.9-7. Direct (measured) TTS data from explosives are not available. Criteria used to define TTS from explosives is derived from data on fishes exposed to seismic air gun signals (Popper et al., 2005) as summarized in the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014). TTS has not been documented in fishes without a swim bladder from exposure to other impulsive sources (pile driving and air guns). Although it is possible that fishes without a swim bladder could receive TTS from exposure to explosives, fishes without a swim bladder are typically less susceptible to hearing impairment than fishes with a swim bladder. If TTS occurs in fishes without a swim bladder, it would likely occur within the range of injury; therefore, no thresholds for TTS are proposed. General research findings regarding hearing loss in fishes as well as findings specific to exposure to other impulsive sound sources are discussed in Section 3.9.2.2.1.2 (Hearing Loss).

As discussed in Section 3.9.2.2.1.2 (Hearing Loss), exposure to sound produced from seismic air guns at a cumulative sound exposure level of 186 dB re 1 μPa$^2$-s has resulted in TTS in fishes with a swim bladder involved in hearing (Popper et al., 2005). TTS has not occurred in fishes with a swim bladder not involved in hearing and would likely occur above the given threshold in Table 3.9-7.

**Table 3.9-7: Sound Exposure Criteria for Hearing Loss from Explosives**

| ***Fish Hearing Group*** | ***TTS (SEL$_{cum}$)*** |
|---|---|
| Fishes without a swim bladder | NC |
| Fishes with a swim bladder not involved in hearing | > 186 |
| Fishes with a swim bladder involved in hearing | 186 |
| Fishes with a swim bladder and high-frequency hearing | 186 |

Notes: TTS = Temporary Threshold Shift, SEL$_{cum}$ = Cumulative sound exposure level (decibel referenced to 1 micropascal squared seconds [dB re 1 μPa2-s]), NC = no criteria are reported, “>” indicates that the given effect would occur above the reported threshold.

#### 3.9.2.2.2.2 Impact Ranges for Explosives

The following section provides estimated range to effects for fishes exposed to sound and energy produced by explosives. Ranges are calculated using criteria from Table 3.9-6 and Table 3.9-7 and the Navy Acoustic Effects Model. Fishes within these ranges would be predicted to receive the associated effect. Ranges may vary greatly depending on factors such as the cluster size, location, depth, and season of the event.

Table 3.9-8 provides range to mortality and injury for all fishes. Only one table (Table 3.9-9) is provided for range to TTS for all fishes with a swim bladder. However, ranges to TTS for fishes with a swim bladder not involved in hearing would be shorter than those reported because this effect has not been observed in fishes without a swim bladder exposed to the described TTS threshold.

#### 3.9.2.2.2.3 Impacts from Explosives Under Alternative 1

Activities using explosives would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Training and Testing Activities Descriptions). General characteristics, quantities, and net explosive weights of in-water explosives used during training and testing activities under Alternative 1 are provided in Section 3.0.4.2 (Explosive Stressors).

## Table 3.9-8: Range to Mortality and Injury for All Fishes from Explosives

| Bin | Range to Effects (meters) | |
|---|---|---|
| | Onset of Mortality | Onset of Injury |
| | $SPL_{peak}$ | $SPL_{peak}$ |
| E1 (0.25 lb. NEW) | 50<br>(45–50) | 122<br>(120–130) |
| E2 (0.5 lb. NEW) | 63<br>(60–65) | 156<br>(110–170) |
| E3 (2.5 lb. NEW) | 108<br>(100–110) | 276<br>(260–280) |
| E4 (5 lb. NEW) | 141<br>(140–170) | 381<br>(350–725) |
| E5 (10 lb. NEW) | 175<br>(170–250) | 433<br>(410–775) |
| E6 (20 lb. NEW) | 218<br>(210–230) | 526<br>(500–625) |
| E7 (60 lb. NEW) | 330<br>(330–330) | 856<br>(825–875) |
| E8 (100 lb. NEW) | 375<br>(360–410) | 920<br>(850–1,025) |
| E9 (250 lb. NEW) | 490<br>(480–500) | 1,025<br>(1,025–1,025) |
| E10 (500 lb. NEW) | 617<br>(600–775) | 1,388<br>(1,275–1,775) |
| E11 (650 lb. NEW) | 785<br>(700–1,525) | 2,111<br>(1,525–4,775) |
| E12 (1,000 lb. NEW) | 770<br>(750–800) | 1,781<br>(1,775–2,025) |
| E16 (14,500 lb. NEW) | 50<br>(45–50) | 122<br>(120–130) |

Notes: SPLpeak = Peak sound pressure level. Range to effects represent modeled predictions in different areas and seasons within the Study Area. Each cell contains the estimated average, minimum and maximum range to the specified effect.
NEW = net explosive weight, lb. = pound(s)

## Table 3.9-9: Range to TTS for Fishes with a Swim Bladder from Explosives

| *Bin* | *Cluster Size* | *Range to Effects (meters)* |
|---|---|---|
| | | *TTS*[1] |
| | | *SEL$_{cum}$* |
| E1 (0.25 lb. NEW) | 1 | < 50<br>(45–55) |
| | 18 | < 196<br>(160–230) |
| E2 (0.5 lb. NEW) | 1 | < 58<br>(55–60) |
| E3 (2.5 lb. NEW) | 1 | < 127<br>(95–160) |
| | 19 | < 474<br>(340–600) |
| E4 (5 lb. NEW) | 1 | < 204<br>(190–300) |
| E5 (10 lb. NEW) | 1 | < 172<br>(150–450) |
| | 20 | < 674<br>(525–2,775) |
| E6 (20 lb. NEW) | 1 | < 210<br>(190–390) |
| E7 (60 lb. NEW) | 1 | < 634<br>(600–725) |
| E8 (100 lb. NEW) | 1 | < 527<br>(310–775) |
| E9 (250 lb. NEW) | 1 | < 513<br>(420–1,025) |
| E10 (500 lb. NEW) | 1 | < 685<br>(525–1,775) |
| E11 (650 lb. NEW) | 1 | < 1,679<br>(1,525–2,775) |
| E12 (1,000 lb. NEW) | 1 | < 815<br>(675–2,025) |

Notes: SELcum = Cumulative sound exposure level, TTS = Temporary Threshold Shift, "<" indicates that the given effect would occur at distances less than the reported range(s). Range to effects represent modeled predictions in different areas and seasons within the Study Area. Each cell contains the estimated average, minimum and maximum range to the specified effect. NEW = net explosive weight, lb. = pound(s)

Under Alternative 1, there could be fluctuation in the amount of explosions that could occur annually, although potential impacts would be similar from year to year. The number of impulsive sources in this SEIS/OEIS compared with the totals analyzed in the 2015 MITT Final EIS/OEIS are described in Table 2.5-1 and Table 2.5-2. The number of torpedo testing activities (both explosive and non-explosive) planned under Alternative 1 testing can vary slightly from year to year; however, all other training and testing activities would remain consistent from year to year.

With the exception of mine warfare events which occur at the three established Underwater Detonation ranges, most scheduled training and testing activities involving explosions would occur well offshore (greater than 12 NM), primarily within special use airspace (e.g., W-517). Activities that involve underwater detonations and explosive munitions typically occur more than 3 NM from shore and in the range complexes, rather than in the transit corridor. The Navy will implement mitigation to avoid potential impacts on hammerhead sharks in the Mariana Islands Range Complex during explosive mine neutralization activities involving Navy divers, as discussed in Section 5.3.3 (Explosive Stressors). In addition to procedural mitigation, the Navy will implement mitigation to avoid impacts from explosives on seafloor resources in mitigation areas throughout the Study Area (see Section 5.4.1, Mitigation Areas for Seafloor Resources), which will consequently also help avoid potential impacts on fishes that shelter and feed on shallow-water coral reefs, live hard bottom, artificial reefs, and shipwrecks.

Sound and energy from explosions could result in mortality and injury, on average, for hundreds to even thousands of meters from some of the largest explosions. Exposure to explosions could also result in hearing loss in nearby fishes. The estimated range to each of these effects based on explosive bin size is provided in Table 3.9-8 and Table 3.9-9. Generally, explosives that belong to larger bins (with large net explosive weights) produce longer ranges within each effect category. However, some ranges vary depending upon a number of other factors (e.g., number of explosions in a single event, depth of the charge, etc.). Fishes without a swim bladder, adult fishes, and larger species would generally be less susceptible to injury and mortality from sound and energy associated with explosive activities than small, juvenile or larval fishes. Fishes that experience hearing loss could miss opportunities to detect predators or prey, or show a reduction in interspecific communication.

If an individual fish were repeatedly exposed to sound and energy from in-water 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. If detonations occurred close together (within a few seconds), there could be the potential for masking to occur but this would likely happen at farther distances from the source where individual detonations might sound more continuous. Training and testing activities involving explosions are generally dispersed in space and time. Consequently, repeated exposure of individual fishes to sound and energy from in-water explosions over the course of a day or multiple days is not likely and most behavioral effects are expected to be short-term (seconds or minutes) and localized. Exposure to multiple detonations over the course of a day would most likely lead to an alteration of natural behavior or the avoidance of that specific area.

As discussed previously in Section 3.9.1.1 (Hearing and Vocalization), all ESA-listed fish species that occur in the Study Area are capable of detecting sound produced by explosives. In addition, all ESA-listed species that occur in the Study Area may be exposed to explosives associated with training and testing activities. The Indo-West Pacific Distinct Population Segment of scalloped hammerhead could occur in nearshore waters, such as bays and estuaries, but is also known to occur in offshore portions of the Study Area. The giant manta ray and oceanic whitetip shark would most likely be exposed to low-frequency sonar in offshore areas throughout the Study Area. Overall, impacts on ESA-listed species that encounter explosions would be similar to those discussed above for impacts on fishes in general.

*Pursuant to the ESA, the use of explosives during training and testing activities, as described under Alternative 1, may affect ESA-listed Indo-West Pacific Distinct Population Segment scalloped hammerhead sharks, oceanic whitetip sharks and giant manta rays.*

###### 3.9.2.2.2.4 Impacts from Explosives Under Alternative 2

As described in Chapter 2 (Description of Proposed Action and Alternatives), Section 3.0.4.2 (Explosive Stressors), and Appendix A (Training and Testing Activities Descriptions), training and testing activities under Alternative 2 would be almost identical to those described under Alternative 1. The differences in the number of events within each range complex across a year is nominal with only slight changes annually; therefore, the locations, types, and severity of predicted impacts would not be discernible from those described above in Section 3.9.2.2.2.3 (Impacts from Explosives Under Alternative 1 – Training Activities).

*Pursuant to the ESA, the use of explosives during training and testing activities, as described under Alternative 2, may affect ESA-listed Indo-West Pacific Distinct Population Segment scalloped hammerhead sharks, oceanic whitetip sharks and giant manta rays.*

###### 3.9.2.2.2.5 Impacts from Explosives Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Explosive stressors, as described above, would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer explosive stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for explosive impacts on individual fishes, but would not measurably improve the status of fish populations or subpopulations, including those listed under ESA and those federally managed under the MSA.

#### 3.9.2.3 Energy Stressors

Energy stressors are discussed in Section 3.0.4.3. Energy stressors that may impact fishes include in-water electromagnetic devices and high-energy lasers. While the number of training and testing events would change under this SEIS/OEIS, the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.9.3.2 (Energy Stressors) remains valid. The changes in training and testing activities are not substantial and would not result in an appreciable change to existing environmental conditions or an increase in the level or intensity of energy stressors within the Study Area. High-energy lasers were not covered in the 2015 MITT Final EIS/OEIS and represent a new stressor analyzed in this SEIS/OEIS.

As discussed in Section 3.0.4.3.2.2 (High-Energy Lasers), high-energy laser weapons are designed to disable surface targets, rendering them immobile. Fish could be exposed to a laser only if the beam missed the target. Should the laser strike the sea surface, individual fish at or near the surface could be exposed. The potential for exposure to a high-energy laser beam decreases as the water depth increases. Most fish are unlikely to be exposed to laser activities because they primarily occur more than a few meters below the sea surface.

#### 3.9.2.3.1 Impacts from In-Water Electromagnetic Devices Under Alternative 1

Under Alternative 1, the number of proposed training and testing events involving the use of in-water electromagnetic devices would decrease in comparison to the 2015 MITT Final EIS/OEIS (Table 3.0-9). The activities would occur in the same locations and in a similar manner as were analyzed previously.

As stated in the 2015 MITT Final EIS/OEIS, in-water electromagnetic devices 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. 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.

ESA-listed scalloped hammerhead sharks, oceanic whitetip sharks, and giant manta rays are capable of detecting electromagnetic energy. Therefore, energy stressors such as in-water electromagnetic devices could affect these species by causing temporary disturbances in their normal sensory perception during migratory or foraging movements, or avoidance reactions (Kalmijn, 2000). However, electromagnetic signals are temporally variable and would cover only a small spatial range during each activity in the Study Area. Therefore, impacts on fishes under Alternative 1 from in-water electromagnetic devices would be negligible.

*Pursuant to the ESA, the use of in-water electromagnetic devices associated with training and testing activities, as described under Alternative 1, may affect ESA-listed Indo-West Pacific Distinct Population Segment of scalloped hammerhead sharks oceanic whitetip sharks, and giant manta rays.*

#### 3.9.2.3.2 Impacts from In-Water Electromagnetic Devices Under Alternative 2

Under Alternative 2, the number of proposed training and testing events involving the use of in-water electromagnetic devices would decrease in comparison to the 2015 MITT Final EIS/OEIS (Table 3.0-9). The activities would occur in the same locations and in a similar manner as were analyzed previously and above for Alternative 1.

Under Alternative 2, impacts on fishes from in-water electromagnetic devices should not be expected to occur and would be negligible.

*Pursuant to the ESA, the use of in-water electromagnetic devices associated with training and testing activities, as described under Alternative 2, may affect ESA-listed Indo-West Pacific Distinct Population Segment of scalloped hammerhead sharks, oceanic whitetip sharks, and giant manta rays.*

#### 3.9.2.3.3 Impacts from In-Water Electromagnetic Devices Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Energy stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer energy stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for energy impacts on individual fishes, but would not measurably improve the status of fish populations or subpopulations, including those listed under ESA and those federally managed under the MSA.

#### 3.9.2.3.4 Impacts from High-Energy Lasers Under Alternative 1

Under Alternative 1, the number of proposed events involving the use of high-energy lasers would be 54 (Table 3.0-10); this is a new substressor that was not analyzed in the 2015 MITT Final EIS/OEIS. As discussed above, the potential for fishes to be exposed to high-energy lasers is extremely low, and impacts from high-energy laser activities proposed under Alternative 1 should not be expected to occur. Therefore, impacts on fishes under Alternative 1 from high-energy lasers, would be negligible.

*Pursuant to the ESA, the use of high-energy lasers during training and testing activities, as described under Alternative 1, may affect ESA-listed Indo-West Pacific Distinct Population Segment of scalloped hammerhead sharks oceanic whitetip sharks, and giant manta rays.*

#### 3.9.2.3.5 Impacts from High-Energy Lasers Under Alternative 2

Under Alternative 2, the number of proposed events involving the use of high-energy lasers would increase from 54 to 60 compared to Alternative 1 (Table 3.0-10) and the 2015 MITT Final EIS/OEIS; however, as discussed above, impacts on fishes from high-energy lasers should not be expected to occur. Therefore, impacts on fishes under Alternative 2 from energy stressors, including high-energy lasers, would be negligible.

*Pursuant to the ESA, the use of high-energy lasers during training and testing activities, as described under Alternative 2, may affect ESA-listed Indo-West Pacific Distinct Population Segment of scalloped hammerhead sharks, oceanic whitetip sharks, and giant manta rays.*

#### 3.9.2.3.6 Impacts from High-Energy Lasers Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Energy stressors, as listed above, would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer energy stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for energy impacts on individual fishes, but would not measurably improve the status of fish populations or subpopulations, including those listed under ESA and those federally managed under the MSA.

### 3.9.2.4 Physical Disturbance and Strike Stressors

Physical disturbance and strike stressors are discussed in Section 3.0.4.4. Physical disturbance and strike stressors that may impact fishes include (1) vessels and in-water devices, (2) military expended materials, and (3) seafloor devices. While the number of training and testing events would change under this SEIS/OEIS, the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.9.3.3 (Physical Disturbance and Strike) remains valid. The changes in training and testing activities are not substantial and would not result in an overall change to existing environmental conditions or an increase in the level or intensity of physical disturbance and strike stressors within the Study Area.

As stated in the 2015 MITT Final EIS/OEIS, with few exceptions, activities involving vessels and in-water devices are not intended to contact the seafloor. There is minimal potential strike impact other than bottom-crawling unmanned underwater vehicles. Physical disturbance and strike stressors from vessels and in-water devices, military expended materials, and seafloor devices have the potential to affect all marine fish groups found within the Study Area, although some fish groups may be more susceptible to strike potential than others. In addition, the potential responses to physical strikes are varied, but include behavioral changes such as avoidance, altered swimming speed and direction, physiological stress, and physical injury or mortality.

#### 3.9.2.4.1 Impacts from Physical Disturbance and Strike Stressors Under Alternative 1

Under Alternative 1, the combined number of proposed training and testing events involving vessels and in-water devices would decrease slightly from those presented in the 2015 MITT Final EIS/OEIS (Table 3.0-12 and Table 3.0-13). Military expended materials (Table 3.0-14, Table 3.0-15, and Table 3.0-16) combined would generally increase, and seafloor devices (Table 3.0-18) would decrease slightly from the number in the 2015 MITT Final EIS/OEIS. Increases in physical disturbance and strike stressors, such as military expended materials, could increase the level of impact on some fishes. Analysis by individual category of expended items indicates that those items having the most potential to affect fishes have decreased. Overall, these changes do not appreciably change the analysis or impact conclusions presented in the 2015 MITT Final EIS/OEIS because the impact analysis was based on the probability of an impact on a resource.

The risk of a strike from vessels and in-water devices used in training and testing activities on an individual fish 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. Therefore, impacts on fish or fish populations would be negligible.

Similar to most other fish species described above, ESA-listed scalloped hammerhead sharks, oceanic whitetip sharks, and giant manta rays, would be able to sense pressure changes in the water column and swim quickly, and are likely to escape collision with vessels and in-water devices.

Therefore, under Alternative 1, impacts on fishes from the use of vessels and in-water devices, military expended materials, and seafloor devices would be negligible.

*Pursuant to the ESA, the use of vessels and in-water devices associated with training and testing activities, as described under Alternative 1, may affect ESA-listed Indo-West Pacific Distinct Population Segment of scalloped hammerhead sharks, oceanic whitetip sharks, and giant manta rays.*

#### 3.9.2.4.2 Impacts from Physical Disturbance and Strike Stressors Under Alternative 2

Under Alternative 2, the combined number of proposed training and testing events involving vessels and in-water devices would decrease slightly from those presented in the 2015 MITT Final EIS/OEIS (Table 3.0-12 and Table 3.0-13). Military expended materials (Table 3.0-14, Table 3.0-15, and Table 3.0-16) combined would generally increase, and seafloor devices (Table 3.0-18) would decrease slightly from the number in the 2015 MITT Final EIS/OEIS. Increases in some physical disturbance and strike stressors such as military expended materials could increase the impact risk on fishes but does not appreciably change the analysis or impact conclusions presented in the 2015 MITT Final EIS/OEIS. Impacts on fishes would be inconsequential for the same reasons detailed above and would have no appreciable change on the impact conclusions for physical disturbance and strike stressors, as presented in the 2015 MITT Final EIS/OEIS and summarized above under Alternative 1.

Therefore, under Alternative 2, impacts on fishes from physical disturbance and strike would be negligible.

*Pursuant to the ESA, the use of vessels and in-water devices associated with training and testing activities, as described under Alternative 2, may affect ESA-listed Indo-West Pacific Distinct Population Segment of scalloped hammerhead sharks, oceanic whitetip sharks, and giant manta rays.*

#### 3.9.2.4.3 Impacts from Physical Disturbance and Strike Stressors Under the No Action Alternative

Under the No Action Alternative, proposed training and testing. Other military activities not associated with this Proposed Action would continue to occur. Physical disturbance and strike stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer physical disturbance and strike stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for physical disturbance and strike impacts on individual fishes, but would not measurably improve the status of fish populations or subpopulations, including those listed under ESA and those federally managed under the MSA.

### 3.9.2.5 Entanglement Stressors

Entanglement stressors are discussed in Section 3.0.4.5. Entanglement stressors considered for fishes include (1) fiber optic cable and guidance wires, and (2) decelerators/parachutes. The annual number of wires and cables and decelerators/parachutes proposed under the alternatives and in comparison to current ongoing activities are presented in Tables 3.0-20, 3.0-21, and 3.0-22. There have been no known instances of any fish being entangled in wires and cables, or decelerators/parachutes associated with Navy training and testing activities prior to or since the 2015 MITT Final EIS/OEIS.

#### 3.9.2.5.1 Impacts from Entanglement Stressors Under Alternative 1

Under Alternative 1, the combined number of fiber optic cables (Table 3.0-20) decrease, guidance wires (Table 3.0-21) increase, and decelerators/parachutes (Table 3.0-22) decrease compared to the number of events proposed in the 2015 MITT Final EIS/OEIS. Decreases in the number of training and testing events would potentially decrease the level of entanglement stressors on fishes in the Study Area.

As stated in the 2015 MITT Final EIS/OEIS, while individual fish susceptible to entanglement would encounter wires and cables, including guidance wires, fiber optic cables, and sonobuoy wires during training and testing activities, the long-term consequences of entanglement are unlikely for either individuals or populations because (1) the encounter rate for wires and cables is low, (2) the types of fishes that are susceptible to these items is limited, (3) there is restricted overlap with susceptible fishes, and (4) the physical characteristics of the wires and cables reduce entanglement risk to fishes compared to monofilament used for fishing gear. Potential impacts from exposure to fiber optic cables and guidance wires 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.

As described in the 2015 MITT Final EIS/OEIS, it would be very unlikely that fishes would encounter and become entangled in any decelerators/parachutes or sonobuoy accessories. This is mainly due to the size of the range complexes and the resulting widely scattered decelerators/parachutes. If a few individual fish were to encounter and become entangled in a decelerator/parachute, the growth, survival, annual reproductive success, or lifetime reproductive success of the population as a whole would not be impacted directly or indirectly.

Therefore, impacts on fishes under Alternative 1 from the use of fiber optic cables and guidance wires and decelerators/parachutes would be negligible.

*Pursuant to the ESA, the use of fiber optic cables and guidance wires and decelerators/parachutes associated with training and testing activities, as described under Alternative 1, may affect ESA-listed Indo-West Pacific Distinct Population Segment of scalloped hammerhead sharks, oceanic whitetip sharks, and giant manta rays.*

#### 3.9.2.5.2 Impacts from Entanglement Stressors Under Alternative 2

Under Alternative 2, the combined number of entanglement stressors decrease (Table 3.0-20 through Table 3.0-22) compared to the number of events proposed in the 2015 MITT Final EIS/OEIS and would increase or stay the same compared to Alternative 1. However, as stated above for Alternative 1, training and testing activities involving fiber optic cables, guidance wires, and decelerators/parachutes are not expected to impact an individual's behavior, fitness, or species recruitment, and are not expected to result in population-level impacts.

Therefore, impacts on fishes from entanglement stressors such as wires and cables and decelerators/parachutes under Alternative 2 would be negligible.

*Pursuant to the ESA, the use of fiber optic cables and guidance wires and decelerators/parachutes associated with training and testing activities, as described under Alternative 2, may affect ESA-listed Indo-West Pacific Distinct Population Segment of scalloped hammerhead sharks, oceanic whitetip sharks, and giant manta rays.*

#### 3.9.2.5.3 Impacts from Entanglement Stressors Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Entanglement stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer physical disturbance and strike stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for entanglement impacts on the fishes from entanglement, but would not measurably improve the status of fish populations or subpopulations, including those listed under ESA and those federally managed under the MSA.

### 3.9.2.6 Ingestion Stressors

Ingestion stressors (military expended materials – munition and military expended materials – other than munition) are discussed in Section 3.0.4.6. Ingestion stressors that may impact fishes include various types of military expended materials such as munitions and expended materials other than munitions used by the Navy during training and testing activities within the Study Area. While the number of training and testing events would change under this SEIS/OEIS, the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.9.3.2 (Ingestion Stressors) remains valid. The changes in training and testing activities are not substantial and would not result in an appreciable change to existing environmental conditions or an increase in the amount of ingestion stressors within the Study Area.

#### 3.9.2.6.1 Impacts from Ingestion Stressors Under Alternative 1

Under Alternative 1, the combined number of ingestion stressors would increase compared to the number in the 2015 MITT Final EIS/OEIS (see Table 3.0-14, Table 3.0-15, Table 3.0-16, Table 3.0-23, and Table 3.0-24). However, increases in the number of ingestion stressors do not appreciably change the impact analysis or conclusions presented in the 2015 MITT Final EIS/OEIS.

As presented in the 2015 MITT Final EIS/OEIS, open-ocean predators and open-ocean planktivores are most likely to ingest materials in the water column, while coastal bottom-dwelling predators and estuarine bottom-dwelling predators could ingest materials from the seafloor. Open-ocean predators such as tunas and sharks may eat floating or sinking expended materials, while open-ocean planktivores, such as sardines and filter-feeding species such as whale sharks, may ingest floating expended materials incidentally as they feed in the water column. Other fish species such as skates and rays forage on the seafloor and may ingest expended materials on the seafloor. Encounter rates for all of these feeding guilds would be extremely low, but may result in injury or death to individuals; however, population-level effects are not anticipated.

Potential impacts of ingestion on some adult fishes are different than for other life stages (eggs, larvae, and juveniles) because early life stages for some species are too small to ingest any military expended materials except for chaff, which has been shown to have limited effects on fishes in the concentration levels that it is released at (Arfsten et al., 2002; U.S. Department of the Air Force, 1997; U.S. Department of the Navy, 1999). Therefore, with the exception of later stage larvae and juveniles that could ingest microplastics, no ingestion potential impacts on early life stages are expected.

Overall, the potential impacts of ingesting expended military materials such as munitions or other expended materials, such as chaff and flare end caps and pistons, would be limited to individual fish that might suffer a negative response from a given ingestion event. While ingestion of military expended materials could result in sublethal or lethal effects to a small number of individuals, the likelihood of a fish encountering an expended item is dependent on where that species feeds and the amount of material expended. Furthermore, an encounter may not lead to ingestion, as a fish might "taste" an item, then expel it (Felix et al., 1995), in the same manner that a fish would take a lure into its mouth then spit it out.

Therefore, the number of fishes potentially impacted by ingestion of military expended materials such as munitions and other expended materials would be negligible.

*Pursuant to the ESA, the use of military expended materials associated with training and testing activities, as described under Alternative 1, may affect ESA-listed Indo-West Pacific Distinct Population Segment of scalloped hammerhead sharks, oceanic whitetip sharks, and giant manta rays.*

#### 3.9.2.6.2 Impacts from Ingestion Stressors Under Alternative 2

Under Alternative 2, the combined number of ingestion stressors would increase compared to the number proposed for use in the 2015 MITT Final EIS/OEIS and above for Alternative 1 (see Table 3.0-14, Table 3.0-15, Table 3.0-16, Table 3.0-23, and Table 3.0-24). However, these increases do not appreciable change the impact analysis or conclusions presented in the 2015 MITT Final EIS/OEIS and presented above under Alternative 1.

Therefore, impacts on fishes from ingestion of military expended materials under Alternative 2 would be negligible.

*Pursuant to the ESA, the use of military expended materials associated with training and testing activities, as described under Alternative 2, may affect ESA-listed Indo-West Pacific Distinct Population Segment of scalloped hammerhead sharks, oceanic whitetip sharks, and giant manta rays.*

##### 3.9.2.6.3 Impacts from Ingestion Stressors Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Ingestion stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer ingestion stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for ingestion impacts on the fishes from ingestion of military expended material, but would not measurably improve the status of fish populations or subpopulations, including those listed under ESA and those federally-managed under the MSA.

#### 3.9.2.7 Secondary Stressors

Secondary stressors from training and testing activities that could pose secondary or indirect impacts on fishes via habitat, prey, sediment, and water quality include (1) explosives and byproducts; (2) metals; (3) chemicals; (4) other materials such as targets, chaff, and plastics; and (5) impacts on fish habitat. While the number of training and testing events would change under this SEIS/OEIS, the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.9.3.6 (Secondary Stressors) remains valid. The changes in training and testing activities are not substantial and would not result in an appreciable change to existing environmental conditions or an increase in the level or intensity of energy stressors within the Study Area.

As stated in the 2015 MITT Final EIS/OEIS, indirect impacts of explosives and unexploded ordnance on fishes via water could not only cause physical impacts, but prey might also have behavioral reactions to underwater sound. For example, 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. Secondary impacts from underwater explosions would be temporary, 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.

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 & 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 & Lotufo, 2010). 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.), but these impacts are expected to be short term and localized.

Certain metals are harmful to fishes at concentrations above background levels (e.g., cadmium, chromium, lead, mercury, zinc, copper, manganese, and many others) (Wang & 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. Indirect impacts of metals to fishes via sediment and water involve concentrations that are 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.

Several training and testing activities introduce potentially harmful chemicals into the marine environment; principally, flares and propellants for rockets, missiles, and torpedoes. 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. 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.

As described in the 2015 MITT Final EIS/OEIS, 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 become encrusted by natural processes and incorporated into the seafloor, or (3) when the military expended materials become 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.

Secondary stressors can also involve impacts on habitat (sediment or water quality) or prey (i.e., impacting the availability or quality of prey) that have the potential to affect fish species, including ESA-listed scalloped hammerhead sharks, oceanic whitetip sharks, and manta rays. Secondary stressors that may affect ESA-listed species only include those related to the use of explosives. Secondary effects on prey and habitat from the release of metals, chemicals, and other materials into the marine environment during training and testing activities are not anticipated. In addition to directly impacting ESA-listed species, underwater explosives could impact other species in the food web, including those that these species prey upon. The impacts of explosions would differ depending upon the type of prey species in the area of the blast. In addition to physical effects of an underwater blast, prey might have behavioral reactions to underwater sound. For instance, prey species might exhibit a strong startle reaction to explosions that might include swimming to the surface or scattering away from the source. This startle and flight response is the most common secondary defense among animals. The abundances of prey species near the detonation point could be diminished for a short period of time, affecting prey availability for ESA-listed species feeding in the vicinity. Any effects to prey, other than prey located within the impact zone when the explosive detonates, would be temporary. The likelihood of direct impacts on fishes and mobile invertebrates is low, as described in this section. No lasting effects on prey availability or the pelagic food web would be expected.

### 3.9.3 Public Scoping Comments

The public raised a number of issues during the scoping period in regards to fishes. The issues are summarized in the list below.

- **Acoustic and explosive disturbance to fish and EFH –** As described in the 2015 MITT Final EIS/OEIS, and documented in Section 3.9.2.1 (Acoustic Stressors), Navy training and testing activities may affect individual fish by causing some minor behavioral reactions. However, these activities would not cause a population-level impact. For federally managed fish species and habitats under the MSA, those impacts are detailed in Chapter 6. The Navy would also use mitigation measures detailed in Chapter 5 (Mitigation) to reduce potential impacts on less than significant levels. For example, during Explosive Mine Neutralization Activities involving Navy divers, divers will notify their supporting small boat or Range Safety Officer of hammerhead shark sightings (of any hammerhead species, due to the difficulty of differentiating species) at the detonation location. The Navy will delay fuse initiations or detonations until the shark is observed exiting the detonation location.
- **Direct and cumulative impacts from military-expended material and debris on marine biology –** As described in the 2015 MITT Final EIS/OEIS and above, military expended material may affect marine biological resources such as fishes through physical disturbance and strike, entanglement, ingestion, and have a cumulative effect on these resources. However, due to the low potential for interaction between biological resources and entanglement, ingestion, and strike stressors for reasons discussed above and in the 2015 MITT Final EIS/OEIS, military expended materials are not expected to pose a significant risk to the marine resources, including fishes.
- **Direct and cumulative impacts on fish populations–** As described in the 2015 MITT Final EIS/OEIS and in most sections above, impacts on fish from acoustic and explosive stressors (Section 3.9.2.1, Acoustic Stressors, and Section 3.9.2.2, Explosive Stressors) may injure or kill a few individuals but are unlikely to have measurable impacts on overall stocks or populations, including ESA-listed scalloped hammerhead sharks, oceanic whitetip sharks, and giant manta rays. As stated in the 2015 MITT Final EIS/OEIS, if an underwater explosion occurred in an area of high fish density, then more fish would be impacted; however, the probability of this occurring is low based on the patchy distribution of dense schooling fish. In addition, near shore areas used for underwater seafloor detonations are areas that have been previously disturbed and unlikely to support large schools or groups of fish. Cumulative impacts may affect individual fish, but would not have population-level impacts.

- **Impacts on marine species from the metals in the water (copper and lead) (see Section 3.9.2.7, Secondary Stressors) –** As described in the 2015 MITT Final EIS/OEIS and above, metals would be 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. 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.

# REFERENCES

Alves, D., M. C. P. Amorim, and P. J. Fonseca. (2016). Boat noise reduces acoustic active space in the lusitanian toadfish Halobatrachus didactylus. *Proceedings of Meetings on Acoustics*, 010033.

Arfsten, D. P., C. L. Wilson, and B. J. Spargo. (2002). Radio frequency chaff: The effects of its use in training on the environment. *Ecotoxicology and Environmental Safety, 53*, 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, Part A, 124*, 19–27.

Baum, J., E. Medina, J. A. Musick, and M. Smale. (2015). *Carcharhinus longimanus. The International Union for Conservation of Nature Red List of Threatened Species 2015: e.T39374A85699641*. Retrieved from http://www.iucnredlist.org/details/39374/0.

Booman, C., H. Dalen, H. Heivestad, A. Levesen, T. van der Meeren, and K. Toklum. (1996). (Seismic-fish) Effekter av luftkanonskyting pa egg, larver og ynell. *Havforskningsinstituttet, 3*, 1–88.

Bracciali, C., D. Campobello, C. Giacoma, and G. Sara. (2012). Effects of nautical traffic and noise on foraging patterns of Mediterranean damselfish (*Chromis chromis*). *PLoS ONE, 7*(7), e40582.

Brown, K. T., J. Seeto, M. M. Lal, and C. E. Miller. (2016). Discovery of an important aggregation area for endangered scalloped hammerhead sharks, *Sphyrna lewini*, in the Rewa River estuary, Fiji Islands. *Pacific Conservation Biology, 22*(3), 242–248.

Bruintjes, R., J. Purser, K. A. Everley, S. Mangan, S. D. Simpson, and A. N. Radford. (2016). Rapid recovery following short–term acoustic disturbance in two fish species. *Royal Society - Open Science, 3*(1), 150686.

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.

Buran, B. N., X. Deng, and A. N. Popper. (2005). Structural variation in the inner ears of four deep-sea elopomorph fishes. *Journal of Morphology, 265*, 215–225.

Casper, B., P. Lobel, and H. Yan. (2003). The hearing sensitivity of the little skate, *Raja erinacea*: A comparison of two methods. *Environmental Biology of Fishes, 68*, 371–379.

Casper, B., and D. Mann. (2006). Evoked potential audiograms of the nurse shark (*Ginglymostoma cirratum*) and the yellow stingray (*Urabatis jamaicensis*). *Environmental Biology of Fishes, 76*(1), 101–108.

Casper, B. M., and D. A. Mann. (2009). Field hearing measurements of the Atlantic sharpnose shark, *Rhizoprionodon terraenovae*. *Journal of Fish Biology, 75*(10), 2768–2776.

Casper, B. M., M. B. Halvorsen, and A. N. Popper. (2012a). Are Sharks Even Bothered by a Noisy Environment? In A. N. Popper & A. D. Hawkins (Eds.), *The Effects of Noise on Aquatic Life II* (Vol. 730). New York, NY: Springer.

Casper, B. M., A. N. Popper, F. Matthews, T. J. Carlson, and M. B. Halvorsen. (2012b). Recovery of barotrauma injuries in Chinook salmon, *Oncorhynchus tshawytscha* from exposure to pile driving sound. *PLoS ONE, 7*(6), e39593.

Casper, B. M., M. B. Halvorsen, F. Matthews, T. J. Carlson, and A. N. Popper. (2013a). Recovery of barotrauma injuries resulting from exposure to pile driving sound in two sizes of hybrid striped bass. *PLoS ONE, 8*(9), e73844.

Casper, B. M., M. E. Smith, M. B. Halvorsen, H. Sun, T. J. Carlson, and A. N. Popper. (2013b). Effects of exposure to pile driving sounds on fish inner ear tissues. *Comparative Biochemistry and Physiology, Part A, 166*(2), 352–360.

Casper, B. M., M. B. Halvorsen, T. J. Carlson, and A. N. Popper. (2017). Onset of barotrauma injuries related to number of pile driving strike exposures in hybrid striped bass. *The Journal of the Acoustical Society of America, 141*(6), 4380.

Chapman, C. J., and A. D. Hawkins. (1973). Field study of hearing in cod, *Gadus morhua* L. *Journal of Comparative Physiology, 85*(2), 147–167.

Codarin, A., L. E. Wysocki, F. Ladich, and M. Picciulin. (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.

Colleye, O., L. Kever, D. Lecchini, L. Berten, and E. Parmentier. (2016). Auditory evoked potential audiograms in post-settlement stage individuals of coral reef fishes. *Journal of Experimental Marine Biology and Ecology, 483*, 1–9.

Coombs, S., and J. C. Montgomery. (1999). The Enigmatic Lateral Line System. In R. R. Fay & A. N. Popper (Eds.), *Comparative Hearing: Fish and Amphibians* (pp. 319–362). New York, NY: Springer-Verlag.

Cox, B. S., A. M. Dux, M. C. Quist, and C. S. Guy. (2012). Use of a seismic air gun to reduce survival of nonnative lake trout embryos: A tool for conservation? *North American Journal of Fisheries Management, 32*(2), 292–298.

Cuetos-Bueno, J., and P. Houk. (2014). Re-estimation and synthesis of coral-reef fishery landings in the Commonwealth of the Northern Mariana Islands since the 1950s suggests the decline of a common resource. *Reviews in Fish Biology and Fisheries, 25*(1), 179–194.

De Robertis, A., and N. O. Handegard. (2013). Fish avoidance of research vessels and the efficacy of noise-reduced vessels: A review. *ICES Journal of Marine Science, 70*(1), 34–45.

Debusschere, E., B. De Coensel, A. Bajek, D. Botteldooren, K. Hostens, J. Vanaverbeke, S. Vandendriessche, K. Van Ginderdeuren, M. Vincx, and S. Degraer. (2014). *In situ* mortality experiments with juvenile sea bass (*Dicentrarchus labrax*) in relation to impulsive sound levels caused by pile driving of windmill foundations. *PLoS ONE, 9*(10), e109280.

Defenders of Wildlife. (2015a). *A Petition to List the Oceanic Whitetip Shark (Carcharhinus longimanus) as an Endangered, or Alternatively as a Threatened, Species Pursuant to the Endangered Species Act and for the Concurrent Designation of Critical Habitat*. Denver, CO: Defenders of Wildlife.

Defenders of Wildlife. (2015b). *A Petition to List the Giant Manta Ray (Manta birostris), Reef Manta Ray (Manta alfredi), and Caribbean Manta Ray (Manta c.f. birostris) as Endangered, or Alternatively as Threatened, Species Pursuant to the Endangered Species Act and for the Concurrent Designation of Critical Habitat*. Denver, CO: Defenders of Wildlife.

Deng, X., H. J. Wagner, and A. N. Popper. (2011). The inner ear and its coupling to the swim bladder in the deep-sea fish *Antimora rostrata* (Teleostei: Moridae). *Deep Sea Research Part 1, Oceanographic Research Papers, 58*(1), 27–37.

Deng, X., H. J. Wagner, and A. N. Popper. (2013). Interspecific variations of inner ear structure in the deep-sea fish family Melamphaidae. *The Anatomical Record, 296*(7), 1064–1082.

Doksaeter, L., O. R. Godo, N. O. Handegard, P. H. Kvadsheim, F. P. A. Lam, C. Donovan, and P. J. O. Miller. (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.

Doksaeter, L., N. O. Handegard, O. R. Godo, P. H. Kvadsheim, and N. Nordlund. (2012). Behavior of captive herring exposed to naval sonar transmissions (1.0–1.6 kHz) throughout a yearly cycle. *The Journal of the Acoustical Society of America, 131*(2), 1632–1642.

Ebert, D. A., S. Fowler, and M. Dando. (2015). *A Pocket Guide to Sharks of the World*. Princeton, NJ and Oxford, United Kingdom: Princeton University Press.

Edds-Walton, P. L., and J. J. Finneran. (2006). *Evaluation of Evidence for Altered Behavior and Auditory Deficits in Fishes Due to Human-Generated Noise Sources*. (Technical Report 1939). San Diego, CA: SPAWAR Systems Center.

Engås, A., O. A. Misund, A. V. Soldal, B. Horvei, and A. Solstad. (1995). Reactions of penned herring and cod to playback of original, frequency-filtered and time-smoothed vessel sound. *Fisheries Research, 22*(3), 243–254.

Enger, P. S. (1981). *Frequency Discrimination in Teleosts–Central or Peripheral?* New York, NY: Springer-Verlag.

Eschmeyer, W. N., and J. D. Fong. (2017). *Catalog of Fishes*. San Francisco, CA: California Academy of Sciences. Retrieved from http://researcharchive.calacademy.org/research/ichthyology/catalog/SpeciesByFamily.asp.

Faulkner, S. G., W. M. Tonn, M. Welz, and D. R. Schmitt. (2006). Effects of explosives on incubating lake trout eggs in the Canadian Arctic. *North American Journal of Fisheries Management, 26*(4), 833–842.

Faulkner, S. G., M. Welz, W. M. Tonn, and D. R. Schmitt. (2008). Effects of simulated blasting on mortality of rainbow trout eggs. *Transactions of the American Fisheries Society, 137*(1), 1–12.

Felix, A., M. E. Stevens, and R. L. Wallace. (1995). Unpalatability of a colonial rotifer, *Sinantherina socialis,* to small zooplanktivorous fishes. *Invertebrate Biology, 114*(2), 139–144.

Fewtrell, J. L., and R. D. McCauley. (2012). Impact of air gun noise on the behaviour of marine fish and squid. *Marine Pollution Bulletin, 64*(5), 984–993.

Fitch, J. E., and P. H. Young. (1948). *Use and Effect of Explosives in California Coastal Waters*. Sacramento, CA: California Division Fish and Game.

Food and Agriculture Organization of the United Nations. (2013). *Report of the Fourth FAO Expert Advisory Panel for the Assessment of Proposals to Amend Appendices I and II of CITES Concerning Commercially-Exploited Aquatic Species*. Rome, Italy: Food and Agriculture Organization Fisheries Department, Fishery Resources Division, Marine Resources Service.

Gaspin, J. B. (1975). *Experimental Investigations of the Effects of Underwater Explosions on Swimbladder Fish, I: 1973 Chesapeake Bay Tests*. Silver Spring, MD: Naval Surface Weapons Center, White Oak Laboratory.

Gaspin, J. B., G. B. Peters, and M. L. Wisely. (1976). *Experimental Investigations of the Effects of Underwater Explosions on Swimbladder Fish*. Silver Spring, MD: Naval Ordnance Lab.

Gitschlag, G. R., M. J. Schirripa, and J. E. Powers. (2000). *Estimation of Fisheries Impacts Due to Underwater Explosives Used to Sever and Salvage Oil and Gas Platforms in the U.S. Gulf of Mexico: Final Report*. Washington, DC: U.S. Department of the Interior.

Goertner, J. F. (1978). *Dynamical Model for Explosion Injury to Fish*. Dalgren, VA: U.S. Department of the Navy, Naval Surface Weapons Center.

Goertner, J. F., M. L. Wiley, G. A. Young, and W. W. McDonald. (1994). *Effects of Underwater Explosions on Fish Without Swimbladders*. Silver Spring, MD: Naval Surface Warfare Center.

Goetz, S., M. B. Santos, J. Vingada, D. C. Costas, A. G. Villanueva, and G. J. Pierce. (2015). Do pingers cause stress in fish? An experimental tank study with European sardine, *Sardina pilchardus* (Walbaum, 1792) (Actinopterygii, Clupeidae), exposed to a 70 kHz dolphin pinger. *Hydrobiologia, 749*(1), 83–96.

Govoni, J. J., L. R. Settle, and M. A. West. (2003). Trauma to juvenile pinfish and spot inflicted by submarine detonations. *Journal of Aquatic Animal Health, 15*, 111–119.

Govoni, J. J., M. A. West, L. R. Settle, R. T. Lynch, and M. D. Greene. (2008). Effects of Underwater Explosions on Larval Fish: Implications for a Coastal Engineering Project. *Journal of Coastal Research, 2*, 228–233.

Halpern, B., S. Walbridge, K. A. Selkoe, C. V. Kappel, F. Micheli, C. D'Agrosa, J. F. Bruno, K. S. Casey, C. Ebert, H. E. Fox, R. Fujita, D. Heinemann, H. S. Lenihan, E. M. P. Madin, M. T. Perry, E. R. Selig, M. Spalding, R. S. Steneck, and R. Watson. (2008). A global map of human impact on marine ecosystems. *Science, 319*(5865), 948–952.

Halvorsen, M. B., B. M. Casper, C. M. Woodley, T. J. Carlson, and A. N. Popper. (2011). *Hydroacoustic Impacts on Fish from Pile Installation* (Research Results Digest). Washington, DC: National Cooperative Highway Research Program, Transportation Research Board, National Academy of Sciences.

Halvorsen, M. B., B. M. Casper, F. Matthews, T. J. Carlson, and A. N. Popper. (2012a). Effects of exposure to pile-driving sounds on the lake sturgeon, Nile tilapia and hogchoker. *Proceedings of the Royal Society B: Biological Sciences, 279*(1748), 4705–4714.

Halvorsen, M. B., B. M. Casper, C. M. Woodley, T. J. Carlson, and A. N. Popper. (2012b). Threshold for onset of injury in Chinook salmon from exposure to impulsive pile driving sounds. *PLoS ONE, 7*(6), e38968.

Halvorsen, M. B., D. G. Zeddies, W. T. Ellison, D. R. Chicoine, and A. N. Popper. (2012c). Effects of mid-frequency active sonar on hearing in fish. *The Journal of the Acoustical Society of America, 131*(1), 599–607.

Halvorsen, M. B., D. G. Zeddies, D. Chicoine, and A. N. Popper. (2013). Effects of low-frequency naval sonar exposure on three species of fish. *The Journal of the Acoustical Society of America, 134*(2), EL205–210.

Handegard, N. O., K. Michalsen, and D. Tjøstheim. (2003). Avoidance behaviour in cod (*Gadus morhua*) to a bottom-trawling vessel. *Aquatic Living Resources, 16*(3), 265–270.

Handegard, N. O., A. D. Robertis, G. Rieucau, K. Boswell, G. J. Macaulay, and J. M. Jech. (2015). The reaction of a captive herring school to playbacks of a noise-reduced and a conventional research vessel. *Canadian Journal of Fisheries and Aquatic Sciences, 72*(4), 491–499.

Hastings, M., A. Popper, J. Finneran, and P. Lanford. (1996). Effects of low-frequency underwater sound on hair cells of the inner ear and lateral line of the teleost fish *Astronotus ocellatus*. *The Journal of the Acoustical Society of America, 99*(3), 1759–1766.

Hastings, M. C. (1991). *Effects of underwater sound on bony fishes*. Paper presented at the 122nd Meeting of the Acoustical Society of America. Houston, TX.

Hastings, M. C. (1995). *Physical effects of noise on fishes.* Paper presented at the 1995 International Congress on Noise Control Engineering. Newport Beach, CA.

Hastings, M. C., and A. N. Popper. (2005). *Effects of Sound on Fish* (Final Report #CA05-0537). Sacramento, CA: California Department of Transportation.

Hawkins, A. D., L. Roberts, and S. Cheesman. (2014). Responses of free-living coastal pelagic fish to impulsive sounds. *The Journal of the Acoustical Society of America, 135*(5), 3101–3116.

Hawkins, A. D., A. E. Pembroke, and A. N. Popper. (2015). Information gaps in understanding the effects of noise on fishes and invertebrates. *Reviews in Fish Biology and Fisheries, 25*, 39–64.

Higgs, D. M. (2005). Auditory cues as ecological signals for marine fishes. *Marine Ecology Progress Series, 287*, 278–281.

Higgs, D. M., and C. A. Radford. (2013). The contribution of the lateral line to 'hearing' in fish. *The Journal of Experimental Biology, 216*(Pt 8), 1484–1490.

Holt, D. E., and C. E. Johnston. (2014). Evidence of the Lombard effect in fishes. *Behavioral Ecology, 25*(4), 819–826.

Hubbs, C., and A. Rechnitzer. (1952). Report on experiments designed to determine effects of underwater explosions on fish life. *California Fish and Game, 38*, 333–366.

Iafrate, J. D., S. L. Watwood, E. A. Reyier, D. M. Scheidt, G. A. Dossot, and S. E. Crocker. (2016). Effects of pile driving on the residency and movement of tagged reef fish. *PLoS ONE, 11*(11), e0163638.

Inter-American Tropical Tuna Commission. (2015). *Tunas, Billfishes, and Other Species in the Eastern Pacific Ocean in 2014* (Fishery Status Report). La Jolla, CA: Inter-American Tropical Tuna Commission.

Jain-Schlaepfer, S., E. Fakan, J. L. Rummer, S. D. Simpson, and M. I. McCormick. (2018). Impact of motorboats on fish embryos depends on engine type. *Conservation Physiology, 6*(1), coy014.

Jensen, J. O. T. (2003). *New Mechanical Shock Sensitivity Units in Support of Criteria for Protection of Salmonid Eggs from Blasting or Seismic Disturbance*. Nanaimo, Canada: Fisheries and Oceans Canada Science Branch Pacific Region, Pacific Biological Station.

Jørgensen, R., K. K. Olsen, I. B. Falk-Petersen, and P. Kanapthippilai. (2005). *Investigations of Potential Effects of Low Frequency Sonar Signals on Survival, Development and Behaviour of Fish Larvae and Juveniles*. Tromsø, Norway: University of Tromsø, The Norwegian College of Fishery Science.

Joung, S. J., N. F. Chen, H. H. Hsu, and K. M. Liu. (2016). Estimates of life history parameters of the oceanic whitetip shark, *Carcharhinus longimanus*, in the Western North Pacific Ocean. *Marine Biology Research, 12*(7), 758–768.

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.

Kane, A. S., J. Song, M. B. Halvorsen, D. L. Miller, J. D. Salierno, L. E. Wysocki, D. Zeddies, and A. N. Popper. (2010). Exposure of fish to high intensity sonar does not induce acute pathology. *Journal of Fish Biology, 76*(7), 1825–1840.

Keevin, T. M., and G. L. Hempen. (1997). *The Environmental Effects of Underwater Explosions with Methods to Mitigate Impacts*. St. Louis, MO: U.S. Army Corps of Engineers.

Kéver, L., O. Colleye, A. Herrel, P. Romans, and E. Parmentier. (2014). Hearing capacities and otolith size in two ophidiiform species (*Ophidion rochei* and *Carapus acus*). *The Journal of Experimental Biology, 217*(Pt 14), 2517–2525.

Kritzler, H., and L. Wood. (1961). Provisional audiogram for the shark, *Carcharhinus leucas*. *Science, 133*(3463), 1480–1482.

Kujawa, S. G., and M. C. Liberman. (2009). Adding insult to injury: Cochlear nerve degeneration after "temporary" noise-induced hearing loss. *The Journal of Neuroscience, 29*(45), 14077–14085.

Kvadsheim, P. H., and E. M. Sevaldsen. (2005). *The Potential Impact of 1-8 kHz Active Sonar on Stocks of Juvenile Fish During Sonar Exercises*. Kjeller, Norway: Norwegian Defence Research Establishment.

Ladich, F. (2008). Sound communication in fishes and the influence of ambient and anthropogenic noise. *Bioacoustics, 17*, 35–37.

Ladich, F., and R. R. Fay. (2013). Auditory evoked potential audiometry in fish. *Reviews in Fish Biology and Fisheries, 23*(3), 317–364.

Ladich, F. (2014). Fish bioacoustics. *Current Opinion in Neurobiology, 28*, 121–127.

LGL Ltd Environmental Research Associates, Lamont Doherty Earth Observatory, and National Science Foundation. (2008). *Environmental Assessment of a Marine Geophysical Survey by the R/V Melville in the Santa Barbara Channel*. King City, Ontario: La Jolla, CA, Scripps Institution of Oceanography and Arlington, VA, National Science Foundation: Division of Ocean Sciences.

Liberman, M. C. (2016). Noise-induced hearing loss: Permanent versus temporary threshold shifts and the effects of hair cell versus neuronal degeneration. *Advances in Experimental Medicine and Biology, 875*, 1–7.

Lin, H. W., A. C. Furman, S. G. Kujawa, and M. C. Liberman. (2011). Primary neural degeneration in the guinea pig cochlea after reversible noise-induced threshold shift. *Journal of the Association for Research in Otolaryngology, 12*(5), 605–616.

Lindseth, A., and P. Lobel. (2018). Underwater Soundscape Monitoring and Fish Bioacoustics: A Review. *Fishes, 3*(3), 36.

Løkkeborg, S., E. Ona, A. Vold, and A. Salthaug. (2012). Effects of sounds from seismic air guns on fish behavior and catch rates. In A. N. Popper & A. Hawkins (Eds.), *The Effects of Noise on Aquatic Life* (Vol. 730, pp. 415–419). New York, NY: Springer.

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. *Hearing Research, 66*, 166–174.

Lombarte, A., and A. N. Popper. (1994). Quantitative analyses of postembryonic hair cell addition in the otolithic endorgans of the inner ear of the European hake, *Merluccius merluccius* (Gadiformes, Teleostei). *The Journal of Comparative Neurology, 345*, 419–428.

Løvik, A., and J. M. Hovem. (1979). An experimental investigation of swimbladder resonance in fishes. *The Journal of the Acoustical Society of America, 66*(3), 850–854.

MacDonald, J., and C. Mendez. (2005). *Unexploded ordnance cleanup costs: Implications of alternative protocols*. Santa Monica, CA: Rand Corporation.

Madaro, A., R. E. Olsen, T. S. Kristiansen, L. O. Ebbesson, T. O. Nilsen, G. Flik, and M. Gorissen. (2015). Stress in Atlantic salmon: Response to unpredictable chronic stress. *The Journal of Experimental Biology, 218*(16), 2538–2550.

Mann, D., D. Higgs, W. Tavolga, M. Souza, and A. Popper. (2001). Ultrasound detection by clupeiform fishes. *The Journal of the Acoustical Society of America*, 3048–3054.

Mann, D. A., Z. Lu, and A. N. Popper. (1997). A clupeid fish can detect ultrasound. *Nature, 389*, 341.

Mann, D. A., Z. Lu, M. C. Hastings, and A. N. Popper. (1998). Detection of ultrasonic tones and simulated dolphin echolocation clicks by a teleost fish, the American shad (*Alosa sapidissima*). *The Journal of the Acoustical Society of America, 104*(1), 562–568.

Mann, D. A. (2016). Acoustic Communications in Fishes and Potential Effects of Noise. In A. N. Popper & A. D. Hawkins (Eds.), *The Effects of Noise on Aquatic Life II* (pp. 673–678). New York, NY: Springer.

Martin, B., D. G. Zeddies, B. Gaudet, and J. Richard. (2016). Evaluation of three sensor types for particle motion measurement. *Advances in Experimental Medicine and Biology, 875*, 679–686.

McCartney, B. S., and A. R. Stubbs. (1971). Measurements of the acoustic target strengths of fish in dorsal aspect, including swimbladder resonance. *Journal of Sound and Vibration, 15*(3), 397–420.

McCauley, R. D., and D. H. Cato. (2000). Patterns of fish calling in a nearshore environment in the Great Barrier Reef. *Philosophical Transactions: Biological Sciences, 355*(1401), 1289–1293.

McCauley, R. D., J. Fewtrell, A. J. Duncan, C. Jenner, M.-N. Jenner, J. D. Penrose, R. I. T. Prince, A. Adhitya, J. Murdoch, and K. A. McCabe. (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*. Bentley, Australia: Centre for Marine Science and Technology.

McCauley, R. D., J. Fewtrell, and A. N. Popper. (2003). High intensity anthropogenic sound damages fish ears. *The Journal of the Acoustical Society of America, 113*(1), 638–642.

McCauley, R. D., and C. S. Kent. (2012). A lack of correlation between air gun signal pressure waveforms and fish hearing damage. *Advances in Experimental Medicine and Biology, 730*, 245–250.

McCormick, M. I., B. J. M. Allan, H. Harding, and S. D. Simpson. (2018). Boat noise impacts risk assessment in a coral reef fish but effects depend on engine type. *Scientific Reports, 8*(1), 3847.

McIver, E. L., M. A. Marchaterre, A. N. Rice, and A. H. Bass. (2014). Novel underwater soundscape: Acoustic repertoire of plainfin midshipman fish. *The Journal of Experimental Biology, 217*(Pt 13), 2377–2389.

Mensinger, A. F., R. L. Putland, and C. A. Radford. (2018). The effect of motorboat sound on Australian snapper *Pagrus auratus* inside and outside a marine reserve. *Ecology and Evolution, 8*(13), 6438–6448.

Miller, J. D. (1974). Effects of noise on people. *The Journal of the Acoustical Society of America, 56*(3), 729–764.

Miller, M. H., and C. Klimovich. (2016). *Endangered Species Act Status Review Report: Giant Manta Ray (Manta birostris) and Reef Manta Ray (Manta alfredi).* Silver Spring, MD: National Marine Fisheries Service, Office of Protected Resources.

Misund, O. A. (1997). Underwater acoustics in marine fisheries and fisheries research. *Reviews in Fish Biology and Fisheries, 7*, 1–34.

Mueller-Blenkle, C., P. K. McGregor, A. B. Gill, M. H. Andersson, J. Metcalfe, V. Bendall, P. Sigray, D. Wood, and F. Thomsen. (2010). *Effects of Pile-Driving Noise on the Behaviour of Marine Fish*. London, United Kingdom: COWRIE Ltd.

Myrberg, A. A., C. R. Gordon, and A. P. Klimley. (1976). Attraction of free ranging sharks by low frequency sound, with comments on its biological significance. In A. Schuijf & A. D. Hawkins (Eds.), *Sound Reception in Fish*. Amsterdam, Netherlands: Elsevier.

Myrberg, A. A. (1980). Ocean noise and the behavior of marine animals: Relationships and implications. In F. P. Diemer, F. J. Vernberg, & D. Z. Mirkes (Eds.), *Advanced Concepts in Ocean Measurements for Marine Biology* (pp. 461–491). Columbia, SC: University of South Carolina Press.

Myrberg, A. A., Jr., A. Banner, and J. D. Richard. (1969). Shark attraction using a video-acoustic system. *Marine Biology, 2*(3), 264–276.

Myrberg, A. A., Jr., S. J. Ha, S. Walewski, and J. C. Banbury. (1972). Effectiveness of acoustic signals in attracting epipelagic sharks to an underwater sound source. *Bulletin of Marine Science, 22*, 926–949.

Myrberg, A. A., Jr. (2001). The acoustical biology of elasmobranchs. *Environmental Biology of Fishes, 60*, 31–45.

National Marine Fisheries Service. (2011). *Petition to List the Scalloped Hammerhead Shark (Sphyrna lewini) Under the U.S. Endangered Species Act Either Worldwide or as One or More Distinct Population Segments*. Silver Spring, MD: National Marine Fisheries Service.

National Oceanic and Atmospheric Administration. (2016a). *Oceanic Whitetip Shark (Carcharhinus longimanus)*. Retrieved from https://www.fisheries.noaa.gov/species/oceanic-whitetip-shark.

National Oceanic and Atmospheric Administration. (2016b). *Manta rays (Manta spp.)*. Retrieved from https://www.fisheries.noaa.gov/species/giant-manta-ray.

National Research Council. (1994). *Low-Frequency Sound and Marine Mammals: Current Knowledge and Research Needs*. Washington, DC: The National Academies Press.

National Research Council. (2003). *Ocean Noise and Marine Mammals*. Washington, DC: The National Academies Press.

Nedelec, S. L., S. D. Simpson, E. L. Morley, B. Nedelec, and A. N. Radford. (2015). Impacts of regular and random noise on the behaviour, growth and development of larval Atlantic cod (*Gadus morhua*). *Proceedings of the Royal Society B: Biological Sciences, 282*(1817), 1–7.

Nedelec, S. L., J. Campbell, A. N. Radford, S. D. Simpson, and N. D. Merchant. (2016a). Particle motion: The missing link in underwater acoustic ecology. *Methods in Ecology and Evolution, 7*(7), 836–842.

Nedelec, S. L., S. C. Mills, D. Lecchini, B. Nedelec, S. D. Simpson, and A. N. Radford. (2016b). Repeated exposure to noise increases tolerance in a coral reef fish. *Environmental Pollution, 216*, 428–236.

Nedelec, S. L., S. C. Mills, A. N. Radford, R. Beldade, S. D. Simpson, B. Nedelec, and I. M. Cote. (2017a). Motorboat noise disrupts co-operative interspecific interactions. *Scientific Reports, 7*(1), 6987.

Nedelec, S. L., A. N. Radford, L. Pearl, B. Nedelec, M. I. McCormick, M. G. Meekan, and S. D. Simpson. (2017b). Motorboat noise impacts parental behaviour and offspring survival in a reef fish. *Proceedings of the Royal Society of London B: Biological Sciences, 284*(1856).

Neenan, S. T. V., R. Piper, P. R. White, P. Kemp, T. G. Leighton, and P. J. Shaw. (2016). Does Masking Matter? Shipping Noise and Fish Vocalizations. In A. N. Popper & A. D. Hawkins (Eds.), *The Effects of Noise on Aquatic Life II* (pp. 747–754). New York, NY: Springer.

Nelson, D. R., and R. H. Johnson. (1972). Acoustic attraction of Pacific reef sharks: Effect of pulse intermittency and variability. *Comparative Biochemistry and Physiology Part A, 42*, 85–95.

Neo, Y. Y., J. Seitz, R. A. Kastelein, H. V. Winter, C. Ten Cate, and H. Slabbekoorn. (2014). Temporal structure of sound affects behavioural recovery from noise impact in European seabass. *Biological Conservation, 178*, 65–73.

Neo, Y. Y., E. Ufkes, R. A. Kastelein, H. V. Winter, C. Ten Cate, and H. Slabbekoorn. (2015). Impulsive sounds change European seabass swimming patterns: Influence of pulse repetition interval. *Marine Pollution Bulletin, 97*(1–2), 111–117.

Nichols, T. A., T. W. Anderson, and A. Širović. (2015). Intermittent noise induces physiological stress in a coastal marine fish. *PLoS ONE, 10*(9), e0139157.

Nix, P., and P. Chapman. (1985). *Monitoring of underwater blasting operations in False Creek, British Columbia.* Paper presented at the Proceedings of the Workshop on Effects of Explosive Use in the Marine Environment. Ottawa, Canada.

O'Keeffe, D. J. (1984). *Guidelines for Predicting the Effects of Underwater Explosions on Swimbladder Fish*. Dahlgren, VA: Naval Surface Weapons Center.

O'Keeffe, D. J., and G. A. Young. (1984). *Handbook on the Environmental Effects of Underwater Explosions*. Silver Spring, MD: U.S. Navy, Naval Surface Weapons Center (Code R14).

Payne, N. L., D. E. van der Meulen, I. M. Suthers, C. A. Gray, and M. D. Taylor. (2015). Foraging intensity of wild mulloway *Argyrosomus japonicus* decreases with increasing anthropogenic disturbance. *Journal of Marine Biology, 162*(3), 539–546.

Pearson, W. H., J. R. Skalski, and C. I. Malme. (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.

Pena, H., N. O. Handegard, and E. Ona. (2013). Feeding herring schools do not react to seismic air gun surveys. *ICES Journal of Marine Science, 70*(6), 1174–1180.

Pepper, C. B., M. A. Nascarella, and R. J. Kendall. (2003). A review of the effects of aircraft noise on wildlife and humans, current control mechanisms, and the need for further study. *Environmental Management, 32*(4), 418–432.

Pickering, A. D. (1981). *Stress and Fish*. New York, NY: Academic Press.

Popper, A., D. Plachta, D. Mann, and D. Higgs. (2004). Response of clupeid fish to ultrasound: A review. *ICES Journal of Marine Science, 61*(7), 1057–1061.

Popper, A. N., and B. Hoxter. (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. (2003). Effects of anthropogenic sounds on fishes. *Fisheries, 28*(10), 24–31.

Popper, A. N., R. R. Fay, C. Platt, and O. Sand. (2003). Sound detection mechanisms and capabilities of teleost fishes. In S. P. Collin & N. J. Marshall (Eds.), *Sensory Processing in Aquatic Environment*. New York, NY: Springer-Verlag.

Popper, A. N., M. E. Smith, P. A. Cott, B. W. Hanna, A. O. MacGillivray, M. E. Austin, and D. A. Mann. (2005). Effects of exposure to seismic airgun use on hearing of three fish species. *The Journal of the Acoustical Society of America, 117*(6), 3958–3971.

Popper, A. N., M. B. Halvorsen, A. Kane, D. L. Miller, M. E. Smith, J. Song, P. Stein, and L. E. Wysocki. (2007). The effects of high-intensity, low-frequency active sonar on rainbow trout. *The Journal of the Acoustical Society of America, 122*(1), 623–635.

Popper, A. N. (2008). *Effects of Mid- and High-Frequency Sonars on Fish*. Newport, RI: Naval Undersea Warfare Center Division.

Popper, A. N., and M. C. Hastings. (2009a). The effects of anthropogenic sources of sound on fishes. *Journal of Fish Biology, 75*(3), 455–489.

Popper, A. N., and M. C. Hastings. (2009b). The effects of human-generated sound on fish. *Integrative Zoology, 4*, 43–52.

Popper, A. N., and R. R. Fay. (2010). Rethinking sound detection by fishes. *Hearing Research, 273*(1–2), 25–36.

Popper, A. N., A. D. Hawkins, R. R. Fay, D. A. Mann, S. M. Bartol, T. J. Carlson, S. Coombs, W. T. Ellison, R. L. Gentry, M. B. Halvorsen, S. Løkkeborg, P. H. Rogers, B. L. Southall, D. G. Zeddies, and W. N. Tavolga. (2014). *ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. New York, NY and London, United Kingdom: Acoustical Society of America Press and Springer Briefs in Oceanography.

Popper, A. N., J. A. Gross, T. J. Carlson, J. Skalski, J. V. Young, A. D. Hawkins, and D. G. Zeddies. (2016). Effects of exposure to the sound from seismic airguns on pallid sturgeon and paddlefish. *PLoS ONE, 11*(8), e0159486.

Popper, A. N., and A. D. Hawkins. (2018). The importance of particle motion to fishes and invertebrates. *Journal of the Acoustical Society of America, 143*(1), 470.

Purser, J., and A. N. Radford. (2011). Acoustic noise induces attention shifts and reduces foraging performance in three-spined sticklebacks (*Gasterosteus aculeatus*). *PLoS ONE, 6*(2), e17478.

Radford, A. N., E. Kerridge, and S. D. Simpson. (2014). Acoustic communication in a noisy world: Can fish compete with anthropogenic noise? *Behavioral Ecology, 25*(5), 1022–1030.

Radford, A. N., L. Lebre, G. Lecaillon, S. L. Nedelec, and S. D. Simpson. (2016). Repeated exposure reduces the response to impulsive noise in European seabass. *Global Change Biology, 22*(10), 3349–3360.

Radford, C. A., J. C. Montgomery, P. Caiger, and D. M. Higgs. (2012). Pressure and particle motion detection thresholds in fish: A re-examination of salient auditory cues in teleosts. *The Journal of Experimental Biology, 215*(Pt 19), 3429–3435.

Radford, C. A., R. L. Putland, and A. F. Mensinger. (2018). Barking mad: The vocalisation of the John Dory, Zeus faber. *PLoS ONE, 13*(10), e0204647.

Ramcharitar, J., D. M. Higgs, and A. N. Popper. (2001). Sciaenid inner ears: A study in diversity. *Brain, Behavior and Evolution, 58*, 152–162.

Ramcharitar, J., and A. N. Popper. (2004). Masked auditory thresholds in sciaenid fishes: A comparative study. *The Journal of the Acoustical Society of America, 116*(3), 1687–1691.

Ramcharitar, J., D. P. Gannon, and A. N. Popper. (2006). Bioacoustics of fishes of the family Sciaenidae (croakers and drums). *Transactions of the American Fisheries Society, 135*, 1409–1431.

Remage-Healey, L., D. P. Nowacek, and A. H. Bass. (2006). Dolphin foraging sounds suppress calling and elevate stress hormone levels in a prey species, the Gulf toadfish. *The Journal of Experimental Biology, 209*(Pt 22), 4444–4451.

Rice, J., and S. Harley. (2012). *Stock Assessment of Oceanic Whitetip Sharks in the Western and Central Pacific Ocean.* Paper presented at the Western and Central Pacific Fisheries Commission Meeting, Busan, Republic of Korea.

Roberts, L., S. Cheesman, and A. D. Hawkins. (2016a). Effects of Sounds on the Behavior of Wild, Unrestrained Fish Schools. In A. N. Popper & A. D. Hawkins (Eds.), *The Effects of Noise on Aquatic Life II* (pp. 917–924). New York, NY: Springer.

Roberts, L., R. Perez-Dominguez, and M. Elliott. (2016b). Use of baited remote underwater video (BRUV) and motion analysis for studying the impacts of underwater noise upon free ranging fish and implications for marine energy management. *Marine Pollution Bulletin, 112*(1–2), 75–85.

Rosen, G., and G. R. Lotufo. (2010). Fate and effects of composition B in multispecies marine exposures. *Environmental Toxicology and Chemistry, 29*(6), 1330–1337.

Rountree, R. A., F. Juanes, and M. Bolgan. (2018). Air movement sound production by alewife, white sucker, and four salmonid fishes suggests the phenomenon is widespread among freshwater fishes. *PLoS ONE, 13*(9), e0204247.

Rowell, T. J., M. T. Schärer, and R. S. Appeldoorn. (2018). Description of a New Sound Produced by Nassau Grouper at Spawning Aggregation Sites. *Gulf and Caribbean Research, 29*, GCFI22-GCFI26.

Sabet, S. S., K. Wesdorp, J. Campbell, P. Snelderwaard, and H. Slabbekoorn. (2016). Behavioural responses to sound exposure in captivity by two fish species with different hearing ability. *Animal Behaviour, 116*, 1–11.

Scholik, A. R., and H. Y. Yan. (2001). Effects of underwater noise on auditory sensitivity of a cyprinid fish. *Hearing Research, 152*(1–2), 17–24.

Scholik, A. R., and H. Y. Yan. (2002a). Effects of boat engine noise on the auditory sensitivity of the fathead minnow, *Pimephales promelas*. *Environmental Biology of Fishes, 63*, 203–209.

Scholik, A. R., and H. Y. Yan. (2002b). The effects of noise on the auditory sensitivity of the bluegill sunfish, *Lepomis macrochirus*. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology, 133*(1), 43–52.

Schwarz, A. B., and G. L. Greer. (1984). Responses of Pacific herring, *Clupea harengus pallasi*, to some underwater sounds. *Canadian Journal of Fisheries and Aquatic Science, 41*, 1183–1192.

Settle, L. R., J. J. Govoni, M. D. Greene, M. A. West, R. T. Lynch, and G. Revy. (2002). *Investigation of Impacts of Underwater Explosions on Larval and Early Juvenile Fishes*. Beaufort, NC: Center for Coastal Fisheries and Habitat Research.

Shah, A. A., F. Hasan, A. Hameed, and S. Ahmed. (2008). Biological degradation of plastics: A comprehensive review. *Biotechnology Advances, 26*(3), 246–265.

Sierra-Flores, R., T. Atack, H. Migaud, and A. Davie. (2015). Stress response to anthropogenic noise in Atlantic cod *Gadus morhua* L. *Aquacultural Engineering, 67*, 67–76.

Simpson, S. D., J. Purser, and A. N. Radford. (2015). Anthropogenic noise compromises antipredator behaviour in European eels. *Global Change Biology, 21*(2), 586–593.

Simpson, S. D., A. N. Radford, S. L. Nedelec, M. C. Ferrari, D. P. Chivers, M. I. McCormick, and M. G. Meekan. (2016). Anthropogenic noise increases fish mortality by predation. *Nature Communications, 7*, 10544.

Sisneros, J. A., and A. H. Bass. (2003). Seasonal plasticity of peripheral auditory frequency sensitivity. *The Journal of Neuroscience, 23*(3), 1049–1058.

Sivle, L. D., P. H. Kvadsheim, M. A. Ainslie, A. Solow, N. O. Handegard, N. Nordlund, and F. P. A. Lam. (2012). Impact of naval sonar signals on Atlantic herring (*Clupea harengus*) during summer feeding. *ICES Journal of Marine Science, 69*(6), 1078–1085.

Sivle, L. D., P. H. Kvadsheim, and M. A. Ainslie. (2014). Potential for population-level disturbance by active sonar in herring. *ICES Journal of Marine Science, 72*(2), 558–567.

Sivle, L. D., P. H. Kvadsheim, and M. Ainslie. (2016). Potential population consequences of active sonar disturbance in Atlantic herring: Estimating the maximum risk. *Advances in Experimental Medicine and Biology, 875*, 217–222.

Slabbekoorn, H., N. Bouton, I. van Opzeeland, A. Coers, C. ten Cate, and A. N. Popper. (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., K. Hansen, J. Dalen, and E. Ona. (2004). Acoustic mapping of pelagic fish distribution and abundance in relation to seismic shooting area off the Norwegian west coast. *Fisheries Research, 67*, 143–150.

Smith, M. E., A. S. Kane, and A. N. Popper. (2004a). Noise-induced stress response and hearing loss in goldfish (*Carassius auratus*). *The Journal of Experimental Biology, 207*(3), 427–435.

Smith, M. E., A. S. Kane, and A. N. Popper. (2004b). Acoustical stress and hearing sensitivity in fishes: Does the linear threshold shift hypothesis hold water? *The Journal of Experimental Biology, 207*, 3591–3602.

Smith, M. E., A. B. Coffin, D. L. Miller, and A. N. Popper. (2006). Anatomical and functional recovery of the goldfish (*Carassius auratus*) ear following noise exposure. *The Journal of Experimental Biology, 209*(21), 4193–4202.

Smith, M. E., and R. R. Gilley. (2008). Testing the equal energy hypothesis in noise-exposed fishes. *Bioacoustics, 17*(1–3), 343–345.

Song, J., D. A. Mann, P. A. Cott, B. W. Hanna, and A. N. Popper. (2008). The inner ears of northern Canadian freshwater fishes following exposure to seismic air gun sounds. *The Journal of the Acoustical Society of America, 124*(2), 1360–1366.

Spiga, I., N. Aldred, and G. S. Caldwell. (2017). Anthropogenic noise compromises the anti-predator behaviour of the European seabass, Dicentrarchus labrax (L.). *Marine Pollution Bulletin, 122*(1-2), 297-305.

Sprague, M. W., and J. J. Luczkovich. (2004). Measurement of an individual silver perch, *Bairdiella chrysoura,* sound pressure level in a field recording. *The Journal of the Acoustical Society of America, 116*(5), 3186–3191.

Sverdrup, A., E. Kjellsby, P. G. Krüger, R. Fløysand, F. R. Knudsen, P. S. Enger, G. Serck-Hanssen, and K. B. Helle. (1994). Effects of experimental seismic shock on vasoactivity of arteries, integrity of the vascular endothelium and on primary stress hormones of the Atlantic salmon. *Journal of Fish Biology, 45*(6), 973–995.

Swisdak, M. M., Jr. (1978). *Explosion Effects and Properties Part II–Explosion Effects in Water*. (NSWC/WOL/TR-76-116). Dahlgren, VA and Silver Spring, MD: Naval Surface Weapons Center.

Swisdak, M. M., Jr., and P. E. Montanaro. (1992). *Airblast and Fragmentation Hazards Produced by Underwater Explosions*. Silver Spring, MD: Naval Surface Warfare Center.

Tavolga, W. N. (1974). Signal/noise ratio and the critical band in fishes. *The Journal of the Acoustical Society of America, 55*(6), 1323–1333.

U.S. Department of the Air Force. (1997). *Environmental Effects of Self-Protection Chaff and Flares*. Langley Air Force Base, VA: U.S. Air Force, Headquarters Air Combat Command.

U.S. Department of the Navy. (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.

Voellmy, I. K., J. Purser, D. Flynn, P. Kennedy, S. D. Simpson, and A. N. Radford. (2014a). Acoustic noise reduces foraging success in two sympatric fish species via different mechanisms. *Animal Behaviour, 89*, 191–198.

Voellmy, I. K., J. Purser, S. D. Simpson, and A. N. Radford. (2014b). Increased noise levels have different impacts on the anti-predator behaviour of two sympatric fish species. *PLoS ONE, 9*(7), e102946.

Wang, W. X., and P. S. Rainbow. (2008). Comparative approaches to understand metal bioaccumulation in aquatic animals. *Comparative Biochemistry and Physiology, Part C, 148*(4), 315–323.

Wardle, C. S., T. J. Carter, G. G. Urquhart, A. D. F. Johnstone, A. M. Ziolkowski, G. Hampson, and D. Mackie. (2001). Effects of seismic air guns on marine fish. *Continental Shelf Research, 21*, 1005–1027.

Webb, J. F., J. C. Montgomery, and J. Mogdans. (2008). Bioacoustics and the Lateral Line of Fishes. In J. F. Webb, R. R. Fay, & A. N. Popper (Eds.), *Fish Bioacoustics* (pp. 145–182). New York, NY: Springer.

Weijerman, M., I. Williams, J. Gutierrez, S. Grafeld, B. Tibbatts, and G. Davis. (2016). Trends in biomass of coral reef fishes, derived from shore-based creel surveys in Guam. *Fishery Bulletin, 114*(2), 237–256.

Western Pacific Regional Fishery Management Council. (2016). *Fishery Ecosystem Plan for the Pacific Pelagic Fisheries - Working Draft*. Honolulu, HI: Western Pacific Regional Fishery Management Council.

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*(2), 223–284.

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, Canada: Western Region Department of Fisheries and Oceans.

Wysocki, L. E., J. P. Dittami, and F. Ladich. (2006). Ship noise and cortisol secretion in European freshwater fishes. *Biological Conservation, 128*, 501–508.

Wysocki, L. E., J. W. Davidson, III, M. E. Smith, A. S. Frankel, W. T. Ellison, P. M. Mazik, A. N. Popper, and J. Bebak. (2007). Effects of aquaculture production noise on hearing, growth, and disease resistance of rainbow trout, *Oncorhynchus mykiss*. *Aquaculture, 272*, 687–697.

Yau, A., M. O. Nadon, B. L. Richards, J. Brodziak, and E. Fletcher. (2016). *Stock Assessment Updates of the Bottomfish Management Unit Species of American Samoa, the Commonwealth of the Northern Mariana Islands, and Guam in 2015 Using Data through 2013*. Honolulu, HI: National Oceanic and Atmospheric Administration Pacific Islands Fisheries Science Center.

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*. Albuquerque, NM: Defense Nuclear Agency.

Yelverton, J. T., and D. R. Richmond. (1981). *Underwater Explosion Damage Risk Criteria for Fish, Birds, and Mammals.* Paper presented at the 102nd Meeting of the Acoustical Society of America. Miami Beach, FL.

Young, C. N., J. Carlson, C. Hutt, D. Kobayashi, C. T. McCandless, and J. Wraith. (2016). *Status review report: Oceanic whitetip shark (Carcharhinius longimanus)* (Final Report to the National Marine Fisheries Service, Office of Protected Resources). Silver Spring, MD: National Marine Fisheries Service & National Oceanic and Atmospheric Administration.

Zelick, R., D. A. Mann, and A. N. Popper. (1999). Acoustic communication in fishes and frogs. In R. R. Fay & A. N. Popper (Eds.), *Comparative Hearing: Fish and Amphibians* (pp. 363–411). New York, NY: Springer-Verlag.

# 3.10 Terrestrial Species and Habitats

# Supplemental Environmental Impact Statement/

# Overseas Environmental Impact Statement

# Mariana Islands Training and Testing

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## 3.10 Terrestrial Species and Habitats

### 3.10.1 Affected Environment

The purpose of this section is to supplement the analysis of impacts on terrestrial species and habitats presented in the 2015 Mariana Islands Training and Testing (MITT) Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) with new information relevant to proposed changes in training activities conducted at Farallon de Medinilla (FDM). Information presented in the 2015 MITT Final EIS/OEIS that remains valid is noted as such and referenced in the appropriate sections. Any new or updated information describing the affected environment and analysis of impacts on terrestrial species and habitats associated with the Proposed Action is provided in this section. Comments received from the public during scoping related to terrestrial species and habitats are addressed in Section 3.10.3 (Public Scoping Comments).

Section 3.10 in the 2015 MITT Final EIS/OEIS analyzed the potential impacts of training activities on three Endangered Species Act (ESA)-listed plant species (*Serianthes nelsonii*, *Osmoxylon mariannense,* and *Nesogenes rotensis*), eight bird species typically found in terrestrial habitats[1] (Mariana swiftlet [*Aerodramus bartschi*], Mariana crow [*Corvus kubaryi*], Mariana common moorhen, [*Gallinula chloropus guami*], Guam Micronesian kingfisher [*Todiramphus cinnamomina*], Micronesian megapode [*Megapodius laperouse*], Guam rail [*Rallus owstoni*], Nightingale reed-warbler [*Acrocephalus luscinia*], and Rota bridled white-eye [*Zosterops rotensis*]), and one mammal species (Mariana fruit bat [*Pteropus mariannus*]). Of these species, only the Micronesian megapode and Mariana fruit bat are found on FDM; therefore, only these ESA-listed species are included in the Navy's Supplemental EIS (SEIS)/OEIS (Table 3.10-1). FDM has no critical habitat designations on the island; therefore, critical habitat is not addressed in this SEIS/OEIS.

In addition to the analysis completed for ESA-listed species, the Navy's 2015 MITT Final EIS/OEIS also considered species that at the time were candidates for ESA listing status. Since the publication of the 2015 MITT Final EIS/OEIS, the United States Fish and Wildlife Service (USFWS) has published its Final Rule determining ESA listing status for 23 additional species in the Mariana Islands (80 Federal Register 59423). Because some of these newly listed species were known to occur within the land training areas analyzed in the 2015 MITT Final EIS/OEIS, the Navy and the USFWS reinitiated consultation to include 14 plant species (*Bulbophyllum guamense, Cycas micronesica, Dendrobium guamense, Eugenia bryanii, Heritiera longipetiolata, Maesa walker, Nervilia jacksoniae, Psychotria malaspinae, Solanum guamense, Tabernaemontana rotensis, Tinospora homosepala, Tuberolabium guamense, Hedyotis megalantha*, *Phyllanthus saffordii*) and four terrestrial invertebrates (Mariana eight-spot butterfly [*Hypolimnas octocula marianensis*], Guam tree snail [*Partula radiolata*], fragile tree snail [*Samoana fragilis*], and humped tree snail [*Partula gibba*]). The USFWS concurred with the Navy's determination that the activities originally proposed in the Navy's 2015 MITT Final EIS/OEIS would not adversely affect these newly listed species and that species and habitat protections described in the 2015 MITT Final EIS/OEIS

[1] The 2015 MITT Final EIS/OEIS analyzed bird species in two different sections. In the 2015 MITT Final EIS/OEIS, birds that typically depend on non-marine habitats were analyzed together with other terrestrial plant and animal species (see Section 3.10 of the 2015 MITT Final EIS/OEIS). Marine birds were analyzed separately in Section 3.6 (Marine Birds) of the 2015 MITT Final EIS/OEIS. These species include birds that occur only in pelagic habitats within the Study Area, as well as marine birds that nest within the Study Area. This SEIS/OEIS follows this organization.

would also protect newly listed species (U.S. Fish and Wildlife Service, 2016). FDM is not included in the range for any of these species (80 Federal Register 59423) and, based on the structure and composition of the remnant forest on the island, it is extremely unlikely that there is habitat for any of these species on FDM. Therefore, none of these species are included in this SEIS/OEIS. Review of the 2015 MITT Final EIS/OEIS confirms the analysis for these species in that document is accurate and represents the best available science.

### Table 3.10-1: Endangered Species Act Listed Species on Farallon de Medinilla

| Species Name and Regulatory Status | | | Presence in Study Area[1] | |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | **Endangered Species Act Status** | **Open Ocean** | **Visitor/Breeding on FDM** |
| Micronesian megapode (Sasangat) | *Megapodius laperouse* | Endangered | Yes | Yes |
| Mariana fruit bat (Fanihi) | *Pteropus mariannus* | Threatened | Yes | Yes, possible breeding |

[1]Study Area = Mariana Islands Training and Testing Study Area
Note: FDM = Farallon de Medinilla

#### 3.10.1.1 Vegetation Communities on Farallon de Medinilla

The United States (U.S.) military has used the island of FDM as a bombing range since 1971 (U.S. Department of the Navy, 1975), and the agreement between the U.S. Government and the Commonwealth of the Northern Mariana Islands was formalized in a 50-year lease agreement (United States of America and Commonwealth of the Northern Mariana Islands, 1983). FDM's vegetation appears to have undergone significant changes since the island was leased by the Department of Defense 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 were 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 & Fosberg, 1998; Mueller-Dombois & Fosberg, 2013).

The island's vegetation may be grouped into the following vegetation communities: coastal vegetation, cliff-line vegetation, upland shrubland and herbaceous vegetation, and bare ground exposed within impact zones. A brief botanical survey of the northern portion of the island carried out in 1996 identified 43 plant species, 32 of which were native (Mueller-Dombois & Fosberg, 1998; Mueller-Dombois & Fosberg, 2013). Periodic helicopter-based surveys have occurred since 1998 (monthly up to 2009, and quarterly thereafter through September 2016) for marine birds nesting on the island. Although the primary goal of these surveys is to count marine birds, observations of other species observed, condition of vegetation communities, and general structure are made during the surveys. Because of continued access constraints associated with the unexploded ordnance risk, no formal plant surveys have been completed on FDM since the publication of the 2015 MITT Final EIS/OEIS. Because of a lack of commercial helicopter transit services, surveys have not been conducted since 2016. The most recent surveys have not provided any indications that the vegetation communities have changed since the 2015 MITT Final EIS/OEIS.

#### 3.10.1.2 Wildlife Communities on Farallon de Medinilla

##### 3.10.1.2.1 Birds

FDM is recognized by regional ornithologists as an important bird area for many species of marine birds and migrant shorebirds, and supports a limited number of terrestrial bird species (Lusk et al., 2000; U.S. Department of the Navy, 2013a; U.S. Fish and Wildlife Service, 1998). Seabird and shorebird species are discussed in Section 3.6 (Marine Birds) of this SEIS/OEIS. No new information is available since the publication of the 2015 MITT Final EIS/OEIS regarding FDM's terrestrial avifauna; therefore, the description of the avian portion of FDM's wildlife community in the 2015 MITT Final EIS/OEIS remains valid. (Lusk et al., 2000; U.S. Department of the Navy, 2013a, 2013b).

##### 3.10.1.2.2 Mammals

Incidental observations of fruit bats during bird surveys described in the 2015 MITT Final EIS/OEIS, 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 introduced small-sized rats, believed to be *Rattus exulans*. Commonly observed during past natural resource surveys (U.S. Department of the Navy, 2008a, 2013b), it is believed that rats negatively impact breeding activities for seabirds, and upland terrestrial birds on the island. There is no new information available that would inform the impact analysis on FDM's mammals since the publication of the 2015 MITT Final EIS/OEIS; therefore, the description of the mammalian portion of FDM's wildlife community in the 2015 MITT Final EIS/OEIS remains valid.

##### 3.10.1.2.3 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. No new information has become available since the publication of the 2015 MITT Final EIS/OEIS that expands upon the known list of reptiles on FDM; therefore, the description of FDM's reptiles and amphibians in the 2015 MITT Final EIS/OEIS remains valid.

##### 3.10.1.2.4 Invertebrates

Since the publication of the 2015 MITT Final EIS/OEIS, no new inventories for invertebrate species have been conducted on FDM. Prior to the 2015 MITT Final EIS/OEIS, no formal surveys for invertebrates were conducted; 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, 2013b).

#### 3.10.1.3 Endangered Species Act Listed Species

##### 3.10.1.3.1 Micronesian Megapode/Sasangat (*Megapodius laperouse laperouse*)

The Micronesian megapode was first listed as endangered in 1970 (under the Endangered Species Conservation Act, 35 Federal Register 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, hunting and illegal egg collection, increased tourism, and predation by introduced predators (U.S. Fish and Wildlife Service, 1998). 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 (Amidon et al., 2011; U.S. Department of the Navy, 2013a). Recent surveys and modeling suggests that islands with low human presence and without ungulates have the highest densities of megapodes (i.e., Maug, Asuncion, Guguan, and Sarigan) (Amidon et al., 2011).

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, a population of 10 Micronesian megapodes was estimated on FDM (Kessler & Amidon, 2009; Lusk et al., 2000; U.S. Fish and Wildlife Service, 1998). However, due to an approaching 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, who estimated 21 adult pairs (U.S. Department of the Navy, 2008b, 2008c). The most recent survey for megapodes on FDM was completed in 2013, when Navy biologists detected 11 megapodes while surveying a limited transect in the north part of the island (Impact Areas 1 and 2) (U.S. Department of the Navy, 2013b).

Poaching has been identified as a potential threat to megapodes in the northern Mariana Islands (Reichel, 1991; U.S. Fish and Wildlife Service, 1998). 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 south of this area). These measures were included as non-discretionary terms and conditions in the USFWS's biological opinion for activities consulted on in 2015.

Since the publication of the 2015 MITT Final EIS/OEIS, there is no new information available to further expand the life history and status of the Micronesian megapodes on FDM. Therefore, the information in the 2015 MITT Final EIS/OEIS is valid for analyzing potential impacts on the Micronesian megapode.

#### 3.10.1.3.2 Mariana Fruit Bat/Fanihi (*Pteropus mariannus mariannus*)

The Guam population of the Mariana fruit bat (Mariana flying fox) was federally listed as endangered in 1984 (U.S. Fish and Wildlife Service, 2009). However, in 2005, the Mariana fruit bat was listed as threatened throughout the Mariana archipelago and downlisted to threatened on Guam. The recovery plan for the Mariana fruit bat was first finalized in 1990; however, a draft revised recovery plan for the Mariana fruit bat was released in March 2010. Critical habitat is designated on Guam and Rota, but there is no critical habitat designated on FDM.

Since the publication of the 2015 MITT Final EIS/OEIS, no new information on the Mariana fruit bat life history or status on FDM is available. Therefore, the information in the 2015 MITT Final EIS/OEIS is valid for analyzing potential impacts on the Mariana fruit bat.

### 3.10.1.4 Major Terrestrial Species Taxonomic Group Descriptions

There have been no updates to the status and life history descriptions for the major taxonomic groups that occur within Mariana Island terrestrial environments since the publication of the 2015 MITT Final EIS/OEIS.

### 3.10.2 Environmental Consequences

The 2015 MITT Final EIS/OEIS analyzed training and testing activities currently occurring in the MITT Study Area and considered all potential stressors related to terrestrial biological resources. Stressors applicable to terrestrial biological resources on FDM are the same stressors analyzed in the 2015 MITT Final EIS/OEIS. For this supplemental analysis, explosives, which were analyzed under acoustic stressors in 2015, are now analyzed as a separate stressor.

In addition, the 2015 MITT Final EIS/OEIS assessed potential impacts on training locations on Guam, Rota, Tinian, Saipan, and FDM, whereas this SEIS/OEIS only updates the analysis on FDM.

The following stressors are analyzed for terrestrial biological resources; the analyses include stressor description updates from the 2015 MITT Final EIS/OEIS:

- Acoustic (weapons noise)
- Explosives (explosions on land at FDM)
- Physical Disturbance and Strike (aircraft and aerial targets, military expended materials, ground disturbance, and wildfires)
- Secondary stressors (impacts on habitat, impacts on prey availability, introduction of potential invasive species)

This section evaluates how and to what degree potential impacts on terrestrial biological resources from stressors described in Section 3.0 (General Approach to Analysis) may have changed since the analysis presented in the 2015 MITT Final EIS/OEIS was published. Table 2.5-1 in Chapter 2 (Description of Proposed Action and Alternatives) lists the proposed training activities that would occur on FDM and includes the number of times each activity would be conducted annually under each alternative. The tables also present the same information for activities described in the 2015 MITT Final EIS/OEIS so that the proposed levels of training and testing under this SEIS/OEIS can be easily compared.

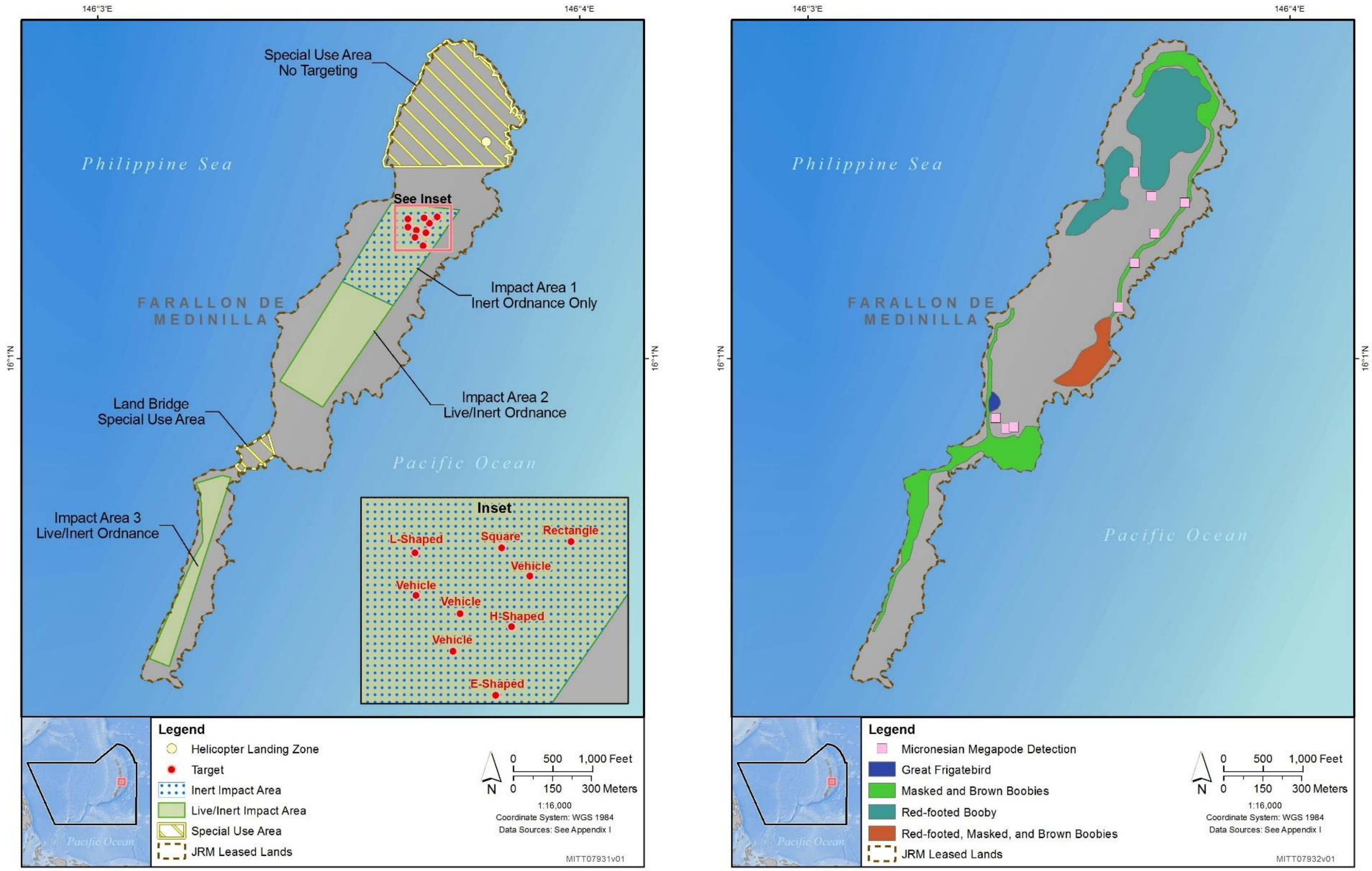
The analysis presented in this section also considers measures that the Navy would implement to avoid or reduce potential impacts on terrestrial biological resources on FDM from stressors associated with the proposed training activities. As with the 2015 MITT Final EIS/OEIS, no testing activities would occur on FDM.

#### 3.10.2.1 Acoustic Stressors

The potential impacts of explosives noise and weapons firing noise on FDM's wildlife are discussed in Section 3.10.3.1.1 (Impacts from Explosives and Weapons Firing Noise) in the 2015 MITT Final EIS/OEIS. Impacts from aircraft noise are discussed in Section 3.10.3.1.2 (Impacts from Aircraft Noise) in the 2015 MITT Final EIS/OEIS. These sections discuss the different types of sounds, frequency ranges, and intensity generated from munitions use on FDM. 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, lasting for a long time without interruption, or impulsive, lasting for only a short duration. Continuous impulses (e.g., 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 sounds are distinguished here as they differ in their effects. Continuous and impulsive sounds can result in hearing damage, while shorter duration, less frequent, or lower sound levels typically elicit physiological or behavioral responses. Some birds may be killed or injured during these activities, or expend energy stores needed for migration to avoid or reduce perturbations generated by explosions.

FDM has three impact areas, a special use area on the northern portion of the island, and a special use area on the land bridge. Targeting of areas inside of the special use areas and other areas outside of impact areas are prohibited. In other words, all areas outside of the impact areas are considered “no-fire areas.” Any ordnance that inadvertently lands outside of impact areas, including special use areas and in water, must be reported to MIRC Operations, in accordance with Commander, U.S. Naval Forces Marianas Instruction 3500.4A (U.S. Department of the Navy, 2011). The impact areas and special use areas are shown on Figure 3.10-1 and described below:

- **Northern Special Use Area**. Reserved for direct action (tactical air control party) type exercises and personnel recovery. This area is about 41 acres (ac.) (17 hectares [ha]) and includes a landing zone. Weapons may be fired from the special use area into impact areas, such as small-caliber rounds, grenades, and mortars.
- **Impact Area 1**. This area contains high-fidelity target structures and is comprised of vehicle shells and cargo containers. This area is authorized for inert ordnance only, and operators are required to report any live ordnance inadvertently dropped into Impact Area 1 to MIRC Operations. Impact Area 1 contains 10 targets of varying shapes and sizes, including 4 vehicles and 6 targets comprised of shipping containers.
- **Impact Area 2**. Impact Area 2 may be used for both live and inert ordnance. Strafing is permitted in this area. Impact Area 2 is about 22 ac. (9 ha).
- **Land Bridge**. The land bridge is designated as a “no target zone.” Operators are required to report ordnance observed impacting the land bridge.
- **Impact Area 3**. This area is south of the land bridge and authorized for inert ordnance, although live ordnance may be used only with prior approval from Joint Region Marianas. Strafing is permitted in this area. Impact Area 3 is about 11 ac. (4.5 ha).




Note: Target locations in Impact Area 1 may change depending on target maintenance and training requirements.

**Figure 3.10-1: Farallon de Medinilla Impact Zones and Micronesian Megapode Occurrences**

#### 3.10.2.1.1 Impacts from Acoustic Stressors Under Alternative 1

Under Alternative 1, there would be an overall increase in the number of training events and munitions used on the island, which would increase the number of exposures to explosives noise, weapons firing noise, and aircraft overflights to deliver munitions to the impact zones on FDM. The types of explosive munitions used on FDM include explosive bombs (less than or equal to 2,000 pounds [lb.]), missiles, rockets, explosive grenades and mortars, medium-caliber projectiles, and large-caliber projectiles. The calculations for the increases in the number of events proposed on FDM are shown on Table 3.6-1. Table 3.6-2 shows the calculations for the proposed increases in the number of explosive and non-explosive munitions expended on FDM. These increases in events and munitions would result in an increase in net explosive weight (NEW) of explosives over the course of a training year. The calculations for NEW expended on FDM resulting from proposed training activities are shown in Table 3.6-3. The NEW for each ordnance type may vary within each class. Based on these NEW ranges within each explosives bin, the Navy calculated the range of total munitions' NEW under each alternative proposed in this SEIS/OEIS by multiplying the number of munitions used by the low and high NEW ranges for each ordnance type. Based on these calculations, the following assumptions are presented as additional analysis for this SEIS/OEIS:

- In terms of the number of events, there would be an increase of less than 2 percent over what was analyzed previously in the 2015 MITT Final EIS/OEIS. No new activity types are proposed in this SEIS/OEIS from what were previously analyzed in the 2015 MITT Final EIS/OEIS. Some activity types, however, would increase in the number of events per year and/or the number of ordnance items expended. Other activities would not change compared to what was analyzed previously in the 2015 MITT Final EIS/OEIS, and therefore would not contribute to an increase in NEW or the number of munitions expended on FDM. For example, Bombing Exercise (Air-to-Ground) is the most impactful in terms of explosive power released on FDM and would not increase compared to what was analyzed in the 2015 MITT Final EIS/OEIS. Table 3.6-1 shows the number of events that would occur under each alternative compared to what was analyzed in the 2015 MITT Final EIS/OEIS.
- In terms of munitions item numbers, there would be an increase of approximately 9 percent over what was analyzed previously in the 2015 MITT Final EIS/OEIS in the total number of munitions used on FDM. Most of these increases are associated with small-caliber rounds, which do not contribute to increases in NEW. Table 3.6-2 shows the number of munitions proposed under each alternative compared to what was analyzed in the 2015 MITT Final EIS/OEIS.
- In terms of NEW, explosives used on FDM would increase by less than 1 percent compared to what was analyzed in the 2015 MITT Final EIS/OEIS (see calculations in Table 3.6-3).

Sources of noise from weapons firing that may be heard by wildlife on FDM (including the ESA-listed Micronesian megapode and Mariana fruit bat, bird species protected under the MBTA, and other native terrestrial wildlife assessed in the 2015 MITT Final EIS/OEIS) include close-in weapons firing from vessels, helicopters, close-combat surface firing from fixed-wing aircraft, and surface firing, with the largest increase in munitions use resulting from small arms, medium-caliber explosives, and mortar and grenade use during Direct Action training activities. As shown in Table 3.6-1, the number of training events (that involve weapon firing on or proximate to FDM) would stay the same compared to what was previously analyzed in the 2015 MITT Final EIS/OEIS; however, the number of munitions used would increase during each training event (see Table 3.6-2). These training events would occur within the Northern Special Use Area and fire into the impact areas towards the south; therefore, more megapodes and bats (along with other wildlife species) would be exposed to more weapons firing noise under Alternative 1 because of the increased number of small-caliber rounds, medium-caliber explosives, and grenades and mortars fired into impact areas from the Northern Special Use Area. The weapons-firing noise would likely be masked somewhat by natural sounds on FDM, such as waves and winds. The impulsive sound caused by weapon firings would have limited potential to mask any important biological sound simply because the duration of the impulse is brief, even when multiple shots are fired in series.

Although more ordnance may be used on FDM under Alternative 1 compared to what was analyzed previously in the 2015 MITT Final EIS/OEIS, all of the ordnance would be targeted at impact zones, with the same mitigation measures in place (discussed above in Section 3.10.2.1, Acoustic Stressors and Chapter 5, Mitigation), and there would be no changes in how activities are performed compared to the previous analysis in 2015. For FDM's terrestrial biological resources, including ESA-listed species (the Micronesian megapode and Mariana fruit bat), bird species protected under the MBTA, and other native terrestrial plants and wildlife assessed in the 2015 MITT Final EIS/OEIS, the relatively small increase in annual NEW, numbers of ordnance expended, and the number of activities on FDM would not result in an appreciable change in the impact conclusions presented in the 2015 MITT Final EIS/OEIS for the following two reasons: (1) the increase in the amount of NEW (less than 1 percent increase), number of items expended (less than 10 percent increase), and the number of activities (less than 2 percent increase) would be minor when comparing Alternative 1 to NEW amounts analyzed in the 2015 MITT Final EIS/OEIS); and (2) the Navy would continue to implement the same avoidance and minimization measures in place as with the 2015 MITT Final EIS/OEIS (see Section 5.5, Terrestrial Mitigation Measures to be Implemented, and Table 5.5-1).

The USFWS's 2015 Biological Opinion provided the Navy with an incidental take statement for the Mariana fruit bat and the Micronesian megapode (U.S. Fish and Wildlife Service, 2015). The Mariana fruit bat would not likely occur in impact zones and, if present on FDM, would likely be confined to the remnant tree cover at the northern end of the island. In the USFWS's 2015 Biological Opinion, one Mariana fruit bat was estimated to be killed over the course of five years as a result of bombing, gunnery, and missile exercises proposed in the 2015 MITT Final EIS/OEIS. The likelihood of increased exposure is negligible because of the small increases in the number of events, munitions, and NEW expended on FDM compared to what was analyzed in the 2015 MITT Final EIS/OEIS and 2015 USFWS Biological Opinion. In addition, the same avoidance and minimization measures in place included in the 2015 MITT Final EIS/OEIS and 2015 USFWS Biological Opinion would continue under Alternative 1 (see Section 5.5, Terrestrial Mitigation Measures to be Implemented, and Table 5.5-1).

In the USFWS's 2015 Biological Opinion, four Micronesian megapodes per year were estimated to be killed as a result of bombing, gunnery, and missile exercises proposed in the 2015 MITT Final EIS/OEIS. Based on the habitat conditions that persist within the impact zones, it is unlikely that additional megapodes would be exposed to additional ordnance use when used in the same locations previously analyzed. In summary, as the neither the Mariana fruit bat nor the Micronesian megapode will face increased exposure from the proposed additional ordnance to be expended, the incidental take statement provided to the Navy in 2015 as part of the USFWS's Biological Opinion is sufficient to cover potential impacts on ESA-listed species from activities proposed under Alternative 1 of this SEIS/OEIS.

*Pursuant to the ESA, acoustic stressors during training activities on FDM, as described under Alternative 1, may affect the Micronesian megapode and the Mariana fruit bat. This determination is consistent with the previous consultation between the Navy and USFWS for activities described in the 2015 MITT Final EIS/OEIS. Because of the small increases in the amount of NEW used on FDM, the number of ordnance items expended, and the number of events that would occur on FDM under Alternative 1 compared to what was analyzed in the 2015 MITT Final EIS/OEIS, the activities proposed under Alternative 1 do not constitute a modification of the original proposed activities that causes new or additional effects on ESA-listed species on FDM; therefore, reinitiation of Section 7 consultation between the USFWS and Navy is not necessary.*

*Under the MBTA regulations applicable to military readiness activities (50 Code of Federal Regulations [CFR] Part 21), acoustic stressors on land during training activities under Alternative 1 would not result in significant adverse effects on terrestrial bird populations.*

#### 3.10.2.1.2 Impacts from Acoustic Stressors Under Alternative 2

Under Alternative 2, the number of proposed training activities using explosive munitions would be the similar as compared to Alternative 1, with an increase in the number of Direct Action events under Alternative 2 (compared to Alternative 1, see Table 3.6-1). The number of training events for this activity type would stay the same compared to what was previously analyzed in the 2015 MITT Final EIS/OEIS and under Alternative 1; however, the number of munitions used would increase during each training event under Alterative 2 (see Table 3.6-2). As with Alternative 1, these training events would occur within the Northern Special Use Area and fire into the impact areas towards the south; therefore, more megapodes and bats (along with other wildlife species) would be exposed to more weapons firing noise under Alternative 2 because of the increased number of small-caliber rounds, medium-caliber explosives, and grenades and mortars fired into impact areas from the Northern Special Use Area. The weapons-firing noise would likely be masked somewhat by natural sounds on FDM, such as waves and winds. The impulsive sound caused by weapon firings would have limited potential to mask any important biological sound simply because the duration of the impulse is brief, even when multiple shots are fired in series. In addition, the same avoidance and minimization measures in place included in the 2015 MITT Final EIS/OEIS would continue under Alternative 2 (see Section 5.5, Terrestrial Mitigation Measures to be Implemented, and Table 5.5-1).

Therefore, the same conclusions for Alternative 1 for terrestrial biological resources, including the Micronesian megapode, Mariana fruit bat, and MBTA-protected terrestrial bird species, are applicable to Alternative 2.

*Pursuant to the ESA, acoustic stressors during training activities on FDM, as described under Alternative 2, may affect the Micronesian megapode and the Mariana fruit bat. This determination is consistent with the previous consultation between the Navy and USFWS for activities described in the 2015 MITT Final EIS/OEIS. Because of the small increases in the amount of NEW used on FDM, the number of ordnance items expended, and the number of events that would occur on FDM under Alternative 2 compared to what was analyzed in the 2015 MITT Final EIS/OEIS, the activities proposed under Alternative 2 do not constitute a modification of the original proposed activities that causes new or additional effects on ESA-listed species on FDM; therefore, reinitiation of Section 7 consultation between the USFWS and Navy is not necessary.*

*Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), acoustic stressors on land during training activities under Alternative 2 would not result in significant adverse effects on terrestrial bird populations.*

#### 3.10.2.1.3 Impacts from Acoustic Stressors Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. For FDM, the lease agreement between the U.S. government and the Commonwealth of the Northern Mariana Islands would remain in place, and the island would continue to be maintained as a Navy range, although strike warfare would no longer continue on the island.

Acoustic stressors associated with Navy training activities would no longer be introduced to the island, which would minimize adverse noise impacts on FDM, such as disturbance of nesting and roosting birds and bats, sound pressure waves that may induce injury to wildlife, and adverse impacts associated with military noise on wildlife species at various life stages.

### 3.10.2.2 Explosives Stressors

The training activities that have the greatest impact on vegetation and wildlife communities within the impact areas on FDM are those that result in percussive force from the use of explosive munitions. The potential impacts of activities with these types of disturbances are discussed in Section 3.10.3.1.1 (Impacts from Explosives and Weapons Firing Noise) of the 2015 MITT Final EIS/OEIS.

#### 3.10.2.2.1 Impacts from Explosive Stressors Under Alternative 1

As stated above in Section 3.10.2.1.1 (Impacts from Acoustic Stressors Under Alternative 1), there would be a small increase in the number of explosions on FDM, which would increase the number of exposures to percussive force. The types of explosive munitions used on FDM include explosive bombs (less than or equal to 2,000 lb.), missiles, rockets, explosive grenades and mortars, medium-caliber projectiles, and large-caliber projectiles. The number of explosive bombs (less than or equal to 2,000 lb.) would not change compared to what was analyzed in the 2015 MITT Final EIS/OEIS, while the increases in NEW would be from the increased number of smaller NEW munitions (see Table 3.6-2). The total change in explosives use on FDM, in terms of NEW, would increase by less than 1 percent under Alternative 1 compared to what was analyzed in the 2015 MITT Final EIS/OEIS. Although more ordnance would be used on FDM under Alternative 1, all of the ordnance would target impact zones, with the same avoidance and minimization measures in place (see Section 5.5, Terrestrial Mitigation Measures to be Implemented, and Table 5.5-1).

As discussed in Section 3.10.2.1.1 (Impacts from Acoustic Stressors Under Alternative 1), the USFWS's 2015 Biological Opinion provided the Navy with an incidental take statement for the Mariana fruit bat and the Micronesian megapode (U.S. Fish and Wildlife Service, 2015). The Mariana fruit bat would not likely occur in impact zones and, if present on FDM, would likely be confined to the remnant tree cover at the northern end of the island. In the USFWS's 2015 Biological Opinion, one Mariana fruit bat was estimated to be killed over the course of five years as a result of bombing, gunnery, and missile exercises proposed in the 2015 MITT Final EIS/OEIS. The likelihood of increased exposure is negligible because of the small increases in the number of events, munitions, and NEW expended on FDM compared to what was analyzed in the 2015 MITT Final EIS/OEIS and 2015 USFWS Biological Opinion. In addition, the same avoidance and minimization measures in place included in the 2015 MITT Final EIS/OEIS and 2015 USFWS Biological Opinion would continue under Alternative 1 (see Section 5.5, Terrestrial Mitigation Measures to be Implemented, and Table 5.5-1). In the USFWS's 2015 Biological Opinion, four Micronesian megapodes per year were estimated to be killed as a result of bombing, gunnery, and missile exercises proposed in the 2015 MITT Final EIS/OEIS. Based on the habitat conditions that persist within the impact zones, it is unlikely that additional megapodes would be exposed to additional ordnance use when used in the same locations previously analyzed. In summary, as neither the Mariana fruit bat, nor the Micronesian megapode would face increased exposure from the proposed use of explosive ordnance, the incidental take statement provided to the Navy in 2015 as part of the USFWS's Biological Opinion is sufficient to cover potential impacts on ESA-listed species from activities proposed under Alternative 1 of this SEIS/OEIS.

*Pursuant to the ESA, explosives stressors during training activities on FDM, as described under Alternative 1, may affect the Micronesian megapode and the Mariana fruit bat. This determination is consistent with the previous consultation between the Navy and USFWS for activities described in the 2015 MITT Final EIS/OEIS. Because of the small increases in the amount of NEW used on FDM, the number of ordnance items expended, and the number of events that would occur on FDM under Alternative 1 compared to what was analyzed in the 2015 MITT Final EIS/OEIS, the activities proposed under Alternative 1 do not constitute a modification of the original proposed activities that causes new or additional effects on ESA-listed species on FDM; therefore, reinitiation of Section 7 consultation between the USFWS and Navy is not necessary.*

*Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), explosions and weapons firing on land during training activities under Alternative 1 would not result in significant adverse effects on terrestrial bird populations.*

#### 3.10.2.2.2 Impacts from Explosive Stressors Under Alternative 2

Under Alternative 2, there would be an increase in the number of events using FDM as a training location or target (see Table 3.6-1), with an increase in the number of munitions items expended on FDM (see Table 3.6-2) compared to what was analyzed previously in the 2015 MITT Final EIS/OEIS and under Alternative 1.

Taken together, the increase in the number of events per year or the amount of ordnance used during events would result in an increase in the amount of NEW expended on FDM each year (see Table 3.6-3). Under Alternative 2, Naval Surface Firing Exercise events would expend more large-caliber projectiles, thereby slightly increasing the NEW expended under Alternative 2 compared to Alternative 1. Factors that limit the potential for additional adverse impacts, however, include maintaining the same ordnance type and targeting restrictions included as part of the 2015 MITT Final EIS/OEIS. All ordnance expended on FDM would target existing impact zones, with the same ordnance restrictions imposed on all FDM activities and with the same avoidance and minimization measures in place (see Section 5.5, Terrestrial Mitigation Measures to be Implemented, and Table 5.5-1). As with Alternative 1, the likelihood of increased exposure under Alternative 2 is negligible because of the small increases in the number of events, munitions, and NEW expended on FDM compared to what was analyzed in the 2015 MITT Final EIS/OEIS and 2015 USFWS Biological Opinion. Therefore, the conclusions for terrestrial biological resources (including ESA-listed species and species protected by the MBTA) included in the 2015 MITT Final EIS/OEIS remain valid.

*Pursuant to the ESA, explosive stressors during training activities on FDM, as described under Alternative 2, may affect the Micronesian megapode and the Mariana fruit bat. This determination is consistent with the previous consultation between the Navy and USFWS for activities described in the 2015 MITT Final EIS/OEIS. Because of the small increases in the amount of NEW used on FDM, the number of ordnance items expended, and the number of events that would occur on FDM under Alternative 2 compared to what was analyzed in the 2015 MITT Final EIS/OEIS, the activities proposed under Alternative 2 do not constitute a modification of the original proposed activities that causes new or additional effects on ESA-listed species on FDM; therefore, reinitiation of Section 7 consultation between the USFWS and Navy is not necessary.*

*Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), explosions and weapons firing on land during training activities under Alternative 2 would not result in significant adverse effects on terrestrial bird populations.*

#### 3.10.2.2.3 Impacts from Explosive Stressors Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. For FDM, the lease agreement between the U.S. government and the Commonwealth of the Northern Mariana Islands would remain in place, and the island would continue to be maintained as a Navy range, although strike warfare would no longer continue on the island.

Explosions associated with Navy training activities would no longer occur on the island, which would minimize adverse impacts associated with blast effects.

### 3.10.2.3 Physical Disturbance and Strike Stressors

The 2015 MITT Final EIS/OEIS analyzed the potential for physical disturbance and strike stressors, defined as including (1) direct strike, (2) habitat disturbance, (3) and the potential for wildfires. As discussed in Section 3.10.3.2 (Physical Stressors) in the 2015 MITT Final EIS/OEIS, the potential for impacts on vegetation communities and wildlife resources, including the Micronesian megapode, Mariana fruit bats that may occur on the island, and land bird species, associated with direct strike from inert munitions is considerably lower than the potential for blast effects associated with explosive munitions.

Direct Action training activities require helicopter landings on FDM at a landing zone within the “no target area” (see Appendix A for a description of Direct Action training events). Marines and special warfare personnel would then disembark and conduct Direct Action training activities, where vegetation may be trampled. Because of unexploded ordnance clearance requirements, only marked trails (laid out by explosive ordnance disposal specialists prior to range clearance activities) are used, which reduces the potential for vegetation trampling (as well as nest trampling) in areas away from access trails.

Training activities that involve high explosive detonations on FDM introduce the potential for wildfires on the island. Cluster bombs, live cluster weapons, live scatterable munitions, fuel-air explosives, incendiary devices, and bombs greater than 2,000 lb. are prohibited on FDM. It should be noted that some munitions contain a small amount of phosphorous for spotting charges, and smoke markers are used in some direct action training activities. Phosphorous is not a main constituent to any munitions used on FDM. The live-fire weapons allowed are only targeted at impact areas authorized for live and inert ordnance. The areas for target placement support only low-growing vegetation because of long-term training with explosives. Dense vegetation grows on the northern portion of the island within the special use area, which could create a wildfire if weapons are misfired. Explosions may ignite fires in impact areas, which may spread to higher stature fine fuels outside of impact areas, endangering the remnant forest portions on the northern side of the island. However, the dense vegetation and shaded canopy of trees in the northern portion of the island likely increases the moisture content of vegetation, which should decrease the ability of fires to spread into the special use area.

#### 3.10.2.3.1 Impacts from Physical Disturbance and Strike Stressors Under Alternative 1

Under Alternative 1, direct strike of individual birds and bats on FDM is unlikely because the increased activities (missile exercises and direct-action training activities) would occur within the impact zones already established on the island. These areas are highly degraded and do not support sufficient cover and forage resources to be considered high-value habitat on FDM. Therefore, the impact areas are not likely to attract terrestrial wildlife resources, and would attract few (if any) Micronesian megapodes and likely no Mariana fruit bats.

The small increase in explosions under Alternative 1 (see Table 3.6-3) compared to the amount analyzed in the 2015 MITT Final EIS/OEIS, as measured in terms of NEW, would unlikely be additive to wildfire risk on FDM. 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. 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, as they would be unable to flee smoke or burning vegetation. As stated above, fires are unlikely to spread to the northern portion of FDM; 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. Therefore, despite more explosions on FDM, they would occur within the same impact zones, which reduces the potential for overburns in new previously unburned areas.

*Pursuant to the ESA, physical disturbance and strike stressors during training activities on FDM, as described under Alternative 1, may affect the Micronesian megapode and the Mariana fruit bat. This determination is consistent with the previous consultation between the Navy and USFWS for activities described in the 2015 MITT Final EIS/OEIS. Because of the small increases in the amount of NEW used on FDM, the number of ordnance items expended, and the number of events that would occur on FDM under Alternative 1 compared to what was analyzed in the 2015 MITT Final EIS/OEIS, the activities proposed under Alternative 1 do not constitute a modification of the original proposed activities that causes new or additional effects on ESA-listed species on FDM; therefore, reinitiation of Section 7 consultation between the USFWS and Navy is not necessary.*

*Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), physical disturbance and strike stressors during training activities under Alternative 1 would not result in significant adverse effects on terrestrial bird populations.*

#### 3.10.2.3.2 Impacts from Physical Disturbance and Strike Stressors Under Alternative 2

Under Alternative 2, there would be an increase in the number of events using FDM as a training location or target (see Table 3.6-1), with an increase in the number of munitions items expended on

FDM (see Table 3.6-2) compared to what was analyzed previously in the 2015 MITT Final EIS/OEIS and under Alternative 1.

Taken together, the increase in the number of events per year or the amount of ordnance used during events would result in an increase in the amount of NEW expended on FDM each year (see Table 3.6-3). Although the amount of increased NEW is negligible, the potential exposure to stressors associated with ordnance use would increase under Alternative 2 compared to what was analyzed previously in the 2015 MITT Final EIS/OEIS. Under Alternative 2, Naval Surface Firing Exercise events would expend more large-caliber projectiles, thereby slightly increasing the NEW expended under Alternative 2 compared to Alternative 1. Factors that limit the potential for additional adverse impacts associated with physical disturbance and strike, however, include maintaining the same ordnance type and targeting restrictions included as part of the 2015 MITT Final EIS/OEIS. All ordnance expended on FDM would target existing impact zones, with the same ordnance restrictions imposed on all FDM activities and with the same avoidance and minimization measures in place (see Section 5.5, Terrestrial Mitigation Measures to be Implemented, and Table 5.5-1). Therefore, the increases in ordnance use on FDM shown in Tables 2.5-1 and 2.5-2 do not appreciably change the impact conclusions presented in the 2015 MITT Final EIS/OEIS. The conclusions for terrestrial biological resources (including ESA-listed species and species protected by the MBTA) included in the 2015 MITT Final EIS/OEIS remain valid.

*Pursuant to the ESA, physical disturbance and strike stressors during training activities on FDM, as described under Alternative 2, may affect the Micronesian megapode and the Mariana fruit bat. This determination is consistent with the previous consultation between the Navy and USFWS for activities described in the 2015 MITT Final EIS/OEIS. Because of the small increases in the amount of NEW used on FDM, the number of ordnance items expended, and the number of activities that would occur on FDM under Alternative 2 compared to what was analyzed in the 2015 MITT Final EIS/OEIS, the activities proposed under Alternative 2 do not constitute a modification of the original proposed activities that causes new or additional effects on ESA-listed species on FDM; therefore, reinitiation of Section 7 consultation between the USFWS and Navy is not necessary.*

*Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), physical disturbance and strike stressors during training activities under Alternative 2 would not result in significant adverse effects on terrestrial bird populations.*

#### 3.10.2.3.3 Impacts from Physical Disturbance and Strike Stressors Under No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. For FDM, the lease agreement between the U.S. government and the Commonwealth of the Northern Mariana Islands would remain in place, and the island would continue to be maintained as a Navy range, although strike warfare would no longer continue on the island.

Explosions associated with Navy training activities would no longer occur on the island, which would minimize adverse impacts associated with physical disturbance and strike stressors.

### 3.10.2.4 Secondary Stressors

The 2015 MITT Final EIS/OEIS included an analysis of the potential impacts of secondary stressors on terrestrial species and habitats. Specifically, this section addresses the potential introduction of invasive species. Section 3.10.3.3.1 (Impacts from Invasive Species Introductions) in the 2015 MITT Final EIS/OEIS discusses potential introduction pathways of invasive species associated with training activities described in this SEIS/OEIS.

The 2015 MITT Final EIS/OEIS included a conceptual model of invasive species pathways (Figure 3.10-10 in the 2015 MITT Final EIS/OEIS) resulting from training activities, and specific invasive species interdiction measures that avoid or minimize risk of specific pathways (see Table 3.10-7 in the 2015 MITT Final EIS/OEIS). Of the two training activity types that would increase on FDM under Alternative 1, only Direct Action training activities present potential introduction pathways for invasive species. Introduction pathways that originate on Guam and end on FDM present a potential hazard for brown treesnake dispersal. For activities described in this SEIS/OEIS, potential introduction pathways would be associated with helicopter transports to FDM. The Brown Tree Snake Control and Interdiction Requirements are included in the Commander, U.S. Naval Forces Marianas Instruction 3500.4A (dated October 8, 2013). This document describes roles and responsibilities for exercise planners to interdict and control brown treesnakes and to disseminate information to participants throughout the chain of command. Other policies and instructions associated with military training activities and potential invasive species introductions include Office of the Chief of Naval Operations Instruction 5090.1D (updated in 2013) and Armed Forces Pest Management Board Technical Guide 31 (Armed Forces Pest Management Board, 2012). For instance, any personnel involved in training activities on FDM conduct self inspections to avoid or reduce potential introductions of invasive species from points of origin to FDM. Points of origin include Guam and Saipan, and possibly Tinian. Personnel inspect all gear and clothing (e.g., boots, bags, weapons, and pants) for soil accumulations, seeds, invertebrates, and possible inconspicuous stowaway brown treesnakes).

The Direct Action training activities, which are proposed to increase, would still be subject to biosecurity measures. The potential introduction of invasive species to FDM from additional transits to FDM during Direct Action training activities is unlikely; therefore, there would be no appreciable increase in risk from activities analyzed in the 2015 MITT Final EIS/OEIS.

With the small increase (less than 1 percent) in the amount of NEW used on FDM under Alternative 1 and Alternative 2 compared to what was analyzed in the 2015 MITT Final EIS/OEIS, the activities proposed in this SEIS do not constitute a modification of the original proposed activities that causes new or additional effects from secondary stressors on ESA-listed species on FDM; therefore, reinitiation of Section 7 consultation between the USFWS and Navy is not necessary.

### 3.10.3 Public Scoping Comments

The public raised a number of issues during the scoping period in regard to terrestrial species and habitats. The issues are summarized in the list below.

- **Public comments concerning a lack of studies on FDM –** Some commenters noted a lack of studies documenting the condition of terrestrial biological resources on FDM. Complete natural resource inventories on the island are subject to a number of constraints, such as safety concerns regarding unexploded ordnance and scheduling surveys to avoid both training activities and weather. Surveys are conducted on a periodic basis on FDM. On-the-ground surveys are conducted primarily to monitor Micronesian megapodes on the island. These surveys are described in more detail in Section 3.10.2.3.8.4 (Status within the Mariana Islands Training and Testing Study Area) in the 2015 MITT Final EIS/OEIS. Aerial surveys are conducted more frequently over FDM, with the primary focus on monitoring seabird rookeries (primarily brown boobies, masked boobies, and red-footed boobies). These surveys are described in more detail, along with quantitative trend analysis of populations, in Section 3.6.2 (Farallon de Medinilla) of the 2015 MITT Final EIS/OEIS. All of these studies are summarized and included in updates to the Joint Region Marianas Integrated Natural Resources Management Plan for Joint Region Marianas-administered and Leased Lands On Guam, Tinian, and FDM (U.S. Department of the Navy, 2018), which is shared with cooperating agencies (e.g., Guam Department of Agriculture Division of Aquatic and Wildlife Resources, Commonwealth of Northern Mariana Islands Department of Land and Natural Resources Division of Fish and Wildlife, and USFWS Pacific Islands Fish and Wildlife Office).

- **Potential impacts on vegetation communities on FDM –** One comment raised the concern of vegetation loss resulting from bombing activities at FDM. Vegetation loss over the long term is described in Section 3.10.2.1.5 (Farallon de Medinilla) in the 2015 MITT Final EIS/OEIS. Few vegetation surveys have been conducted on FDM. The first published flora record in 1902, described the island as a plateau covered by brush approximately 13 feet (4.0 meters) high (Mueller-Dombois & Fosberg, 1998); however, aerial photographs from 1944 show large canopy trees on FDM (see Figure 3.10-4 in the 2015 MITT Final EIS/OEIS). FDM's vegetation appears to have undergone significant changes since the island was leased by the Department of Defense 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 & Fosberg, 1998). The avoidance and minimization measures currently implemented on FDM, as described in the 2015 MITT Final EIS/OEIS and Chapter 5 (Mitigation) of this SEIS/OEIS, are designed to protect the area of the island occupied by the Micronesian megapode in the "No Drop Zone." According to Lusk et al. (2000), vegetation in this area has not substantially changed since 1974. The USFWS, in their Biological Opinion signed in 2015 for activities described in the 2015 MITT Final EIS/OEIS, suggests that the avoidance and minimization measures have protected species and habitats in the northern portion of the island (U.S. Fish and Wildlife Service, 2015), while the reductions in vegetation structure and composition have occurred in designated impact zones to the south of the "No Drop Zone." In summary, the Navy concurs that there have been significant losses of vegetation on FDM resulting from military training activities. Mitigation measures that have been designed in cooperation with USFWS personnel provide a level of protection for the northern end of the island, while ordnance use is only allowed in designated impact zones. Increases in ordnance use on FDM would only occur in existing impact zones, causing no new additional vegetation losses on the island.

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# REFERENCES

Amidon, F. A., A. P. Marshall, and C. C. Kessler. (2011). *Status of the Micronesian megapode in the Commonwealth of the Northern Mariana Islands*. Honolulu, HI: U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office.

Armed Forces Pest Management Board. (2012). *Guide for Agricultural and Public Health Preparation of Military Gear and Equipment for Deployment and Redeployment, Technical Guide 31*. Silver Spring, MD: Armed Forces Pest Management Board Information Services Division.

Kessler, C. C., and F. A. Amidon. (2009). *Micronesian Megapode on Tinian and Aguiguan* (Terrestrial Surveys of Tinian and Aguiguan, Mariana Islands, 2008: Working Draft). Honolulu, HI: U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office.

Lusk, M. R., P. Bruner, and C. Kessler. (2000). The Avifauna of Farallon De Medinilla, Mariana Islands. *Journal of Field Ornithology, 71*(1), 22–33.

Mueller-Dombois, D., and F. R. Fosberg. (1998). *Vegetation of the tropical Pacific islands*. New York, NY: Springer-Verlag.

Mueller-Dombois, D., and F. R. Fosberg. (2013). *Vegetation of the Tropical Pacific Islands* (Vol. 132). New York, NY: Springer Science & Business Media.

Reichel, J. D. (1991). Status and conservation of seabirds in the Mariana Islands. In J. P. Croxall (Ed.), *Seabird Status and Conservation, a Supplement* (pp. 248–262). Cambridge, United Kingdom: International Preservation Technical Publication Number 11.

U.S. Department of the Navy. (1975). *Farallon de Medinilla Bombardment Range: Environmental Impact Statement*. Washington, DC: U.S. Department of the Navy.

U.S. Department of the Navy. (2008a). *Micronesian Megapode (Megapodius laperouse laperouse) Surveys on Farallon de Medinilla, Commonwealth of the Northern Marianas Islands (Draft)*. Honolulu, HI: Naval Facilities Engineering Pacific.

U.S. Department of the Navy. (2008b). *Final Environmental Assessment for the Homeporting of Six Zumwalt Class Destroyers at East and West Coast Installations (including Hawaii)*. Norfolk, VA: Naval Facilities Engineering Command Atlantic.

U.S. Department of the Navy. (2008c). *Fiscal Years 2007 and 2008 Report for 61755NR410 Wildlife Surveys on Military Leased Lands, Tinian CNMI*. Honolulu, HI: Naval Facilities Engineering Pacific.

U.S. Department of the Navy. (2011). *Marianas Training Manual*. Naval Base Guam, Guam: Commander Joint Region Marianas.

U.S. Department of the Navy. (2013a). *2013 Joint Region Marianas Integrated Natural Resources Management Plan* (Final). Naval Base Guam, Guam: Joint Region Marianas.

U.S. Department of the Navy. (2013b). *Annual Report: Wildlife Surveys on Tinian and FDM*. Naval Base Guam, Guam: Joint Region Marianas.

U.S. Department of the Navy. (2018). *Joint Region Mariana Islands Integrated Natural Resources Management Plan*. Saipan, Mariana Islands: Joint Region Mariana Islands.

U.S. Fish and Wildlife Service. (1998). *Recovery Plan for the Micronesian Megapode (Megapodius laperouse laperouse)*. Portland, OR: U.S. Fish and Wildlife Service, Region 1 (Pacific Region Office).

U.S. Fish and Wildlife Service. (2009). *Draft Revised Recovery Plan for the Mariana Fruit Bat or Fanihi (Pteropus mariannus mariannus)*. Portland, OR: U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service. (2015). *Biological Opinion for the Mariana Islands Training and Testing Program*. Honolulu, HI: U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office.

U.S. Fish and Wildlife Service. (2016). *Informal Consultation on Mariana Islands Training and Testing Program Affects to Eighteen Newly-Listed Species, Guam and Tinian*. Honolulu, HI: Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office.

United States of America and 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*. Washington, DC: United States Code.

# 3.11 Cultural Resources

# Supplemental Environmental Impact Statement/

# Overseas Environmental Impact Statement

# Mariana Islands Training and Testing

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## 3.11 Cultural Resources

### 3.11.1 Affected Environment

This section supplements the analysis of impacts on Cultural Resources presented in the 2015 Mariana Islands Training and Testing (MITT) Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). New information made available since the publication of the 2015 MITT Final EIS/OEIS is included below to better understand potential stressors and impacts on cultural resources resulting from training and testing activities. Information presented in the 2015 MITT Final EIS/OEIS that remains valid is noted as such and referenced in the appropriate sections. Comments received from the public during scoping related to Cultural Resources are addressed in Section 3.11.3 (Public Scoping Comments).

#### 3.11.1.1 Guam

Following a review of recent literature, no additional submerged cultural resources have been identified around Guam. As such, the information presented in the 2015 MITT Final EIS/OEIS is still valid and the most current.

#### 3.11.1.2 Commonwealth of the Northern Mariana Islands

##### 3.11.1.2.1 Farallon de Medinilla

Following a review of recent literature, no additional submerged cultural resources, land-based archaeological sites, or isolated non-modern artifacts have been identified around or on Farallon de Medinilla (FDM). As such, the information presented in the 2015 MITT Final EIS/OEIS is still valid and the most current.

##### 3.11.1.2.2 Tinian

Following a review of recent literature, additional submerged cultural resources have been identified around Tinian. In 2017, East Carolina University partnered with the non-profit organization Ships of Exploration and Discovery on a National Parks Service America Battlefield Protection Program grant to conduct an archaeological investigation in the Commonwealth of the Northern Mariana Islands (CNMI). A portion of the 2017 project was dedicated to examining Tinian's World War II invasion beaches Unai Babui and Unai Chulu. The 2017 study was a follow-up study on the original American Battlefield Protection Program grant and a 2010 study of the nearshore areas, which identified potential anomalies in the nearshore areas of Unai Chulu (Burns, 2010). Researchers discovered two previously unidentified cultural resources within the Study Area landing beaches of Tinian: a World War II Danforth anchor and a previously unknown, fairly intact Landing Vehicle Tracked-2 in approximately 45 feet (ft.) of water (McKinnon et al., 2017). Researchers also discovered portions of a second Landing Vehicle Tracked, a large stockless U.S. Navy anchor, and a tire that may belong to a DUCKW, a six-wheel-drive amphibious modification of the CCKW trucks (2.5-ton truck) used during World War II in approximately 20 ft. of water in the nearshore area of Unai Babui.

##### 3.11.1.2.3 Saipan

Following a review of recent literature, no additional submerged cultural resources have been identified around Saipan. However, the results of an underwater archaeological survey conducted in 2011 were published in 2016 describing the remains of the ship, artifacts, and debris field associated with a mid-to-late 19th-century wooden ship found in Tanapag Lagoon on the western side of Saipan. While the study confirmed the shipwreck to be from the colonial period prior to World War II, it was inconclusive as to the positive identity of the ship (McKinnon et al., 2016).

#### 3.11.1.2.4 Rota

Following a review of recent literature, no additional submerged cultural resources have been identified around Rota. As such, the information presented in the 2015 MITT Final EIS/OEIS is still valid and the most current.

### 3.11.1.3 Mariana Islands Training and Testing Transit Corridor

The length and variable width of the MITT transit corridor is such a vast and deep area, sometimes over 18,000 ft. (5,486 meters) deep, that it precludes systematic survey for submerged historic resources. In accordance with the addendum to the National Historic Preservation Act (54 United States Code Section 307101(e)) regarding international federal activities affecting historic properties, the World Heritage List was reviewed, and no known cultural resources were identified within the MITT transit corridor.

### 3.11.1.4 Current Requirements, Practices, and Protective Measures

#### 3.11.1.4.1 Avoidance of Obstructions

As stated in the 2015 MITT Final EIS/OEIS, the military routinely avoids locations of known obstructions, which includes submerged cultural resources such as historic shipwrecks. Known obstructions are avoided to prevent damage to sensitive equipment and vessels, for mission success, and to avoid or reduce potential impacts on cultural resources (Section 2.3.3, Standard Operating Procedures and Chapter 5, Mitigation).

#### 3.11.1.4.2 Mariana Islands Range Complex Programmatic Agreement

A Programmatic Agreement was negotiated in 2009 for all military training activities proposed in the Mariana Islands Range Complex (MIRC). The Programmatic Agreement was based on consultations with the Guam State Historic Preservation Officer, CNMI Historic Preservation Officer, Advisory Council on Historic Preservation, and the National Park Service. The training constraints map identifies 13 No Training areas (8 on Guam and 5 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 or the use of rubber-tired vehicles. No pyrotechnics, demolition, or digging is allowed in Limited Training areas without prior consultation with the appropriate Historic Preservation Officer. 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 for land-based training areas. The Programmatic Agreement expires in December 2019 and the Navy is pursuing continued compliance with the National Historic Preservation Act.

## 3.11.2 Environmental Consequences

The 2015 MITT Final EIS/OEIS considered training and testing activities proposed to occur in the Study Area that may have the potential to impact cultural resources. The stressors applicable to cultural resources in the Study Area are the same stressors in the 2015 MITT Final EIS/OEIS and include

- explosive (in-water explosions), and
- physical disturbance and strike (ground disturbance, use of towed in-water devices, deposition of military expended materials, and use of seafloor devices).

This section evaluates how and to what degree potential impacts on cultural resources from stressors described in Section 3.0 (General Approach to Analysis) may have changed since the analysis presented in the 2015 MITT Final EIS/OEIS was completed. Tables 2.5-1 and 2.5-2 in Chapter 2 (Description of Proposed Action and Alternatives) list the proposed training and testing activities and include the number of times each activity would be conducted annually and the locations within the Study Area where the activity would typically occur under each alternative. The tables also present the same information for activities described in the 2015 MITT Final EIS/OEIS so that the proposed levels of training and testing under this Supplemental EIS (SEIS)/OEIS can be easily compared.

The Navy conducted a review of federal and state regulations and standards relevant to cultural resources and reviewed literature published since 2015 for new information on cultural resources (as presented in Section 3.11.1 Affected Environment) that could inform the analysis presented in the 2015 MITT Final EIS/OEIS. The analysis presented in this section also considers standard operating procedures, which are discussed in Section 2.3.3 (Standard Operating Procedures) of this SEIS/OEIS, and mitigation measures that are described in Chapter 5 (Mitigation). The Navy would implement these measures to avoid or reduce potential impacts on cultural resources from stressors associated with the proposed training and testing activities. Protective measures for cultural resources will be coordinated with the Guam State Historic Preservation Officer, CNMI Historic Preservation Officer, Advisory Council on Historic Preservation, and the National Park Service as part of the Section 106 consultation process.

#### 3.11.2.1 Explosive Stressors

Explosive stressors that have the potential to impact cultural resources are shock (pressure) waves and vibrations from underwater detonations (such as explosive torpedoes, missiles, bombs, projectiles, airguns, and mines) and cratering created by underwater explosions. While the number of training and testing activities would change under this SEIS/OEIS, the locations of activities and the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.11.3.1.1 (Impacts from Explosives – Shock [Pressure] Waves from Underwater Explosions) and Section 3.11.3.1.2 (Impacts from Explosives – Cratering) remains valid.

##### 3.11.2.1.1 Impacts from Explosive Stressors Under Alternative 1

Under Alternative 1, the annual number of explosive munitions expended at sea in the Study Area would decrease overall from the 2015 MITT Final EIS/OEIS. However, under this alternative, underwater detonation activities would increase for Limpet Mine Neutralization System and Underwater Demolition Qualification/Certification above the 2015 MITT Final EIS/OEIS (Table 2.5-1 and Table 3.0-16). The explosive ordnance would continue to occur in the same areas and would have no appreciable change in the impact analysis or conclusions for explosive stressors as presented in the 2015 MITT Final EIS/OEIS.

As stated in the 2015 MITT Final EIS/OEIS analysis, training and testing activities using explosives would not typically occur within approximately 3 nautical miles from shore, including the nearshore waters surrounding Tinian, Saipan, or Rota. Therefore, no shock (pressure) waves, vibrations, or cratering from explosions would occur in these areas, and no submerged historic resources would be affected by explosive stressors. For those training activities at the Agat Bay Floating Mine Neutralization Site, Piti Point Floating Mine Neutralization Site, and Apra Harbor Underwater Demolition Site (located within Outer Apra Harbor), the military avoids locations of known obstructions, which includes submerged cultural resources (Section 2.3.3, Standard Operating Procedures, and Section 5.4.1, Mitigation Areas for Seafloor Resources). Thus, it is unlikely that cultural resources could be disturbed or destroyed from shock waves or cratering created by underwater explosions during mine warfare activities, surface warfare activities, torpedo testing, mine countermeasure mission package activities, or other training activities that use explosives.

In summary, given that the training and testing activities would decrease and be conducted in the same areas as described in the 2015 analysis, the amount of shock (pressure) waves, vibrations, or cratering from explosives would not appreciably change the conclusions. Therefore, the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.11.3.1.1 (Explosive Stressors – Shock (Pressure) Waves from Underwater Explosions) and Section 3.11.3.1.2 (Impacts from Explosives – Cratering) remains valid. Explosive stressors resulting from underwater explosions creating shock (pressure) waves, vibrations, and cratering of the seafloor would not adversely affect submerged cultural resources under Alternative 1 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.

#### 3.11.2.1.2 Impacts from Explosive Stressors Under Alternative 2

Under Alternative 2, the annual number of explosive munitions expended at sea in the Study Area would decrease overall from the 2015 MITT Final EIS/OEIS. However, under this alternative, underwater detonation activities would increase for Limpet Mine Neutralization System and Underwater Demolition Qualification/Certification above the 2015 MITT Final EIS/OEIS (Table 2.5.1 and Table 3.0-16). As noted under Alternative 1, the explosive ordnance would continue to occur in the same areas and would have no appreciable change in the impact analysis or conclusions for explosive stressors as summarized above under Alternative 1 and as presented in the 2015 MITT Final EIS/OEIS.

#### 3.11.2.1.3 Impacts from Explosive Stressors Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Explosive stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions of submerged cultural resources would remain unchanged after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer explosive stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for explosive impacts on submerged cultural resources, but would not measurably improve the condition of submerged cultural resources in the Study Area.

### 3.11.2.2 Physical Disturbance and Strike

The physical disturbance and strike stressors that may impact cultural resources include (1) vessels and towed in-water devices, (2) military expended materials, and (3) seafloor devices.

#### 3.11.2.2.1 Impacts from Physical Disturbance and Strike Stressors Under Alternative 1

Under Alternative 1, the number of proposed training and testing events would increase for vessels, decrease for towed in-water devices, increase for non-explosive practice munitions, decrease for military expended materials, and decrease for seafloor devices (see Tables 3.0-12, 3.0-13, 3.0-14, 3.0-15, and 3.0-18, respectively) compared to the numbers in the 2015 MITT Final EIS/OEIS.

Proposed increases under Alternative 1 for vessels would have no appreciable change on the impact analysis or conclusions for physical disturbance and strike stressors presented in the 2015 MITT Final

EIS/OEIS because the increase in training and testing events including the use of vessels is not substantial (Table 3.0-12). Thus, the analysis presented in the 2015 MITT Final EIS/OEIS, Section 3.11.3.2.2 (Impacts from Vessel and In-Water Device Strikes) remains valid.

As stated in the 2015 MITT Final EIS/OEIS, the impact of physical disturbance and strike stressors on cultural resources would be inconsequential for vessels and in-water devices because (1) the types of activities associated with towed systems are conducted in areas where the sea floor is deeper than the length of the tow lines; (2) 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; and (3) devices are designed and operated within the water column and do not contact the seafloor. Activities involving vessels and in-water devices are not expected to affect submerged cultural resources.

The proposed increase under Alternative 1 in non-explosive practice munitions (Table 3.0-14) is attributed to the increase in small-caliber projectiles. Larger non-explosive practice munitions such as torpedoes, bombs, and missiles would all decrease under Alternative 1. As stated in the 2015 MITT Final EIS/OEIS, the 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. However, the impact of non-explosive practice munitions or military expended materials on cultural resources would be inconsequential because most of the anticipated expended munitions would be small objects and fragments that lose velocity after striking the ocean surface and drift to the seafloor. Larger and heavier objects, such as non-explosive practice munitions, would strike the ocean surface with greater velocity, but their acceleration would slow upon impact with the ocean surface. It is possible these larger and heavier objects could impact a submerged historic site by creating sediment and artifact displacement. A historic resource could be impacted by damaging structural elements; the probability increases in areas where there is a higher density of resources. However, this type of impact is not anticipated because the Navy avoids areas with known submerged obstructions, including submerged objects and sites listed on the National Register of Historic Places. Thus, the increase in non-explosive practice munitions would have no appreciable change on the impact analysis or conclusions for physical disturbance and strike stressors presented in the 2015 MITT Final EIS/OEIS.

As stated in the 2015 MITT Final EIS/OEIS, any physical disturbance on the continental shelf and seafloor could inadvertently damage or destroy submerged cultural resources if such resources are located within the Study Area and are not avoided. Under Alternative 1, the impact of seafloor devices on cultural resources would remain inconsequential as presented in the 2015 MITT Final EIS/OEIS because (1) seafloor devices are either stationary or move very slowly along the bottom; and (2) the military avoids locations of known obstructions, which include submerged historic resources (Section 2.3.3, Standard Operating Procedures, and Section 5.4.1, Mitigation Areas for Seafloor Resources). Thus, activities involving seafloor devices are not expected to affect submerged cultural resources.

#### 3.11.2.2.2 Impacts from Physical Disturbance and Strike Stressors Under Alternative 2

Under Alternative 2, the number of proposed training and testing events would increase for vessels, decrease for towed in-water devices, increase for non-explosive practice munitions, decrease for military expended materials, and decrease for seafloor devices (see Tables 3.0-12, 3.0-13, 3.0-14, 3.0-15, and 3.0-18, respectively) compared to the numbers in the 2015 MITT Final EIS/OEIS. Under Alternative 2, increases as compared to Alternative 1 would have no appreciable change on the impact conclusions as summarized above under Alternative 1 and presented in the 2015 MITT Final EIS/OEIS.

#### 3.11.2.2.3 Impacts from Physical Disturbance and Strike Stressors Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Physical disturbance and strike stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions of submerged cultural resources would remain unchanged after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer physical disturbance and strike stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for physical disturbance and strike impacts on submerged cultural resources, but would not measurably improve the condition of submerged cultural resources in the Study Area.

### 3.11.3 Public Scoping Comments

The public raised two issues during the scoping period in regard to cultural resources. The issues are summarized in the list below.

- **U.S. Navy has not consulted with indigenous people for conducting military training –** The 2015 MITT Final EIS/OEIS summarized in Section 3.11.4.2 (Regulatory Determinations) that the 2009 MIRC Programmatic Agreement is in effect and satisfies the requirement for consultation as long as the stipulations in that Programmatic Agreement are followed. The 2009 MIRC Programmatic Agreement was negotiated for all military training activities for the MIRC EIS/OEIS based on consultations with the Guam State Historic Preservation Officer, CNMI Historic Preservation Office, Advisory Council on Historic Preservation, and the National Park Service (U.S. Department of Defense, 2009).
- **The Navy should conduct a cultural survey of FDM –** The 2015 MITT Final EIS/OEIS Section 3.11.2.2.1 (Farallon de Medinilla) evaluated the findings of a preliminary archaeological field survey of FDM conducted in 1996 (Welch, 2010). The survey reports no archaeological sites or isolated non-modern artifacts were observed. Modern debris or litter associated with the military use of the island was observed. Thus the 2015 analysis determined that although training activities would create ground disturbance, there are no known cultural resources on FDM.

# REFERENCES

Burns, J. (2010). *Underwater Archaeology Remote Sensing Survey of the Proposed AAV and LCAC Landing Beaches on Tinian (Unai Chulu and Unai Dankulo), Commonwealth of the Northern Mariana Islands*. Charlottesville, VA: Southeastern Archaeological Research, Inc.

McKinnon, J., S. Nahabedian, and J. Raupp. (2016). A Colonial Shipwreck in Saipan, Northern Mariana Islands. *International Journal of Nautical Archaeology, 45*(1), 94–104.

McKinnon, J., T. Carrell, J. Raupp, K. Yamafune, V. Richards, J. Carpenter, J. Burns, D. Mullins, W. Hoffman, J. Nunn, A. Ropp, P. Harvey, J. Pruitt, S. Arnold, D. Sprague, and K. Clevenger. (2017). *National Park Service American Battlefield Protection Program Grant Project: East Carolina University*. Retrieved from http://www.themua.org/ECUSaipan/index.php?content=arg6.

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*. Washington, DC: U.S. Department of Defense.

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*. Pearl Harbor, HI: Department of the Navy, Naval Facilities Engineering Command, Pacific.

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# 3.12 Socioeconomic Resources and Environmental Justice

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## 3.12 Socioeconomic Resources and Environmental Justice

The purpose of this section is to supplement the analysis of impacts on socioeconomic resources and environmental justice presented in the 2015 Mariana Islands Training and Testing (MITT) Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) with new information relevant to proposed changes in training and testing activities conducted at sea and on Farallon de Medinilla (FDM). Information presented in the 2015 MITT Final EIS/OEIS that remains valid is noted as such and referenced in the appropriate sections. New information made available since the publication of the 2015 MITT Final EIS/OEIS is included below to better understand potential stressors and impacts on socioeconomic resources and environmental justice resulting from training and testing activities. Comments received from the public during scoping related to socioeconomic resources and environmental justice are addressed in Section 3.12.3 (Public Scoping Comments).

Section 3.12 (Socioeconomic Resources) in the 2015 MITT Final EIS/OEIS analyzed subsistence fishing as a socioeconomic resource but did not identify it as an environmental justice issue. This section supplements the analysis of subsistence fishing by expanding the discussion to include other traditional fishing practices and identifying these practices as an environmental justice issue as well as a socioeconomic resource. For the purposes of this analysis, traditional fishing practices are defined by the motivation for the fishing trip and include subsistence, cultural customs, communal sharing, and non-commercial financial benefit (e.g., selling the catch to cover the costs of the fishing trip). These traditional practices, which are longstanding and defining characteristics for many in the local communities on Guam and in the Commonwealth of the Northern Mariana Islands (CNMI), are analyzed separately from recreational and commercial fishing in this section.

### 3.12.1 Affected Environment

The socioeconomic resources and environmental justice issues (i.e., traditional fishing practices) analyzed in this Supplemental EIS (SEIS)/OEIS are the same as the resources identified and analyzed in the 2015 MITT Final EIS/OEIS. The training and testing activities described in Chapter 2 (Description of Proposed Action and Alternatives) of this SEIS/OEIS are generally consistent with the training and testing activities analyzed in the 2015 MITT Final EIS/OEIS and are representative of activities that the Department of Defense (DoD) has been conducting in the MITT Study Area for decades.

The concerns over socioeconomic resources and how they may be impacted by the proposed training and testing activities are similar to those as previously described in the 2015 MITT Final EIS/OEIS. The United States (U.S.) Navy's operating procedures to prevent or lessen impacts on local socioeconomic resources, as described in the 2015 MITT Final EIS/OEIS, remain applicable and will continue to be implemented.

As described in detail in the 2015 MITT Final EIS/OEIS, the socioeconomic analysis evaluated how elements of the human environment might be affected by ongoing and proposed training and testing activities in the Study Area. The Navy identified four broad socioeconomic elements based on their association with human activities and livelihoods in the Study Area:

- Commercial transportation and shipping
- Commercial and recreational fishing
- Traditional fishing practices
- Tourism

Each of these resources is an aspect of the human environment that involves economics (e.g., employment, income, or revenue) and social conditions (e.g., enjoyment and quality of life) associated with the marine environment in the Study Area. These four elements were chosen as the focus of the analysis in this section because of their importance to the local economy and the way of life on Guam and the CNMI and the potential for these elements to be impacted by the proposed training and testing activities.

Data and information from government technical documents and reports, scientific journals, and the Navy's marine resources database of publications were reviewed to assess any changes in the socioeconomic environment from conditions described in the 2015 MITT Final EIS/OEIS. The Navy concluded that socioeconomic resources in the marine environment have not changed appreciably since the year 2015.

The growth in Guam's gross domestic product (GDP) has fallen steadily from 2 percent in the year 2012 to less than 0.5 percent in the year 2016; while growth has remained positive, it has underperformed compared with U.S. GDP growth, which saw a 1.5 percent increase in the year 2016 (Hovland et al., 2017a). Increased spending by tourists and in the retail sector was offset by decreases in the construction sector following completion of a large hospital and luxury hotel (Hovland et al., 2017a). Government spending also decreased with the completion of the Guam Port Authority's improvement plan and fewer DoD construction contracts. However, contracts for construction projects and infrastructure improvements are being awarded to prepare for the relocation of approximately 5,000 Marines and 3,500 dependents from Okinawa, Japan to Guam, which is expected to boost the economy over the next several years (Guam Economic Development Authority, 2018; U.S. Department of the Navy, 2015).

The Guam Economic Development Authority estimates that over 12,800 military personnel and their dependents reside on the island. This includes all military and dependents, including personnel at Naval Base Guam and Andersen Air Force Base, not just those who support the proposed training and testing activities (Guam Economic Development Authority, 2018). In the 2010 U.S. census, the population of Guam was 159,358 (U.S. Census Bureau, 2018a), and the Central Intelligence Agency World Factbook estimated that the population had grown to 167,358 by the year 2017 (U.S. Central Intelligence Agency, 2018a). Based on these estimates, military personnel and their dependents make up approximately 8 percent of the population of Guam. For comparison, the population on Guam grew by just 5 percent from the years 2010 through 2017. In addition to the substantial economic contribution that 8 percent of the population makes to the Guam economy through spending, taxes (e.g., sales tax), and rental or mortgage payments, the DoD continues to fund infrastructure development projects, and the funding is expected to accelerate with the relocation of the Marines. During the last decade, DoD construction contracts have totaled over $2 billion and have recently averaged nearly $240 million annually. The fiscal year (FY) 2017 National Defense Authorization Act appropriated over $253 million for military construction on Guam (Guam Economic Development Authority, 2018).

The GDP for the CNMI increased by over 28 percent from the years 2015 through 2016, driven primarily by increases in tourism-related spending (Hovland et al., 2017b). Steady GDP growth from the years 2012 through 2015 preceded the large increase in the year 2016 and represents a positive trend in the economy. However, GDP growth from the year 2014 to 2015 was a comparatively low 3.8 percent, and it remains to be seen if GDP growth will continue at a high rate in the coming years. In the year 2016, the number of tourists visiting the CNMI, particularly from Korea and China, increased by 10 percent.

Private investment increased by over 60 percent, reflecting investment in the gambling industry and construction of the large casino in Garapan as well as smaller hotels on Saipan (Hovland et al., 2017b).

In the 2010 U.S. census, the population of the CNMI was 53,883 (U.S. Census Bureau, 2018b), and the Central Intelligence Agency World Factbook estimated that the population had declined to 52,263 in the year 2017 (U.S. Central Intelligence Agency, 2018b). Of the 38,679 residents of the CNMI over the age of 16, only 19 reported being in the military in the 2010 U.S. census, indicating that the economic contribution of military personnel and their dependents is not a substantial portion of the CNMI economy (U.S. Census Bureau, 2018c). The Navy has, for the past 5 to 10 years, had seven vessels assigned to Saipan, which provides substantial funding to the CNMI economy through fuel costs, port fees, and maintenance costs. Five of the vessels are “large, medium speed, roll on/roll off” (or LMSR) vessels and the other two are 2nd Lt. John P. Bobo “BOBO” class vessels. The LMSR vessels transport tracked military vehicles (e.g., tanks) and equipment, and the BOBO class vessels are container and-roll on/roll-off vessels used to transport cargo and ammunition. The annual budget for the five LMSR vessels is approximately $41.5 million, and the annual budget for the two BOBO vessels is approximately $9.5 million. Not every dollar enters directly into the CNMI economy; however, the port fees alone are $900 thousand for each of the seven vessels, totaling $6.3 million annually. Having the seven vessels assigned to Saipan adds millions of dollars into the CNMI economy annually.

#### 3.12.1.1 Commercial Transportation and Shipping

The military conducts training and testing activities in operating areas well away from commercially used waterways and inside special use airspace. Refer to Figure 3.12-1 and Figure 3.12-3 of the 2015 MITT Final EIS/OEIS for a depiction of commercial waterways and air routes in proximity to military operating areas and special use airspace in the Study Area. Scheduled training and testing activities are published in Notices to Mariners (NOTMARs) issued by the U.S. Coast Guard and Notices to Airmen (NOTAMs) issued by the Federal Aviation Administration (FAA). These notices are accessible to the public and intended to limit or prevent conflicts between military and non-military uses of shared sea space and airspace.

Following a review of recent literature, including government technical documents and reports, scientific journals, and the Navy’s marine resources database of publications, the information presented on commercial transportation and shipping, as described in the 2015 MITT Final EIS/OEIS, has not appreciably changed and remains valid.

##### 3.12.1.1.1 Ocean Traffic

Ocean traffic is the transit of commercial, private, or military vessels at sea, including submarines. 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 (affecting the location of commercial and recreational fishing vessels), 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 Study Area are designated as danger zones and restricted areas as described in Code of Federal Regulations (CFR) Title 33 (Navigation and Navigable Waters), Part 334 (Danger Zone and Restricted Area Regulations) and established by the U.S. Army Corps of Engineers. A detailed discussion of danger zones and restricted areas located in the Study Area is provided in Chapter 2 (Description of Proposed Action and Alternatives), Figure 2.7-1 and Table 2.7-1, in the 2015 MITT Final

EIS/OEIS. No changes in danger zones and restricted areas in the Study Area have been codified in the Federal Register since the publication of the 2015 MITT Final EIS/OEIS.

###### 3.12.1.1.1.1 Guam

Guam has one commercial port, which is located in Apra Harbor. The Port of Guam is the largest U.S. deepwater port in the Western Pacific, handling over 2 million tons of cargo and over 102,000 shipping containers in FY 2016 (Port Authority of Guam, 2017). The average tonnage handled by the port in FY 2015 and FY 2016 was approximately 16 percent greater than the average of the four previous years, and the average number of shipping containers processed by the port in FY 2015 and FY 2016 was 2.6 percent greater than the average of the four previous years (Port Authority of Guam, 2017). Based on these data, trends in commercial transportation and shipping in Guam appear to be steady and somewhat positive, and the analysis presented in the 2015 MITT Final EIS/OEIS remains valid.

###### 3.12.1.1.1.2 Commonwealth of the Northern Mariana Islands

There are three ports within the CNMI: the Port of Rota, the Port of Tinian, and the Port of Saipan. The Port of Rota, or Rota West Harbor, is located on the southwestern tip of the island of Rota. The port includes a jetty with a pierside water depth of 6–10 feet (ft.), which limits the size of vessels that can access the pier. The Port of Rota is mainly used by ferry boats transporting tourists and residents from Tinian. The Port of Tinian is a small port with three finger piers and a small boat ramp. Pierside water depth ranges from 26–30 ft., allowing relatively large vessels to dock. The Port of Saipan is the largest and most advanced of the three CNMI ports, but is nevertheless described as a small seaport by the World Port Source (World Port Source, 2012). The vast majority of cargo transported to the CNMI comes through the Port of Saipan (Commonwealth Ports Authority, 2017). The Port of Saipan has a cargo terminal and an oil terminal with pierside depths up to 25 ft. (World Port Source, 2012). Port facilities are capable of handling loads over 100 tons, and in FY 2016 the port transferred over 560,441 tons of cargo (Commonwealth Ports Authority, 2017). This represents a 36 percent increase over the FY 2015 total and the second straight year of increases (FY 2015 tonnage was 8 percent greater than FY 2014). For all three seaports combined, total tonnage processed in FY 2016 was 581,028 tons, which is a 34 percent increase over the FY 2015 total (Commonwealth Ports Authority, 2017). Based on these data, trends in commercial transportation and shipping in the CNMI have been positive from the years 2014 through 2017, and the analysis presented in the 2015 MITT Final EIS/OEIS remains valid.

###### 3.12.1.1.1.3 Transit Corridor

Major commercial shipping vessels use the shipping lanes for transporting 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 (usually Japan or Korea) before continuing on to either Hawaii or the continental United States (see Figure 3.12-1 in the 2015 MITT Final EIS/OEIS). Vessels using shipping lanes are outside of military training areas and are required to follow U.S. Coast Guard maritime regulations. Based on available information, overseas commercial shipping traffic potentially passing through the transit corridor, as described in the 2015 MITT Final EIS/OEIS, has not appreciably changed and remains valid.

#### 3.12.1.1.2 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.

Special use airspace is a type of airspace used primarily for military operations. Special use airspace 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. The majority of special use airspace may be used for commercial or general aviation when not reserved for military activities.

One type of special use airspace of particular relevance to the Study Area is a warning area, which is defined in 14 CFR Part 1 as follows:

> "A warning area is airspace of defined dimensions, extending from 3 nautical miles (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."

On March 13, 2017, the FAA issued a final rule on the modification of the restricted area surrounding FDM (*82 Federal Register 13389*). The modification expands restricted airspace R-7201, which extends 3 NM offshore, by designating a new area, R-7201A, that surrounds R-7201. The new restricted area airspace, R-7201A, encompasses the airspace between a 3 NM radius and a 12 NM radius around FDM. The new airspace R-7201A became effective on June 22, 2017, and was codified in 14 CFR Part 73. While restricted area airspace R-7201A had not been designated by the FAA prior to completion of the 2015 MITT Final EIS/OEIS, the Navy had requested the airspace and analyzed potential impacts on socioeconomic resources in the 2015 MITT Final EIS/OEIS in anticipation that R-7201A would be approved and designated. For details and figures describing special use airspace in the Study Area, refer to Chapter 2 (Description of Proposed Action and Alternatives).

##### 3.12.1.1.2.1 Guam

Guam International Air Terminal is the only civilian air transportation facility on Guam. The airport is FAA certified and 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 were 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. Military aircraft originating from Guam most often transit to one of the three warning areas located south of Guam (Figure 2.1-2).

From FY 2014 through FY 2016, the number of passengers arriving at Guam International Airport increased from approximately 1.34 million to 1.51 million; nearly half originated from Japan (Guam Visitors Bureau, 2017). This represents an increase of over 12 percent, a trend that is expected to continue.

Based on the available information, air traffic on Guam, as described in the 2015 MITT Final EIS/OEIS, has not appreciably changed and remains valid.

#### 3.12.1.1.2.2 Commonwealth of the Northern Mariana Islands

Saipan International Airport is the largest commercial airport in the CNMI and the main gateway for commercial air traffic into the CNMI (Commonwealth Ports Authority, 2005). The airport has an 8,700 ft. 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 the islands of Tinian and Rota. Star Mariana Air offers 3 outbound and return flights between Rota and Saipan per day, and 12 outbound and return flights between Saipan and Tinian per day (Star Mariana Air, 2018). Since the completion of the 2015 MITT Final EIS/OEIS, Star Mariana Air opened air service between Rota and Guam, a service made possible by the opening of the light aircraft commuter facility at Guam International Airport (Daleno, 2015).

All commercial flights to Tinian fly into West Tinian Airport. The airport has one runway that is 8,600 ft. by 150 ft. 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. 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 CNMI airports are FAA certified.

From FY 2014 through FY 2016, the number of passengers departing from CNMI airports increased from 542,744 to 605,952, an increase of over 11 percent (Commonwealth Ports Authority, 2017). The vast majority (over 93 percent) departed from Saipan International Airport. Arrivals increased from 493,851 to 542,126 passengers (nearly 10 percent) over that same timeframe. Airport traffic is forecast to continue to increase with the addition of new airlines providing air service to and from Saipan International Airport (Commonwealth Ports Authority, 2017).

Training and testing activities are conducted at commercial airports, with appropriate planning and coordination with the local port authorities and the FAA. For example, 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.

Airspace and sea space may be restricted around FDM. When necessary, the Navy requests that the U.S. Coast Guard issue NOTMARs and that the FAA issues NOTAMs advising the public of potentially hazardous activities occurring in the airspace and sea space surrounding FDM, which may include sea space out to 12 NM from FDM, depending on the nature of the training and testing activities being conducted.

Based on the available information, air traffic and associated activities occurring over islands and sea space in the CNMI, as described in the 2015 MITT Final EIS/OEIS, has not appreciably changed and remains valid.

#### 3.12.1.1.2.3 Transit Corridor

Commercial air routes controlled by the FAA may overlay a portion of the MITT transit corridor. Commercial aircraft typically fly above 30,000 ft. in this area, and would have no interaction with aircraft conducting training and testing activities, which occur within special use airspace (e.g., warning areas) that have minimal overlap with the transit corridor. Air traffic routes for commercial and general aviation flights departing and arriving at Guam International Air Terminal and Saipan International Airport are established such that overlap with military aircraft activities would be avoided.

#### 3.12.1.2 Commercial and Recreational Fishing

Both the CNMI and Guam are categorized as "fishing communities" by the Western Pacific Regional Fishery Management Council. This designation is based on 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). 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 & Beavers, 2012; Hospital & Beavers, 2014; Tibbats & Flores, 2012).

Commercial fishing takes place throughout the 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 most abundant in summer.

##### 3.12.1.2.1 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 & 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 & 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. The survey also noted the importance of fish-aggregating devices to small boat fishers. Ninety-six percent of fishers reported having fished at a device during the previous 12 months and on over half of all fishing trips (Hospital & Beavers, 2012).

More information on fishing practices on Guam, including gear types, target species, charter fishing, commonly used harbors and marinas, and popular fishing sites, is presented in Section 3.12 (Socioeconomic Resources) of the 2015 MITT Final EIS/OEIS.

Commercial fisheries landings for all species from the years 2005 through 2009 were presented in Section 3.12 (Socioeconomic Resources) of the 2015 MITT Final EIS/OEIS (see Table 3.12-2). Since 2010, total fisheries landings (in pounds of fish) and values (dollars) have steadily decreased (Figure 3.12-1). The price per pound of commercial landings has also decreased from a recent high of $2.55 per pound in the year 2011 to $2.39 per pound in the year 2015 (Pacific Islands Fisheries Science Center, 2016b).

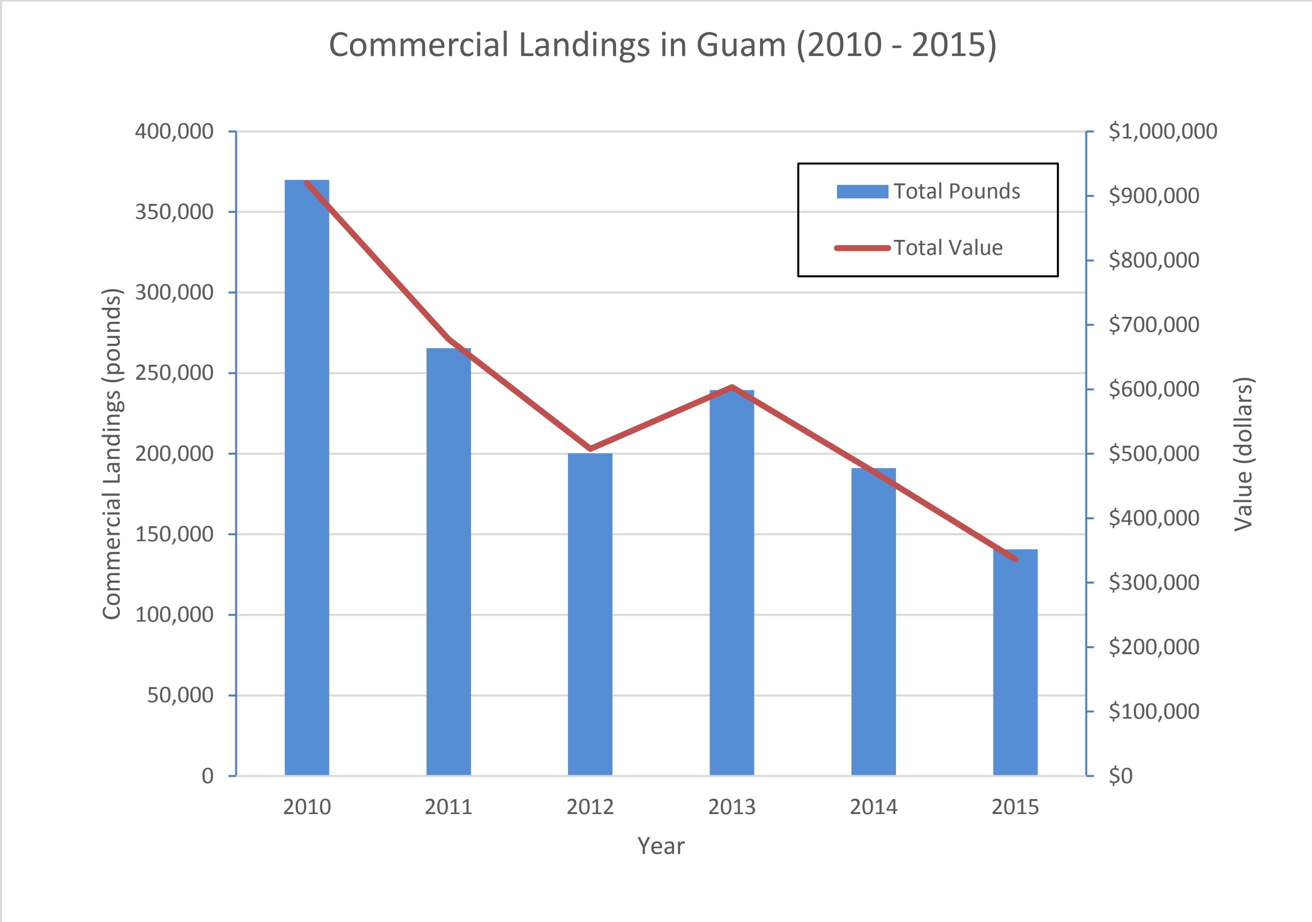



**Figure 3.12-1: Commercial Fisheries Landings in Guam from the Years 2010 through 2015**

The declining trend in fisheries landings is consistent with the results presented by Weijerman et al. (2016), which documented a decline of over 60 percent in the annual catch of reef fish around Guam between the years 1985 and 2012. The declining catch was consistent with a decline in reef fish biomass around the island. Similar declines in reef fish fisheries have been reported for other regions in Micronesia (Cuetos-Bueno & Houk, 2018). Rather than a single cause, it appears that interconnected economic, social, and environmental factors are combining to exert pressure on remote island fisheries. For example, on the economic front, a growing demand for fresh fish worldwide has driven the development of technology to enable the transportation of fresh fish from more remote areas, including islands in Micronesia, which were not previously commercially viable. Expanding the commercial market to include these remote island fisheries has increased commercial fishing in these remote locations to the point of becoming unsustainable (Cuetos-Bueno & Houk, 2018).

#### 3.12.1.2.2 Commonwealth of the Northern Mariana Islands

Similar to Guam, fishing in the CNMI is performed for commercial and recreational purposes as well as for subsistence. Hospital and Beavers (2014) surveyed 112 small boat fishers from Saipan, Tinian, and Rota. Based on the reported information, the researchers were able to characterize fishing practices in the CNMI by analyzing the level of fishing activity, participation in commercial markets, trip costs and other fishing-related expenditures, the social and cultural importance of fishing, fishing as a means of subsistence, and attitudes and perceptions of fishing conditions and fisheries management. The results of the survey are similar to the responses provided by small boat fishers from Guam and do not appreciably change the conclusions presented in Section 3.12 (Socioeconomic Resources) of the 2015 MITT Final EIS/OEIS.

Demographically, small boat fishers are more likely to identify as Chamorro relative to the general population. Approximately 70 percent of boat owners reported that they allowed others to use their boat, indicating that many boats are shared by multiple fishers. As with fishers in Guam, fish-aggregating devices were reported as important to small boat fishers. Over 70 percent reported using a fish aggregating device at least over 12 months. Similar to fishers in Guam, fishers in the CNMI reported consuming approximately 28 percent of their catch at home, giving away 38 percent of their catch, and selling approximately 29 percent. The remaining 5 percent of the catch was either released or exchanged for goods and services (Hospital & Beavers, 2014). However, less than half of fishers in the CNMI were able to sell all of the catch that they wanted to sell, indicating that the market is limited.

Hospital and Beavers (2014) concluded that the CNMI small boat fisheries are a complex mix of subsistence, cultural, recreational, and quasi-commercial fishing practices and validated the socioeconomic importance of fishing to the people of the CNMI.

Small boat fishers were also asked if military activities had affected their fishing trips in the previous 12 months. Approximately one-third of fishers reported trips had been affected by military exercises; however, the survey did not gather information on how trips were affected. While not explicitly clear, the results of the survey imply that waters around FDM were of particular interest to fishers and that activities at FDM were the primary source of impacts on fishing trips. Starmer (2005) noted that many target fish species have become less common in waters around Saipan and Tinian and are more abundant in waters surrounding FDM, which may be an incentive for fishers to attempt to fish near FDM rather than at other unrestricted locations.

Commercial fisheries landings in the CNMI for all species from the years 2005 through 2009 were presented in Section 3.12 (Socioeconomic Resources) of the 2015 MITT Final EIS/OEIS (see Table 3.12-2 in that document). Since the year 2010, total fisheries landings (in pounds of fish) fluctuated between a high of over 315,000 pounds in the year 2013 to 170,000 pounds in the year 2015 (Figure 3.12-2). The value of commercial landings followed a similar pattern, reaching a high of over $798,000 in the year 2014 but decreasing by nearly half in the year 2015. The price per pound also varied, ranging between $2.13 in the year 2010 and $2.69 in the year 2014. Even though the total landings decreased in the year 2015, the price per pound remained relatively high at $2.51 (Pacific Islands Fisheries Science Center, 2016a).

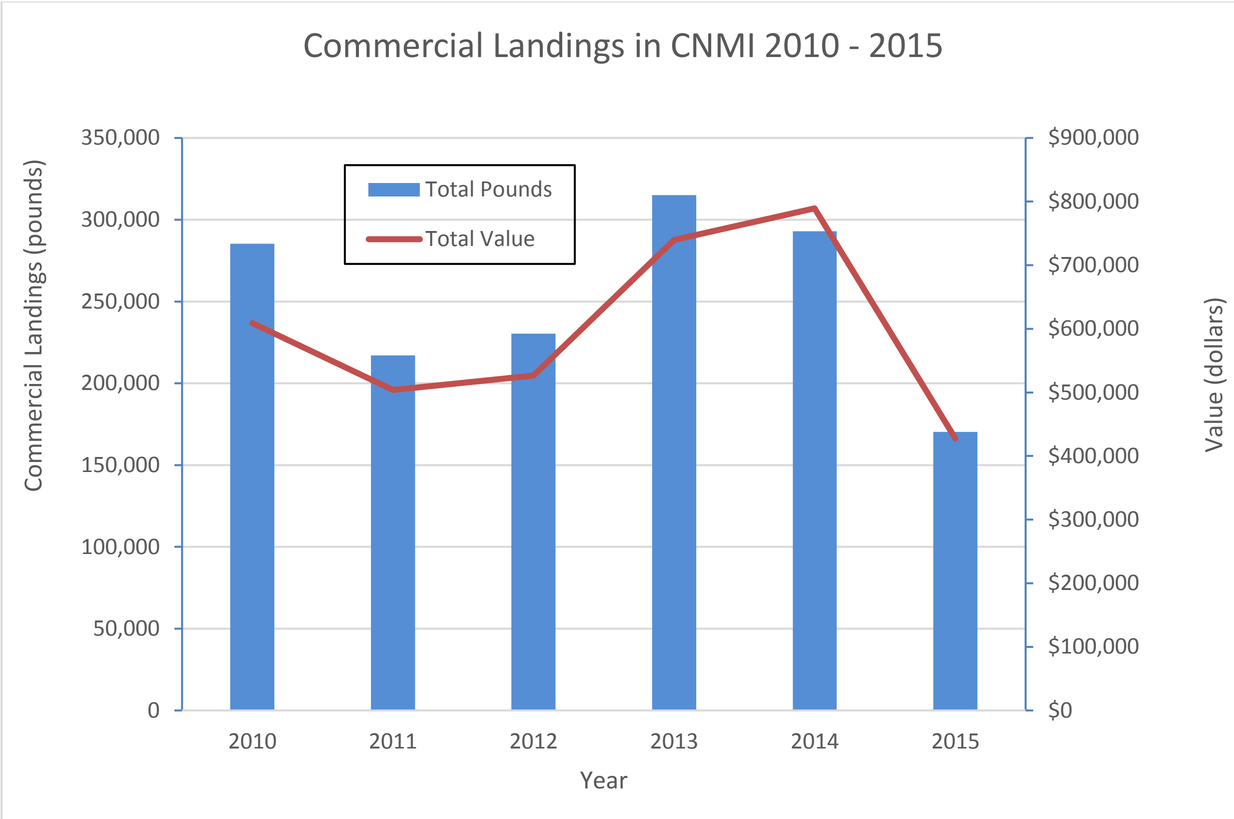



**Figure 3.12-2: Commercial Fisheries Landings in the CNMI from the Years 2010 through 2015**

While the trend in commercial fisheries landings from the years 2010 through 2015 is ambiguous, the historical trend of landings in the coral reef fishery, one of the three major fisheries in the CNMI and Guam and of particular importance to traditional fishers, clearly shows a decline (Cuetos-Bueno & Houk, 2014). Since the 1950s, the researchers estimate that commercial and non-commercial reef fishery landings have declined by 39–73 percent. In addition to greater fishing pressure from commercial, recreational, and traditional fishing practices, particularly near population centers, a decline in the health and extent of coral reefs in the region has contributed to decreased landings. See Section 3.8 (Marine Invertebrates) for more information on coral reefs in the Study Area.

The majority of training and testing activities occur offshore in deep waters and not in close proximity to coral reefs, which are located in relatively shallow, nearshore waters. Refer to Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Training and Testing Activities Descriptions) for information on where the proposed training and testing activities typically occur. Refer to Section 3.8 (Marine Invertebrates) for information and the locations of coral reefs in the Study Area. Some activities, such as those occurring at FDM, have the potential to affect coral reefs and, by extension, the coral reef fishery. Surveys conducted by Smith and Marx (2016) indicate that the health, abundance, and biomass of reef fish populations in the vicinity of FDM are comparable or superior to populations at other locations in the CNMI, likely due to the de facto protection from fishing that results from restricting access to the area around FDM (Thompson et al., 2017). The authors conclude that training and testing activities are having little to no negative impact on the reef fish fishery. Having a de facto protected area around FDM may benefit the reef fish fishery in the CNMI, beyond the restricted area around FDM; however, restricting access to nearshore areas (within 3 NM) around FDM where target species occur limits the ability for fishers to gain access to potentially productive fishing sites.

#### 3.12.1.2.3 Transit Corridor

There are no data on commercial or recreational fishing within the transit corridor. Navy vessels using the corridor travel east from Guam directly into ocean waters far from shore. Due to the distance from land and a lack of known fishing areas within the corridor, it is assumed that there is limited to no commercial and recreational fishing activity within the transit corridor.

### 3.12.1.3 Tourism

Coastal tourism and associated recreational activities that tourists participate in can be defined as the full range of tourism, leisure, and recreationally oriented activities that take place in the coastal zone and offshore coastal waters. From an economic point of view, tourism drives infrastructure development (e.g., hotels, resorts, restaurants, vacation homes), businesses (e.g., retail shops, marinas, fishing tackle stores, dive shops), and services (e.g., guided tours, charter boat cruises, cultural exhibitions arranged for tourists) that create local jobs and tax revenue for the local government. In-water activities that attract tourists to Guam and the CNMI include swimming, snorkeling, scuba diving, wildlife watching (e.g., dolphin cruises), pleasure boating, sailing, and annual events such as the Rota Blue triathlon.

#### 3.12.1.3.1 Guam

Tourism is Guam's largest industry; it generates $1.5 billion annually, makes up 60 percent of business revenue, and supports 33 percent of all employment on the island (Guam Visitors Bureau, 2014, 2017). In 2016, Guam welcomed over million 1.53 million visitors, which is the highest annual total for visitor arrivals on Guam in any calendar year (Guam Visitors Bureau, 2017). Visitors from Japan accounted for half, approximately 752,000 visitors; however, Japanese visitors made up 76 percent of the market in 2010 (Guam Visitors Bureau, 2014, 2017). The decline in the Japanese market share is not entirely due to a reduction in visitors from Japan. It is also attributed to Guam's efforts to broaden its tourism market to include visitors from other countries, particularly China, which has the fastest-growing visitor market in the world. China contributed just 0.7 percent of visitors to Guam in the year 2012, but 1.8 percent in the year 2016, and the Guam Visitor's Bureau projects that Chinese visitors will make up between 5.7 and 17.5 percent of tourists by the year 2020 (Guam Visitors Bureau, 2014, 2017). The other significant visitor markets in the year 2016 were Korea (34.8 percent), the United States (5.2 percent), and Taiwan (2.8 percent).

Approximately 23 percent of the value of Guam's GDP in the year 2016 was from spending by the federal government, including defense spending (Hovland et al., 2017a). Revenue from the government has provided Guam with an economic buffer against fluctuations in the tourism industry. Tourism in Guam has continued to increase both in the number of visitors and in its contribution to the economy since completion of the 2015 MITT Final EIS/OEIS. Even though trends in tourism are positive, the existing conditions and the results of the analysis of impacts on tourism presented in the 2015 MITT Final EIS/OEIS remain valid.

#### 3.12.1.3.2 Commonwealth of the Northern Mariana Islands

Tourism is the largest industry in the CNMI and has driven a positive growth in GDP over the past five years (Hovland et al., 2017b; Marianas Visitors Authority, 2016). Visitors from Korea and China each made up 38 percent of the market in the year 2015, increasing their market share by 39 percent and

15 percent over FY 2014, respectively. The number of visitors from Japan, which has historically been the dominant market, made up just 18 percent of visitors in the year 2015, a 23 percent decrease over 2014. The decline is primarily attributed to a poor exchange rate for Japanese travelers and Japan's stagnant economy; however, it has also been a challenge to maintain regular direct flights from Japan to the CNMI (Marianas Visitors Authority, 2016). Visitors from Russia declined by 80 percent in the year 2015 due to the suspension of direct flights to the CNMI, economic sanctions instituted by the European Union and the United States, and a drop in global oil prices. In the year 2016, the total number of visitors from all countries combined increased by 10 percent over the year 2015 (Hovland et al., 2017b).

Approximately 2 percent of the value of the CNMI's GDP in the year 2016 was from spending by the federal government and 21 percent was from spending by the territorial government (Hovland et al., 2017b). Government spending buffers the CNMI economy against downturns in tourism; however, the CNMI does not receive the same proportion of federal funds as Guam, leaving the CNMI economy more susceptible to fluctuations in tourism. Even though trends in tourism are positive, the existing conditions, as presented in the 2015 MITT Final EIS/OEIS, and the results of the analysis of impacts on tourism remain valid.

#### 3.12.1.3.3 Transit Corridor

It is assumed that there is no tourism activity within the transit corridor due to the distance from land and because the majority of tourism activities occur in nearshore waters.

### 3.12.1.4 Environmental Justice

The U.S. Environmental Protection Agency defines environmental justice as the "fair treatment" and "meaningful involvement" of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (U.S. Environmental Protection Agency, 2016). The phrase "fair treatment" means that no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental, and commercial operations or policies. The phrase "meaningful involvement" means that

- people have an opportunity to participate in decisions about activities that may affect their environment or health,
- the public's contribution can influence the regulatory agency's decision,
- their concerns will be considered in the decision-making process, and
- the decision makers seek out and facilitate the involvement of those potentially affected" (Federal Aviation Administration, 2015).

Based on data from the 2010 U.S. Census, the population over the age of 16 in Guam was 113,067, which represents the working population (U.S. Census Bureau, 2018a). Of those people who are of working age, 61.4 percent were employed in the civilian workforce and 4.4 percent were in the armed forces. According to the census data, 2.3 percent of employed people in Guam also participated in a subsistence activity (e.g., fishing), and just 0.6 percent of people who were not in the labor force participated in a subsistence activity. Therefore, less than 3 percent of the working age population reported participating in a subsistence activity in the year 2010, which is likely to be fishing, but does not exclude other activities, such as growing crops. In the CNMI, 38,679 people are of employable age (at least 16 years old), and 64.2 percent are employed in the civilian workforce (U.S. Census Bureau, 2018b). According to the census data, 2.9 percent of employed people in the CNMI also participated in a subsistence activity (e.g., fishing), and just 0.6 percent of people who were not in the labor force participated in a subsistence activity. Therefore, approximately 3 percent of the working age population in the CNMI reported participating in a subsistence activity in the year 2010.

Traditional fishing practices were identified by residents of Guam and the CNMI as having the potential to be impacted by the proposed training and testing activities occurring at sea and on FDM.

#### 3.12.1.4.1 Traditional Fishing Practices

The U.S. Environmental Protection Agency considers subsistence fishers to be people who rely on non-commercial fish as a major source of protein (U.S. Environmental Protection Agency, 2002). Many communities worldwide meet this definition of subsistence fishing, including local communities on Guam and the CNMI. However, many of these communities engage in traditional fishing practices not just for subsistence or financial reasons but as part of their cultural heritage and social customs (U.S. Environmental Protection Agency, 2002). Native Alaskans regard traditional fishing practices as a way of life, not a marginal existence to overcome or to rise above.

> "It's something rich. It's spiritual. It's economic. It's social. It's getting together with your friends and your relatives going out there harvesting, and sharing with elders, sharing with widows, and that's a pride we get." (U.S. Environmental Protection Agency, 2002).

Although this definition is from a native Alaskan fisher, similar input was received from Asian and Pacific Islander groups, more closely linked to fishers from Guam and the CNMI. For example, ethnic Asian and Pacific Islanders residing in the United States, "consider seafood collection and consumption as healthy activities that reflect a homelike lifestyle."

Traditional fishers tend to consume non-commercial fish or shellfish at higher rates than other populations who fish, and for a greater percentage of the year, because of cultural customs or economic factors. In the United States, there are no particular criteria or thresholds (such as income level or frequency of fishing) that definitively describe traditional fishers. Allen (2013) reported on the complicated issue of defining traditional fishers in the western Pacific region, including Guam and the CNMI. Many fishers identifying as traditional or subsistence fishers also participate in recreational and commercial fishing. It is not always clear when fishers are engaging in subsistence fishing, fishing for cultural or social reasons, fishing for financial gain or leisure, or some combination, which can occur even on a single fishing trip. Nevertheless, the contribution of non-commercial traditional fishing to the GDP of U.S. Pacific island territories is likely underestimated in fisheries catch data by as much as five times (Cuetos-Bueno & Houk, 2014; Zeller et al., 2014).

The multifaceted nature of traditional fishing practices and their contribution to local communities remains difficult to quantify; however, it is clear that there is both a social and economic benefit to many in those communities even for those who rarely or never actually fish (e.g., someone who doesn't fish may receive fish at low or no cost). Allen (2013) offers a framework to better define traditional fishing practices that is aimed at disentangling traditional fishing from other types of fishing (e.g., recreational or commercial fishing). Discerning specific details on when and to what degree traditional fishing is occurring in the Study Area is beyond the scope of this analysis. However, it is clear that traditional fishing is more than an economic necessity; it is an important part of the cultural and social identity of indigenous peoples and Asian immigrant communities living in Guam and in the CNMI (U.S. Environmental Protection Agency, 2002).

Lower-income communities are more likely to engage in subsistence fishing and may be disproportionately affected by declines in a fishery (Allen & Bartram, 2008; Allen, 2013; Hospital & Beavers, 2014; Office of Environmental Health Hazard Assessment, 1997). An important part of the cultural heritage of local communities practicing traditional fishing is sharing the catch, which lower-income individuals and families in the community may depend on as a source of nutrition whether or not they fish. Most subsistence fishing is expected to occur within 3 NM from shore, because the smaller boats that are typically used by traditional fishers are not equipped for long trips offshore, and traditional fishing sites are generally associated with nearshore reefs.

#### 3.12.1.4.1.1 Guam

The 2015 NMFS stock assessment report for the bottomfish fishery in Guam and the CNMI concluded that the fishery was not overfished through the year 2013, and modeled projections predicted that the fishery was very unlikely to become overfished by the year 2017 (Yau et al., 2016). However, coral reef fisheries, which support most traditional fishing in the Study Area, have declined over the past 30 years (Weijerman et al., 2016). From 1985 through 1990 the average annual catch was approximately 100 tons, but from the years 2007 through 2012 the average annual catch decreased to 37 tons. The total estimated fishing effort remained relatively stable over the time period (1985–2012), indicating that fishing for reef fishes as an activity, whether for recreation, subsistence, or commercial purposes, on Guam and the CNMI was not responsible for the decline in the catch. Weijerman et al. (2016) also noted that the decline was distributed over most gear types, indicating that a change associated with a particular gear type (e.g., a restriction on usage) was not disproportionately affecting the catch. Furthermore, historical data on the biomass of targeted fish species showed a general decrease in biomass from the years 1985 through 2012 (Weijerman et al., 2016). These results show that the decline in the reef fish fishery has been occurring for decades and is expected to continue.

If the availability of target species in the reef fish fishery continues to decline, the annual catch from traditional fishers will also decline. As noted above, quantifying the total catch from traditional fishing is a complex issue that makes measuring and predicting the impacts of a decline challenging. Even though the catch may continue to decline, traditional fishing practices may not be proportionately impacted, because the social and cultural aspects of the traditional fishing are not necessarily dependent on successfully catching and harvesting fish. As noted in the research by Weijerman et al. (2016), fishing effort (i.e., a measure of how much fishing occurred) remained relatively stable despite recent declines in the catch. While target fish species may be less available, which may have a greater impact on the success of traditional practices like subsistence fishing, overall traditional fishing practices on Guam have not changed appreciably since the 2015 MITT Final EIS/OEIS, and the analysis in the 2015 MITT Final EIS/OEIS remains valid. Refer to Section 3.12.2.3 (Subsistence Use) of the 2015 MITT Final EIS/OEIS for a discussion of subsistence fishing practices on Guam.

#### 3.12.1.4.1.2 Commonwealth of the Northern Mariana Islands

As reported for Guam (see Section 3.12.1.4.1.1, Guam) NMFS stock assessment report predicted that the bottomfish fishery in the CNMI was highly unlikely to become overfished by the year 2017 (Yau et al., 2016). However, the catch from the non-commercial reef fish fishery in the CNMI, which supports most traditional fishing, has historically been underestimated yet has clearly been in decline since the late 1970s based on data from a new reporting system introduced at that time (Cuetos-Bueno & Houk, 2014). Since the 1950s, the catch, which was estimate to have been 450 tons per year, has declined by 39 to 73 percent depending on the scenario used to extrapolate the survey data. More recently the catch is estimate to have declined from 250 tons per year in the year 2005 to 100 tons in the year 2012, a decrease of 60 percent (Cuetos-Bueno & Houk, 2014).

Similar to traditional fishing practices in Guam, if the availability of target species in the reef fish fishery in the CNMI continues to decline, the annual catch from traditional fishers is likely to decline. Traditional fishers that are more dependent on a successful catch (e.g., subsistence fishers) may be impacted to a greater degree than fishers who engage in traditional practices for social and cultural reasons. As noted in recent research by (Weijerman et al., 2016), fishing effort remained relatively stable despite declines in the catch. While target fish species may be less available, traditional fishing practices in the CNMI have not changed appreciably since the 2015 MITT Final EIS/OEIS, and the analysis in the 2015 MITT Final EIS/OEIS remains valid. Refer to Section 3.12.2.3 (Subsistence Use) of the 2015 MITT Final EIS/OEIS for a discussion of subsistence fishing practices in the CNMI.

##### 3.12.1.4.1.3 Transit Corridor

There are no data on traditional fishing practices occurring in the transit corridor. Navy vessels using the corridor travel east from Guam directly into ocean waters far from shore. It is assumed that traditional fishing practices do not typically occur within the transit corridor, because the corridor is a transoceanic route and the majority of traditional fishing occurs in nearshore waters.

### 3.12.2 Environmental Consequences

The 2015 MITT Final EIS/OEIS analyzed training and testing activities currently occurring in the Study Area and considered all potential stressors related to socioeconomic resources. Stressors applicable to socioeconomic resources in the Study Area are the same stressors analyzed in the 2015 MITT Final EIS/OEIS:

- Accessibility (to the ocean and the airspace)
- Airborne acoustics (weapons firing, aircraft, and vessel noise)
- Physical disturbance and strike (aircraft, vessels and in-water devices, military expended materials)
- Secondary stressors (from availability of resources)

This section evaluates how and to what degree potential impacts on socioeconomic resources from stressors described in Section 3.0 (Introduction) may have changed since the analysis presented in the 2015 MITT Final EIS/OEIS was completed. Tables 2.5-1 and 2.5-2 in Chapter 2 (Description of Proposed Action and Alternatives) list the proposed training and testing activities and include the number of times each activity would be conducted annually and the locations within the Study Area where the activity would typically occur under each alternative. The tables also present the same information for activities described in the 2015 MITT Final EIS/OEIS so that the proposed levels of training and testing activities under this SEIS/OEIS can be easily compared. The analysis includes consideration of the mitigation that the Navy would implement to avoid or reduce potential impacts on seafloor resources, some of which are important socioeconomic resources.

#### 3.12.2.1 Accessibility (to the Ocean and Airspace)

##### 3.12.2.1.1 Impacts from Limits on Accessibility Under Alternative 1

In some cases, under Alternative 1, the number of proposed training and testing events would change as compared to the number of events proposed in the 2015 MITT Final EIS/OEIS (see Tables 2.5-1 and 2.5-2 in this SEIS/OEIS for changes in the number of annual events for specific activities). Training and testing activities that would increase under Alternative 1 would potentially increase limits on accessibility to areas of the Study Area that are used by both the military and the public. However, decreases in the number of training and testing events occurring in areas of co-use would potentially decrease the number of times access to those areas is restricted. Only some training and testing activities that either increased or decreased have the potential to impact accessibility and require further analysis to supplement the analysis in the 2015 MITT Final EIS/OEIS.

The activities that changed (i.e., increased or decreased) are identified (highlighted) in Tables 2.5-1 and 2.5-2 and in Appendix F (Training and Testing Activities Matrices) in this SEIS/OEIS. The two tables and Appendix F were used together to identify which of the activities that either increased or decreased have the potential to impact accessibility in the Study Area. For example, five Gunnery Exercise (GUNEX) (Surface-to-Air–Large Caliber) activities per year were proposed in the 2015 MITT Final EIS/OEIS, and six are proposed under Alternative 1 in this SEIS/OEIS (Table 2.5-1). Referring to Table F-1 (Stressors by Training Activity) in Appendix F, the activity GUNEX (Surface-to-Air) is identified with a check mark as having the potential to limit accessibility (listed as a socioeconomic stressor) by the public to areas in the Study Area.

As shown in Appendix F (Training and Testing Activities Matrices), the majority of the proposed training and testing activities introduce stressors on accessibility, which supports using the number of annual events proposed under each alternative as a metric to compare impacts. Generally, activities involving the use of aircraft, vessels, or in-water devices may temporarily limit accessibility to areas of the Study Area. Table 3.0-11 in Section 3.0 (Introduction) shows that the number of annual events using aircraft would decrease by about 10 percent under Alternative 1; however, Table 3.0-12 and Table 3.0-13 show that the number of annual events using vessels and in-water devices would increase by about 15 and 4 percent, respectively, under Alternative 1 compared to totals in the 2015 MITT Final EIS/OEIS.

After reviewing the changes in the numbers and types of proposed training and testing activities with the potential to limit accessibility, the Navy determined that potential impacts on accessibility would not be substantially different from the 2015 MITT Final EIS/OEIS. Therefore, the analysis, supplemented below, from the 2015 MITT Final EIS/OEIS remains valid.

Training and testing activities have the potential to temporarily limit access to areas of the ocean, which has the potential to impact commercial transportation and shipping, commercial recreation and fishing, traditional fishing practices, and tourism in the Study Area. The military requests that the U.S. Coast Guard issue NOTMARs to warn the public of upcoming training and testing activities requiring the exclusive use of sea space and to ensure the safety of the public and military personnel. Data on the number of NOTMARs issued from the years 2013 through 2017 for FDM and W-517 were added to the previous three years of data presented in the 2015 MITT Final EIS/OEIS (Figure 3.12-3). The data show that the number of NOTMARs issued for FDM peaked at 56 in the year 2017, and for W-517 the peak was in the year 2016 at 50 NOTMARs. The average number of NOTMARs issued annually over the eight years was 41 for FDM and 35 for W-517.

No NOTMARs were issued in 2016 for the recently established warning areas W-11, W-12, and W-13. In the year 2017, two NOTMARs were issued for W-12 affecting a total of five days.

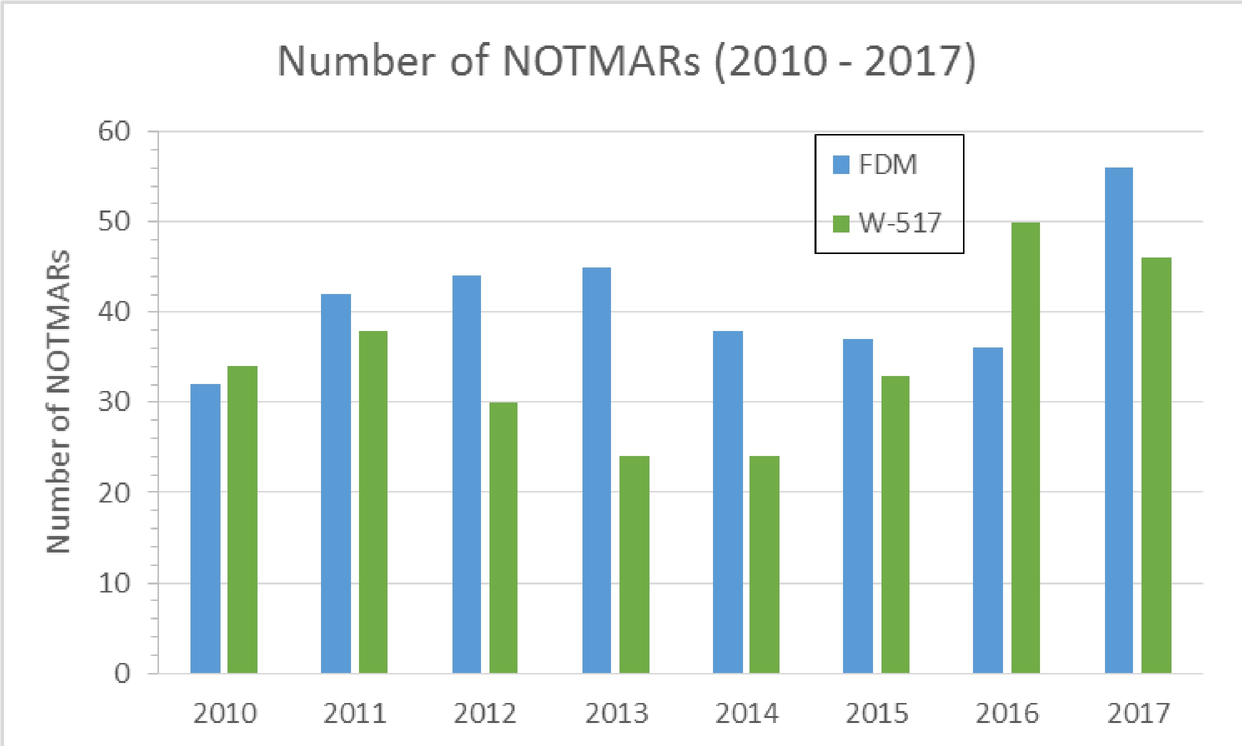



**Figure 3.12-3: Number of NOTMARs Issued for FDM and W-517 from the Years 2010 through 2017**

The number of days affected by activities occurring at FDM and W-517 has varied over the eight-year period from the years 2010 through 2017 (Figure 3.12-4). The data indicate a slightly increasing trend in affected days and potential impacts on accessibility; however, the peak totals are not substantially different from the previous eight years, and the trend appears to be cyclical (increases followed by decreases). Access to waters around FDM between 3 and 12 NM was restricted for an average of 160 days per year (peak of 201 in the year 2012), and access to waters under W-517 was restricted for an average of 91 days per year (peak of 136 in the year 2016). Access to waters within 3 NM of FDM is restricted at all times to ensure public safety during military activities using explosive munitions (33 CFR 334, Danger Zone and Restricted Area Regulations). If a restriction or closure is issued for any part of a particular day, then the day was considered to be affected by that closure. When a NOTMAR is issued, it specifies the time of day and the length of time that a particular area is restricted or closed to the public, which can range from a few hours to the entire day.

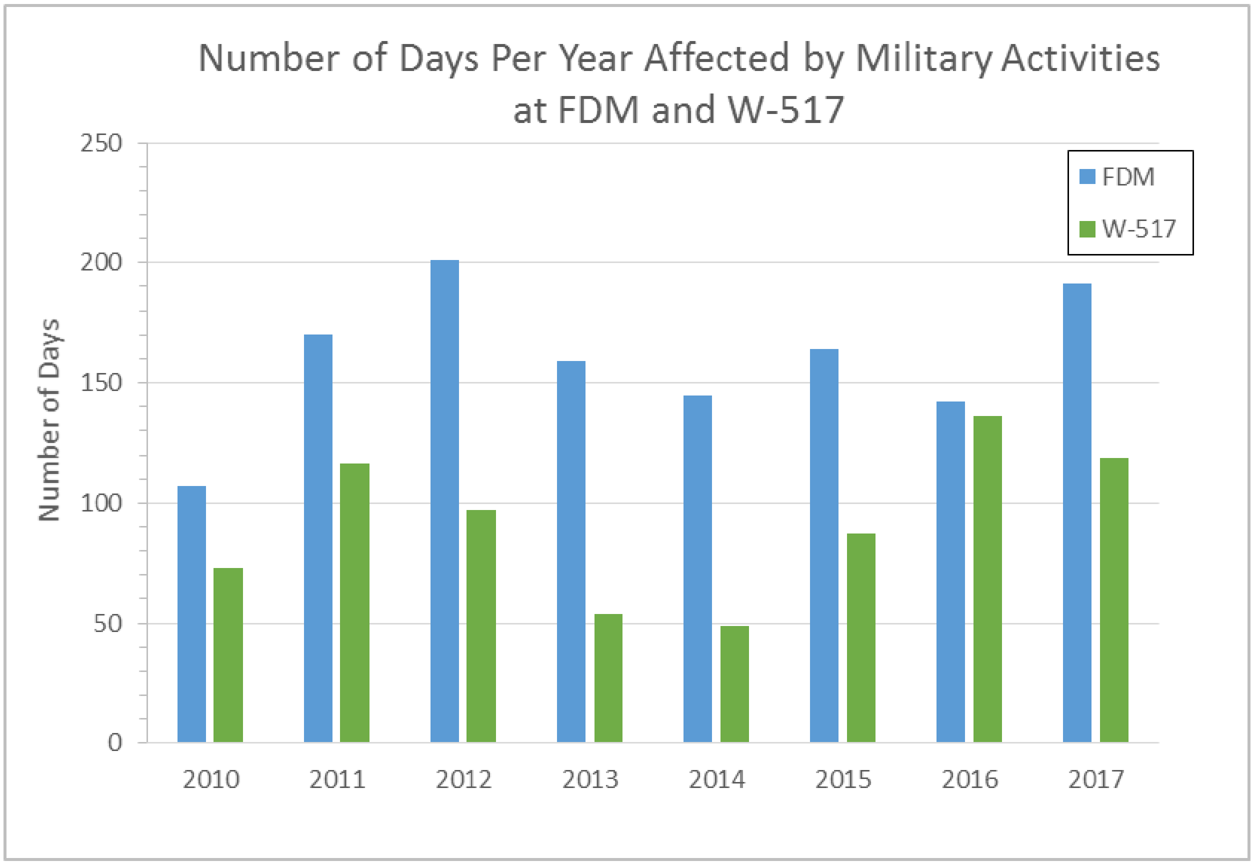



**Figure 3.12-4: Number of Days per Year Affected by Military Activities at FDM and W-517**

New information on commercial fisheries and tourism was added to Section 3.12.1.2 (Commercial and Recreational Fishing) and Section 3.12.1.3 (Tourism), respectively. While accessibility to popular fishing sites is a factor potentially affecting fishing and tourism, the data and supporting information for both industries indicate that other economic factors are driving current trends and forecasts in both industries (Cuetos-Bueno & Houk, 2014; Weijerman et al., 2016).

The military also requests that the FAA issue NOTAMs to warn the public of upcoming military activities requiring the exclusive use of airspace. Military operating areas and SUA are identified on nautical and aeronautical charts to inform surface vessels and aircraft that military activities occur in the area. When necessary, airspace used by the military is restricted for short periods of time (typically on the order of hours) to cover the timeframes of training and testing activities. The Navy posts NOTAMs when restrictions are in place prior to initiating a training or testing activity, and the military follows standard operating procedures to visually scan an area to ensure that non-participants (i.e., civilian vessels and aircraft) 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. Refer to Section 2.3.3 (Standard Operating Procedures) of this SEIS/OEIS for additional information on standard operating procedures.

No commercial or recreational activities occur or are permitted on or near FDM, and aircraft and marine vessels are restricted from entering within 3 NM of FDM. Even when live-fire or other potentially hazardous activities are not occurring at FDM, the threat of unexploded ordnance is always present. As with other activities, the Navy posts NOTMARs and NOTAMS at least 72 hours in advance of potentially hazardous training and testing activities at FDM. NOTMARs and NOTAMs may extend restrictions out to 12 NM as needed for certain training and testing activities to ensure the safety and protection of the public and the military. Detailed information on accessibility to areas in the Study is presented in Section 3.12.3.1 (Accessibility [to the Ocean and Airspace]) in the 2015 MITT Final EIS/OEIS.

In addition to issuing NOTMARs and NOTAMs to announce scheduled training and testing events, upcoming events are communicated to stakeholders (e.g., Guam and CNMI local mayors, Guam legislators, resources agencies, and fishers) via e-mail distribution developed by Joint Region Marianas (JRM) with stakeholder input. Notices are also sent to the National Oceanic and Atmospheric Administration, local cable channels, and emergency management offices.

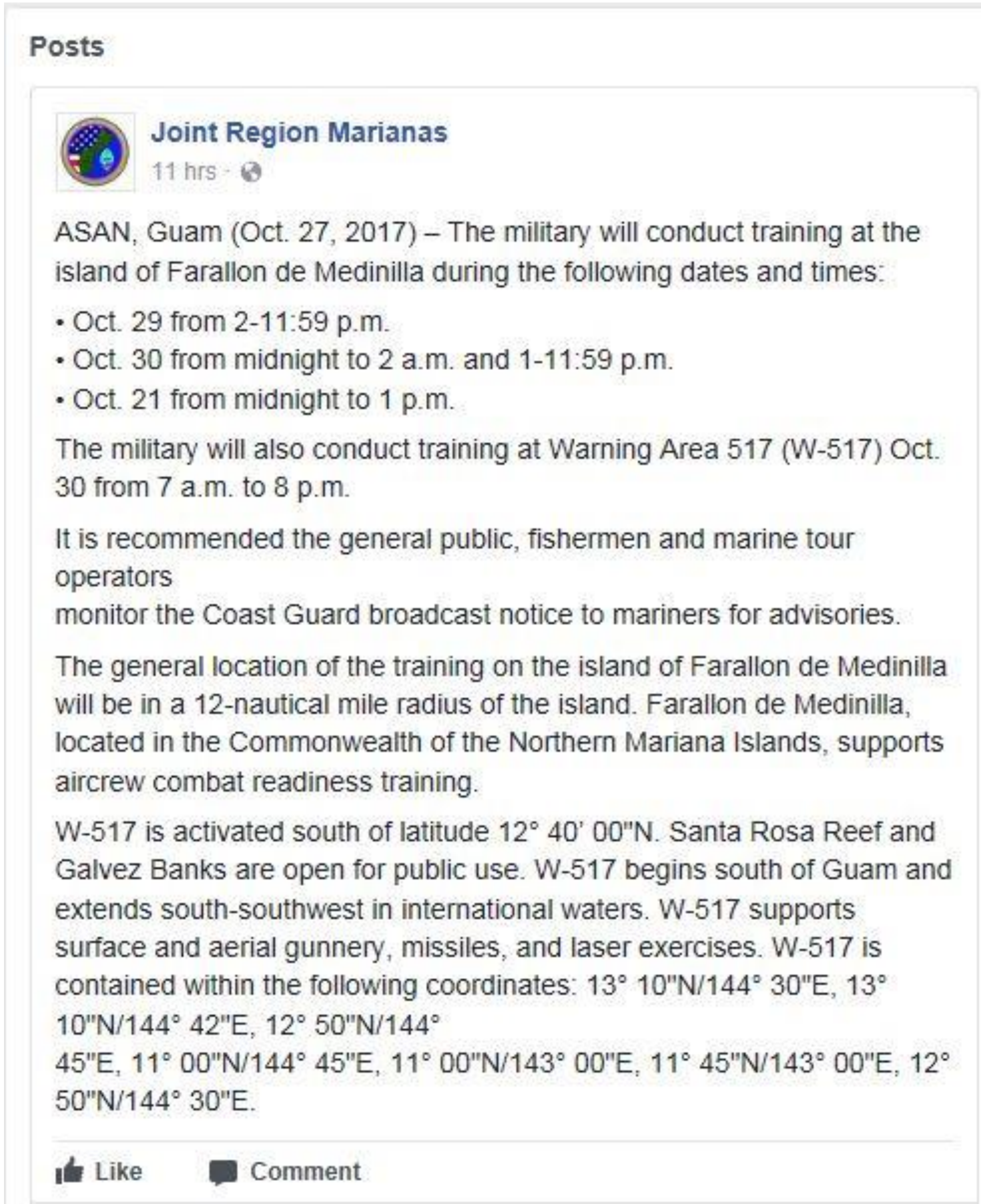
Other communication outlets available to the public include the JRM Public Affairs Office, which posts press releases on the JRM website and on the JRM Facebook page (https://www.facebook.com/jrmguam/) (Figure 3.12-5). Interested members of the public can also follow the JRM on Twitter. Posts to the JRM Facebook page activate a Twitter post. Naval Base Guam Public Affairs posts press releases on the Naval Base Guam Facebook page (https://www.facebook.com/USNavalBaseGuam/), and Naval Facilities Engineering Command, Marianas Public Affairs posts press releases on their Facebook page (https://www.facebook.com/navfacmarianas/).

As new communication tools become available, the military will consider their usefulness in communicating important information to the public about training and testing activities. The military will continue to engage the public on issues associated with accessibility to the ocean and airspace within the Study Area.

New information relevant to accessibility impacts has become available since publication of the 2015 MITT Final EIS/OEIS (Figure 3.12-3 and Figure 3.12-4) (Cuetos-Bueno & Houk, 2014; Weijerman et al., 2016). However, this information confirms that there has been no appreciable change to the existing environmental conditions as presented in the 2015 MITT Final EIS/OEIS, and the results of the analysis of impacts on accessibility to the ocean and airspace remain valid.

Upon completion of training and testing activities, restrictions are lifted and commercial and recreational fishers (and other non-military vessels) would be able to return to fish and transit through the area. To help manage competing demands and maintain public access in the Study Area, the military conducts its offshore operations in a manner that reduces restrictions to commercial fisherman. Military ships, fishers, and recreational users operate within the area together, and keep a safe distance between each other. Military participants would relocate as necessary to avoid conflicts with non-participants. The 3 NM area surrounding FDM is the only area designated as a surface danger zone that is permanently inaccessible to the public. The permanent designation is to ensure public safety.

The 2015 MITT EIS/OEIS notes that some training and testing activities may impact commercial and recreational fishing when areas of co-use are made temporarily, or in the case of waters surrounding FDM, permanently inaccessible to ensure the safety of the public. The number of NOTMARs issued from the years 2010 through 2017 restricting access to waters around FDM peaked in the year 2016 and the number of days affected by activities at FDM was the highest since the year 2012 (Figure 3.12-3, Figure 3.12-4). For W-517, both the number of NOTMARs and the number of days affected peaked in the year 2016. Considering that temporary restrictions on accessing areas of co-use would be infrequent and short-term, and other fishing sites in the Study Area would be available to the public, significant impacts on commercial and recreational fishing are not anticipated.



Posts

Joint Region Marianas
11 hrs ·

ASAN, Guam (Oct. 27, 2017) – The military will conduct training at the island of Farallon de Medinilla during the following dates and times:

- Oct. 29 from 2-11:59 p.m.
- Oct. 30 from midnight to 2 a.m. and 1-11:59 p.m.
- Oct. 21 from midnight to 1 p.m.

The military will also conduct training at Warning Area 517 (W-517) Oct. 30 from 7 a.m. to 8 p.m.

It is recommended the general public, fishermen and marine tour operators
monitor the Coast Guard broadcast notice to mariners for advisories.

The general location of the training on the island of Farallon de Medinilla will be in a 12-nautical mile radius of the island. Farallon de Medinilla, located in the Commonwealth of the Northern Mariana Islands, supports aircrew combat readiness training.

W-517 is activated south of latitude 12° 40’ 00"N. Santa Rosa Reef and Galvez Banks are open for public use. W-517 begins south of Guam and extends south-southwest in international waters. W-517 supports surface and aerial gunnery, missiles, and laser exercises. W-517 is contained within the following coordinates: 13° 10"N/144° 30"E, 13° 10"N/144° 42"E, 12° 50"N/144°
45"E, 11° 00"N/144° 45"E, 11° 00"N/143° 00"E, 11° 45"N/143° 00"E, 12° 50"N/144° 30"E.

Like Comment

**Figure 3.12-5: Joint Region Marianas Facebook Post Announcing Military Training Activities at FDM and W-517**

Traditional fishers in Guam and the CNMI would also be impacted by temporary restrictions limiting access to certain areas where traditional fishing practices take place. As described in Section 3.12.1.4.1 (Traditional Fishing Practices), many fishers identifying as traditional fishers also participate in recreational and commercial fishing, and it is not clear when fishers are engaging in traditional fishing, which has communal and cultural significance, and when they are fishing for financial gain or leisure or some combination of one or more of these motivations, which can occur even on a single fishing trip (Allen, 2013). These data suggest that traditional fishing likely occurs in the same locations as commercial and recreational fishing, and that traditional fishers would not be disproportionately impacted by temporary limits on access to fishing sites. Other fishing sites in the Study Area would be available to traditional fishers, and significant impacts on traditional fishing in the Study Area are not anticipated.

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.

#### 3.12.2.1.2 Impacts from Limits on Accessibility Under Alternative 2

In some cases, under Alternative 2, the number of proposed training and testing events would change as compared to the number of events proposed in the 2015 MITT Final EIS/OEIS (see Tables 2.5-1 and 2.5-2 in this SEIS/OEIS for changes in the number of annual events for specific activities). Only some activities that increased under Alternative 2 have the potential to impact accessibility to areas in the Study Area used by both the military and the public. The activities that increased are identified (highlighted) in Tables 2.5-1 and 2.5-2 and in Appendix F (Training and Testing Activities Matrices) in this SEIS/OEIS. For example, six Gunnery Exercise (Surface-to Air–Large Caliber) activities per year are proposed under Alternative 1, nine are proposed under Alternative 2, and this activity has the potential to limit accessibility.

Under Alternative 2, similar to Alternative 1, activities involving the use of aircraft, vessels, or in-water devices may temporarily limit accessibility to areas of the Study Area. Table 3.0-11 in Section 3.0 (Introduction) shows that the number of annual events using aircraft is approximately the same under Alternative 2 as under Alternative 1, while Table 3.0-12 and Table 3.0-13 show that the number of annual events using vessels and in-water devices is only marginally higher under Alternative 2 compared with Alternative 1.

After reviewing the changes in the numbers and types of training and testing activities with the potential to limit accessibility, the Navy determined that potential impacts on accessibility under Alternative 2 would be the same or similar to impacts identified under Alternative 1. Therefore, increases in the number of events shown in Tables 2.5-1 and 2.5-2 under Alternative 2 would have no appreciable change on the conclusions presented under Alternative 1 and in the 2015 MITT Final EIS/OEIS.

#### 3.12.2.1.3 Impacts from Limits on Accessibility Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Limits on accessibility to the ocean and airspace as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing training and testing activities would result in fewer limits on accessibility within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for limiting accessibility by the public, but would not measurably improve accessibility to the ocean and airspace in the Study Area.

Certain limitations on accessing danger zones, restricted areas, and warning areas as described in the 2015 MITT Final EIS/OEIS and in the CFR would still apply. Refer to CFR, Title 33 (Navigation and Navigable Waters), Part 334 (Danger Zone and Restricted Area Regulations), 33 CFR 165.1401 (Safety Zones), 14 CFR Part 73.1 (Special Use Airspace) for specific regulations regarding these ocean areas and airspace. A more detailed description of danger zones, restricted areas, and special use airspace in the

Study Area is provided in Section 3.12.3.1 (Accessibility [to the Ocean and Airspace]) in the 2015 MITT Final EIS/OEIS.

Not conducting the proposed at-sea training and testing activities may have negative impacts on the socioeconomic resources of Guam and the CNMI. The number of jobs and types of jobs available on Guam, and to a lesser extent on the CNMI, may decline. The Navy and Navy personnel are an important and often stabilizing contributor to the local and regional economies. For example, vessels and associated equipment used specifically for training and testing activities would no longer be needed if all training and testing activities ceased. Consequently, the civilian and Navy personnel supporting those activities may be relocated, reassigned, or have to find other employment. The secondary effects from reducing the number of personnel who support at-sea training and testing activities could include a decline in revenue for local businesses frequented by Navy personnel and their families, such as businesses in the food services, retail, and housing sectors.

As described in Section 3.12.1 (Affected Environment), the Navy contributes to the economies of Guam and the CNMI, which includes expenditures associated with at-sea training and testing activities. If a substantial number of Navy personnel are relocated due to the elimination of training and testing activities, a portion of the 12,800 Navy personnel and their dependents (approximately 8 percent of the population) residing on Guam would potentially be relocated off the island. A reduction in the population and Navy funding for training and testing activities may lessen the ability of military funding to stabilize the economy against fluctuations in the tourism sector. Training activities that use any of the seven vessels assigned to Saipan would no longer be conducted. This may reduce the need for or usage of one or more of the vessels, leading to a reduction in the funding expended to maintain the vessels at Saipan. Based on these two examples, the economies and social communities on Guam and the CNMI would be impacted to some degree if the proposed at-sea training and testing activities were not conducted.

#### 3.12.2.2 Airborne Acoustics

##### 3.12.2.2.1 Impacts from Airborne Acoustic Stressors Under Alternative 1

Training and testing activities that would increase under Alternative 1 and that use vessels, aircraft, or weapons firing would potentially increase airborne acoustics in certain areas of the Study Area that are used by the military (Tables 2.5-1 and 2.5-2). However, decreases in the number of training and testing events occurring in areas of co-use would potentially decrease airborne acoustics in those areas. Only some training and testing activities that either increased or decreased have the potential to generate airborne acoustics and require further analysis to supplement the analysis in the 2015 MITT Final EIS/OEIS.

The activities that changed (i.e., increased or decreased) are identified (highlighted) in Tables 2.5-1 and 2.5-2 and in Appendix F (Training and Testing Activities Matrices) in this SEIS/OEIS. The two tables and Appendix F were used together to identify which of the activities that either increased or decreased have the potential to generate airborne acoustics in the Study Area. For example, five GUNEX (Surface-to-Air–Large Caliber) activities per year were proposed in the 2015 MITT Final EIS/OEIS, and six were proposed under Alternative 1 in this SEIS/OEIS (Table 2.5-1 in Chapter 2, Description of Proposed Action and Alternatives). Referring to Table F-1 (Stressors by Training Activity) in Appendix F (Training and Testing Activities Matrices), the activity GUNEX (Surface-to-Air) is identified with a check mark as having the potential to generate airborne acoustics (listed as a socioeconomic stressor) in the Study Area.

As shown in Appendix F (Training and Testing Activities Matrices), the majority of the proposed training and testing activities generate airborne acoustics, which supports using the number of annual events proposed under each alternative as a metric to compare impacts. Generally, activities involving the use of aircraft, vessels, or explosive munitions may generate airborne acoustics detectable by the public in areas of the Study Area where military and civilian activities occur in close proximity. Table 3.0-11 shows that the number of annual events using aircraft would decrease under Alternative 1 compared to totals in the 2015 MITT Final EIS/OEIS, and Table 3.0-16 shows that the use of nearly all types of explosive munitions would also decrease under Alternative 1.

After reviewing the changes in the numbers and types of proposed training and testing activities with the potential to generate airborne acoustics, the Navy determined that potential impacts from airborne acoustics on socioeconomic resources would not be substantially different from the 2015 MITT Final EIS/OEIS. Therefore, the analysis, supplemented below, from the 2015 MITT Final EIS/OEIS remains valid.

Loud noises generated from training and testing activities such as weapons firing, in-air explosions, and aircraft transiting have the potential to disrupt recreational activities such as wildlife viewing, boating, fishing, and scuba diving. In addition to local residents, tourists participate in these activities in the Study Area. Encountering loud noises, particularly those that occur suddenly and nearby, could interfere with the enjoyment of several types of recreational activities. Disturbance from continuous albeit less intense noises could also affect the enjoyment of an activity. Airborne noises from military activities would occur on a temporary basis and only when weapons firing and in-air explosions occur and as aircraft transit through an area. 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 (e.g., the public). This would reduce the likelihood that noise from these activities, which are taking place far from non-participants, would disturb residents or tourists engaged in recreational activities on the water. Furthermore, most training and testing activities involving aircraft occur more the 12 NM from shore and those that occur closer to shore are typically at least 3 NM offshore (with the exception of activities at FDM). Noises generated from training and testing activities would occur far offshore and at a great distance from the recreational activities that typically occur closer to shore, reducing the disturbing effect of any perceived noise.

Noise from aircraft overflights would occur most frequently around Guam, the busiest airport in the Study Area, during takeoff and landing. Air Traffic Control Assigned Airspace is used for training and testing activities in the Study Area. The airspace referred to as Air Traffic Control Assigned Airspace-6 overlays Guam, Saipan, Tinian, and Rota and has a lower altitude limit of 39,000 ft. Aircraft at that altitude (or higher) are not likely to generate noise at sea level that would disrupt recreational activities. Revenue from tourism and recreational activities is not expected to be impacted by airborne noise. Refer to Section 3.12.2.1.2 (Air Traffic) of the 2015 MITT Final EIS/OEIS for more information on the different types of special use airspace in the Study Area and potential socioeconomic impacts from airborne noise.

There has been no appreciable change to the existing environmental conditions as presented in the 2015 MITT Final EIS/OEIS, and the results of the analysis of impacts from airborne noise on recreational activities and tourism remain the same. Therefore, no impacts on tourism would be anticipated because (1) most military training occurs well out to sea, while most tourism and recreational activities occur nearshore; (2) military aircraft generally depart from Andersen Air Force Base and travel north well away from tourist and residential areas; and (3) training and testing activities producing airborne noise are normally short term and temporary. Therefore, airborne noise impacts on tourism would be negligible.

Traditional fishers in Guam and the CNMI would not be disproportionately impacted by airborne acoustics, because traditional fishing practices likely occurs in the same general areas as recreational fishing (Allen, 2013), which is close to shore and far from the majority of training and testing activities that generate higher levels of airborne acoustics.

#### 3.12.2.2.2 Impacts from Airborne Acoustic Stressors Under Alternative 2

In some cases, under Alternative 2, the number of proposed training and testing events would change as compared to the number of events proposed in the 2015 MITT Final EIS/OEIS (see Tables 2.5-1 and 2.5-2 in this SEIS/OEIS for changes in the number of annual events for specific activities).Only some activities that increased under Alternative 2 have the potential to generate airborne acoustics that would be detectable by the public. The activities that increased are identified (highlighted) in Tables 2.5-1 and 2.5-2 and in Appendix F (Training and Testing Activities Matrices) in this SEIS/OEIS. For example, six GUNEX (Surface-to Air – Large Caliber) activities per year are proposed under Alternative 1, and nine are proposed under Alternative 2, and this activity would generate airborne acoustics that may be detectable by the public.

Under Alternative 2, activities involving the use of aircraft, vessels, or explosive munitions may generate airborne acoustics detectable by the public in areas of the Study Area where military and civilian activities occur in close proximity. Table 3.0-11 shows that the number of annual events using aircraft slightly increases under Alternative 2 compared to Alternative 1, and Table 3.0-12 shows that activities using vessels would increase marginally (<10 percent) under Alternative 2. The numbers of the different types of explosive munitions used under Alternative 2 are either the same or similar to totals under Alternative 1 (Table 3.0-16).

After reviewing the changes in the numbers and types of training and testing activities with the potential to increase airborne acoustics, the Navy determined that potential impacts from airborne acoustics under Alternative 2 would be the same or similar to impacts identified under Alternative 1. Therefore, increases under Alternative 2 would have no appreciable change on the conclusions presented under Alternative 1 and in the 2015 MITT Final EIS/OEIS.

#### 3.12.2.2.3 Impacts from Airborne Acoustic Stressors Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Disturbances from airborne acoustic stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing training and testing activities would result in fewer disturbances from airborne acoustics within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for disturbances from airborne acoustics, but would not measurably change the frequency or severity of disturbances from airborne acoustics experienced by the public in the Study Area.

Not conducting the proposed at-sea training and testing activities may have negative impacts on the socioeconomic resources of Guam and the CNMI. The number of jobs and types of jobs available on Guam and to a lesser extent on the CNMI may decline. The Navy and Navy personnel are an important and often stabilizing contributor to the local and regional economies. For example, vessels and associated equipment used specifically for training and testing activities would no longer be needed if all at-sea training and testing activities ceased. Consequently, the civilian and Navy personnel supporting those activities may be relocated, reassigned, or have to find other employment. The secondary effects from reducing the number of personnel who support at-sea training and testing activities could include a decline in revenue for local businesses frequented by Navy personnel and their families, such as businesses in the food services, retail, and housing sectors.

As described in Section 3.12.1 (Affected Environment), the Navy contributes to the economies of Guam and the CNMI, which includes expenditures associated with at-sea training and testing activities. If a substantial number of Navy personnel are relocated due to the elimination of training and testing activities, a portion of the 12,800 Navy personnel and their dependents (approximately 8 percent of the population) residing on Guam would potentially be relocated off the island. A reduction in the population and Navy funding for training and testing activities may lessen the ability of military funding to stabilize the economy against fluctuations in the tourism sector. Training activities that use any of the seven vessels assigned to Saipan would no longer be conducted. This may reduce the need for or usage of one or more of the vessels, leading to a reduction in the funding expended to maintain the vessels at Saipan. Based on these two examples, the economies and social communities on Guam and the CNMI would be impacted to some degree if the proposed at-sea training and testing activities were not conducted.

#### 3.12.2.3 Physical Disturbance and Strike Stressors

##### 3.12.2.3.1 Impacts from Physical Disturbance and Strike Stressors Under Alternative 1

Training and testing activities that would increase under Alternative 1 and that use vessels, aircraft, munitions, and military expended materials would potentially increase the risk of physical disturbance and strike in certain areas of the Study Area that are used by both the military and the public (Tables 2.5-1 and 2.5-2). However, decreases in the number of training and testing events occurring in areas of co-use would potentially decrease the potential for physical disturbance and strike in those areas. Only some training and testing activities that either increased or decreased have the potential for physical disturbance and strike and require further analysis to supplement the analysis in the 2015 MITT Final EIS/OEIS.

The activities that changed (i.e., increased or decreased) are identified (highlighted) in Tables 2.5-1 and 2.5-2 and in Appendix F (Training and Testing Activities Matrices) in this SEIS/OEIS. The two tables and Appendix F were used together to identify which of the activities that either increased or decreased have the potential to result in a physical disturbance or strike in the Study Area. For example, five GUNEX (Surface-to-Air – Large Caliber) activities per year were proposed in the 2015 MITT Final EIS/OEIS, and six were proposed under Alternative 1 in this SEIS/OEIS (Table 2.5-1 in Chapter 2, Description of Proposed Action and Alternatives). Referring to Table F-1 (Stressors by Training Activity) in Appendix F (Training and Testing Activities Matrices), the activity GUNEX (Surface-to-Air) is identified with a check mark as having the potential for physical disturbance and strike (listed as a socioeconomic stressor) in the Study Area.

As shown in Appendix F (Training and Testing Activities Matrices), the majority of the proposed training and testing activities use vessels, in-water devices, aircraft, munitions, or military expended materials and could result in a physical disturbance or strike, which supports using the number of annual events proposed under each alternative as a metric to compare impacts. Table 3.0-11 shows that the number of events using aircraft would decrease by about 10 percent under Alternative 1 compared to totals in the 2015 MITT Final EIS/OEIS; however, Table 3.0-12 and Table 3.0-13 show that the number of annual events using vessels and in-water devices would increase by about 15 and 4 percent, respectively, under Alternative 1 compared to totals in the 2015 MITT Final EIS/OEIS. Table 3.0-15 shows that the use of some non-explosive practice munitions would increase over the totals in the 2015 MITT Final EIS/OEIS, while other non-explosive practice munitions would decrease; Table 3.0-16 shows that the use of nearly all types of explosive munitions would also decrease under Alternative 1. Most types of other military expended materials would decrease under Alternative 1 (Table 3.0-15).

After reviewing the changes in the numbers and types of proposed training and testing activities with the potential for physical disturbance and strike and the numbers of munitions and other military expended materials that would be used, the Navy determined that potential impacts from physical disturbance and strike on socioeconomic resources would not be substantially different from the 2015 MITT Final EIS/OEIS. Therefore, the analysis, supplemented below, from the 2015 MITT Final EIS/OEIS remains valid.

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 encounters that damage equipment and infrastructure could disrupt the collection (e.g., of fisheries resources) and transport of products, which could impact industry revenue or operating costs. Socioeconomic resources potentially impacted by encounters with military vessels, devices, and objects include commercial transportation and shipping, commercial and recreational fishing, traditional fishing practices, and tourism.

The majority of commercial and recreational fishing, traditional fishing practices, and tourism in the Study Area takes place in nearshore waters (less than 3 NM from shore), where the military conducts limited training and testing activities involving munitions or other expended materials. Therefore, most recreational fishing, traditional fishing practices, and tourism activities would occur far away from physical disturbance and strike stressors.

Larger commercial fishing vessels are more likely to go beyond 3 NM and approach areas where the military trains and tests and could be affected by physical disturbances or strikes. The military's standard operating procedures, which are discussed in Section 2.3.3 (Standard Operating Procedures) of this SEIS/OEIS, includes ensuring that an area is clear of all non-participating vessels before training and testing activities take place, which includes commercial fishing vessels (refer to Section 3.12.3.3, Physical Disturbance and Strike, of the 2015 MITT Final EIS/OEIS for detailed analysis).

Commercial shipping vessels transport goods internationally and would be expected to transit through offshore waters en route to domestic and foreign ports. Shipping vessels follow established routes which are avoided by the military during training and testing activities, and both military and civilian vessels in proximity to each other are expected to communicate their positions. In addition, the military provides advance notification of training and testing activities to the public through NOTMARs and other means of communication as described in Section 3.12.2.1 (Accessibility [to the Ocean and Airspace]). For these reasons, a direct strike or collision with a shipping vessel is unlikely.

Additional information and analysis of physical disturbance and strike stressors and the potential for interactions with commercial fishing vessels and gear is described in Section 3.12.3.3 (Physical Disturbance and Strike) of the 2015 MITT Final EIS/OEIS.

New information relevant to physical disturbance and strike impacts has become available since publication of the 2015 MITT Final EIS/OEIS. There has been no appreciable change to the existing environmental conditions as presented in the 2015 MITT Final EIS/OEIS, and the results of the analysis of impacts from physical disturbance and strike on commercial transportation and shipping, commercial and recreational fishing, traditional fishing practices, and tourism remain the same. The advanced public release of NOTMARs and other public notices would inform the public of upcoming activities, and enable them to plan to avoid the area.

The Navy would implement mitigation to avoid or reduce impacts from physical disturbance and strike stressors on seafloor resources in mitigation areas throughout the Study Area (see Section 5.4.1, Mitigation Areas for Seafloor Resources). The mitigation areas will help avoid or reduce potential impacts on shallow-water coral reefs, live hard bottom, artificial reefs, and shipwrecks, which are valuable assets for the snorkeling, diving, and fishing industries. Considering the size of the Navy's Study Area, the wide distribution of military expended materials over this large area, and implementation of standard operating procedures and mitigation, impacts from physical disturbances and strikes on commercial and recreational fishing, traditional fishing practices, and tourism would be negligible under Alternative 1. Refer to Section 2.3.3 (Standard Operating Procedures) of this SEIS/OEIS for additional information on the Navy's standard operating procedures and Chapter 5 (Mitigation) for information on proposed mitigation measures.

Traditional fishers in Guam and the CNMI would not be disproportionately impacted by a potential physical disturbance and strike, because traditional fishing practices likely occurs in the same general areas as recreational fishing (Allen, 2013), which is close to shore and far from the majority of training and testing activities that have the potential to result in a physical disturbance and strike.

#### 3.12.2.3.2 Impacts from Physical Disturbance and Strike Stressors Under Alternative 2

In some cases, under Alternative 1, the number of proposed training and testing events would change as compared to the number of events proposed in the 2015 MITT Final EIS/OEIS (see Tables 2.5-1 and 2.5-2 in this SEIS/OEIS for changes in the number of annual events for specific activities).Only some activities that increased under Alternative 2 have the potential to increase the risk of physical disturbance and strike in certain areas of the Study Area that are used by both the military and the public. The activities that increased are identified (highlighted) in Tables 2.5-1 and 2.5-2 and in Appendix F (Training and Testing Activities Matrices). For example, six GUNEX (Surface-to Air–Large Caliber) activities per year are proposed under Alternative 1, nine are proposed under Alternative 2, and this activity has the potential to result in a physical disturbance or strike.

As shown in Appendix F (Training and Testing Activities Matrices), the majority of the proposed training and testing activities use vessels, in-water devices, aircraft, munitions, or military expended materials and could result in a physical disturbance or strike, which supports using the number of annual events proposed under each alternative as a metric to compare impacts. Table 3.0-11 shows that the number of annual events using aircraft is approximately the same under Alternative 2 as under Alternative 1, while Table 3.0-12 and Table 3.0-13 show that the number of events using vessels and in-water devices is only marginally higher under Alternative 2 compared with Alternative 1. Table 3.0-14 shows that the use of some non-explosive practice munitions would increase under Alternative 2 compared to totals under Alternative 1; the numbers of the different types of explosive munitions used under Alternative 2 are either the same or similar to totals under Alternative 1 (Table 3.0-16). Five out of the 10 different types of other military expended materials shown in Table 3.0-15 would also increase under Alternative 2; however, the increases are not substantial.

After reviewing the changes in the numbers and types of training and testing activities with the potential to increase the probability of a physical disturbance and strike, the Navy determined that potential impacts from physical disturbance and strike under Alternative 2 would be the same or similar to impacts identified under Alternative 1. Therefore, increases under Alternative 2 would have no appreciable change on the conclusions presented under Alternative 1 and in the 2015 MITT Final EIS/OEIS.

#### 3.12.2.3.3 Impacts from Physical Disturbance and Strike Stressors Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Physical disturbance and strike stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing training and testing activities would result in fewer physical disturbance and strike stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for physical disturbances and strikes, but would not measurably change the number of times the public is exposed to physical disturbance and strike stressors in the Study Area.

Not conducting the proposed at-sea training and testing activities may have negative impacts on the socioeconomic resources of Guam and the CNMI. The number of jobs and types of jobs available on Guam and to a lesser extent on the CNMI may decline. The Navy and Navy personnel are an important and often stabilizing contributor to the local and regional economies. For example, vessels and associated equipment used specifically for at-sea training and testing activities would no longer be needed if all at-sea training and testing activities ceased. Consequently, the civilian and Navy personnel supporting those activities may be relocated, reassigned, or have to find other employment. The secondary effects from reducing the number of personnel who support at-sea training and testing activities could include a decline in revenue for local businesses frequented by Navy personnel and their families, such as businesses in the food services, retail, and housing sectors.

As described in Section 3.12.1 (Affected Environment), the Navy contributes to the economies of Guam and the CNMI, which includes expenditures associated with at-sea training and testing activities. If a substantial number of Navy personnel are relocated due to the elimination of training and testing activities, a portion of the 12,800 Navy personnel and their dependents (approximately 8 percent of the population) residing on Guam would potentially be relocated off the island. A reduction in the population and Navy funding for training and testing activities may lessen the ability of military funding to stabilize the economy against fluctuations in the tourism sector. Training activities that use any of the seven vessels assigned to Saipan would no longer be conducted. This may reduce the need for or usage of one or more of the vessels, leading to a reduction in the funding expended to maintain the vessels at Saipan. Based on these two examples, the economies and social communities on Guam and the CNMI would be impacted to some degree if the proposed at-sea training and testing activities were not conducted.

#### 3.12.2.4 Secondary Stressors

Secondary stressors resulting in indirect impacts on socioeconomic resources are discussed in Section 3.12.3.4 (Secondary Impacts from Availability of Resources) of the 2015 MITT Final EIS/OEIS. A secondary stressor, as defined 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 types of fish, and those same fish are part of 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 commercial fishing.

##### 3.12.2.4.1 Secondary Impacts from Availability of Resources Under Alternative 1 and Alternative 2

The secondary stressor "resource availability" pertains to the potential for loss of fisheries resources, including some invertebrates, within the Study Area, which is relevant to commercial, recreational, and traditional fishing practices as well as tourism. Additionally, impacts on marine mammal populations would have the potential to impact revenue for whale watching businesses if a substantial number of whales were to leave the area. Analysis in Sections 3.4 (Marine Mammals), 3.8 (Marine Invertebrates), and 3.9 (Fishes) 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 secondary impacts on commercial or recreational fishing, traditional fishing practices, or tourism in the Study Area under Alternative 1 or Alternative 2.

##### 3.12.2.4.2 Secondary Impacts from Availability of Resources Under the No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Secondary stressors impacting resource availability as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing training and testing activities would result in fewer secondary stressors from the availability of resources within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for secondary stressors, but would not measurably improve the availability of resources associated with secondary impacts on socioeconomic resources in the Study Area.

Not conducting the proposed at-sea training and testing activities may have negative impacts on the socioeconomic resources of Guam and the CNMI. The number of jobs and types of jobs available on Guam and to a lesser extent on the CNMI may decline. The Navy and Navy personnel are an important and often stabilizing contributor to the local and regional economies. For example, vessels and associated equipment used specifically for at-sea training and testing activities would no longer be needed if all at-sea training and testing activities ceased. Consequently, the civilian and Navy personnel supporting those activities may be relocated, reassigned, or have to find other employment. The secondary effects from reducing the number of personnel who support at-sea training and testing activities could include a decline in revenue for local businesses frequented by Navy personnel and their families, such as businesses in the food services, retail, and housing sectors.

As described in Section 3.12.1 (Affected Environment), the Navy contributes to the economies of Guam and the CNMI, which includes expenditures associated with at-sea training and testing activities. If a substantial number of Navy personnel are relocated due to the elimination of training and testing activities, a portion of the 12,800 Navy personnel and their dependents (approximately 8 percent of the population) residing on Guam would potentially be relocated off the island. A reduction in the population and Navy funding for training and testing activities may lessen the ability of military funding to stabilize the economy against fluctuations in the tourism sector. Training activities that use any of the seven vessels assigned to Saipan would no longer be conducted. This may reduce the need for or usage of one or more of the vessels, leading to a reduction in the funding expended to maintain the vessels at Saipan. Based on these two examples, the economies and social communities on Guam and the CNMI would be impacted to some degree if the proposed at-sea training and testing activities were not conducted.

### 3.12.3 Public Scoping Comments

The public raised a number of issues during the scoping period in regard to socioeconomic resources. The issues are summarized in the list below.

- **Restricting the ability of American citizens to move between islands to fish, recreate, or for general travel** – Access to certain areas of the Study Area is restricted during potentially hazardous training and testing activities to ensure the safety of the public and military personnel. Most areas (with the notable exception of the 3 NM danger zone around FDM) are only restricted on a temporary basis and are accessible to the public when not in use by the military. See Section 3.12.2.1 (Commercial Transportation and Fishing) and 3.12.3.1 (Accessibility [to the Ocean and Airspace]) in the 2015 MITT Final EIS/OEIS.
- **Concerns regarding negative effects of sonar testing on swimming and diving in the waters off Guam and the CNMI** – The Navy follows established standard operating procedures when conducting training and testing activities with sonar to ensure that swimmers, divers, and any anyone else who might be in the water are safe (see Section 2.3.3, Standard Operating Procedures). The Navy avoids using sonar near popular swimming and diving sites. See Section 3.12.2.1 (Accessibility [to the Ocean and Airspace]) and Section 3.12.2.4 (Tourism) in the in the 2015 MITT Final EIS/OEIS. Also, refer to Section 3.13 (Public Health and Safety) for information on Navy procedures for protecting swimmers and divers.
- **Improve safety for fishermen by issuing NOTMARs in advance of military activities and posting NOTMARs at local marinas for boaters to view and be warned** – The Navy requests that the U.S. Coast Guard issues NOTMARs to make fishers and other members of the public aware of upcoming training and testing activities that would limit public access to areas of the Study Area. The Navy continues to search for new ways to communicate important information to the public and now posts information about upcoming closures to several Navy Facebook pages. See Section 3.12.2.1 (Commercial Transportation and Shipping) and 3.12.3.1 (Accessibility [to the Ocean and Airspace]) in the 2015 MITT Final EIS/OEIS. Also, refer to Section 3.13 (Public Health and Safety) for information on Navy procedures for protecting mariners.
- **Request additional and more frequent NOTMARs during military training (e.g., broadcast every two hours, posters at boat harbors, Facebook, and direct communication with fishers)** – The Navy requests that the U.S. Coast Guard issues NOTMARs to make fishers and other members of the public aware of upcoming military activities that would limit public access to areas of the Study Area. In addition to posting NOTMARs, emails are sent to Guam and CNMI local mayors, Guam legislators, resources agencies, and fishers. The distribution was developed by JRM and local stakeholders. In addition, notices are sent to the National Oceanic and

Atmospheric Administration, local cable channels, and emergency management offices. The Navy continues to search for new ways to communicate important information to the public and now posts information about upcoming closures to several Navy Facebook pages. See Section 3.12.2.1 (Commercial Transportation and Shipping) and 3.12.3.1 (Accessibility [to the Ocean and Airspace]) in the 2015 MITT Final EIS/OEIS.

- **Training and testing activities disturbing pelagic and economically important fish and causing them to leave the Study Area** – The analysis in Section 3.9 (Fishes) concludes that there would be no population level effects on any fish species, including economically important species. See Section 3.12.2.1 (Accessibility [to the Ocean and Airspace]) and Section 3.12.2.4 (Secondary Stressors). Also refer to Sections 3.8 (Marine Invertebrates) and 3.9 (Fishes) in this SEIS/OEIS and in the 2015 MITT Final EIS/OEIS for detailed analysis explaining why population level effects are not likely to occur.
- **Direct and cumulative impacts on recreational and commercial fishing and transport between the islands due to the location of restricted areas** – Impacts on commercial and recreational fishing and transportation between islands are not expected to have substantial socioeconomic impacts on recreational and commercial fishing in the region. Upon completion of training and testing activities, restrictions 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 Study Area, the military conducts its offshore operations in a manner that reduces restrictions on commercial fishing. Military vessels, fishers, and recreational users operate within the area together, and keep a safe distance between each other. Military participants would relocate as necessary to avoid conflicts with non-participants. Only specific areas within Study Area have been designated as danger zones or restricted areas. See Section 3.12.2.1 (Commercial Transportation and Shipping) and 3.12.3.1 (Accessibility [to the Ocean and Airspace]) in the 2015 MITT Final EIS/OEIS. Also See Chapter 4 (Cumulative Impacts) for a discussion on potential cumulative impacts from past, present, and future Navy and other military activities in the region occurring simultaneously with civilian activities.
- **Socioeconomic effects on recreational and traditional fishers from limiting access to fishing sites, specifically because of restricted areas** – Access to certain areas of the Study Area is restricted during potentially hazardous training and testing activities to ensure the safety of the public and military personnel. Most areas (with the notable exception of the 3 NM danger zone around FDM) are only restricted on a temporary basis and are accessible to the public when not in use by the military. The Navy understands that individual fishers may be temporarily impacted by a particular event. The Navy will continue to communicate with the public through multiple means to alert fishers and other members of the public of upcoming activities that may limit access to fishing sites. Monitoring NOTMARs and other announcements for scheduled training and testing activities should avoid any conflicts and reduce socioeconomic impacts on fishers. See Section 3.12.2.1 (Accessibility [to the Ocean and Airspace]). See also 3.12.3.1.1.2 (Commercial and Recreational Fishing) and Section 3.12.3.1.1.3 (Subsistence Use) in the 2015 MITT Final EIS/OEIS.
- **Loss of income and revenue from loss of access to prime fishing grounds around FDM with the expansion of the restricted area around FDM** – Access to certain areas of the Study Area is temporarily restricted during potentially hazardous training and testing activities to ensure the

safety of the public and military personnel. Areas within in 3 NM of FDM have been permanently restricted to maintain public safety. Even when hazardous activities are not occurring at FDM, the potential occurrence of unexploded ordnance in waters surrounding the island is a constant threat to public safety. Transiting between Guam, Saipan, Tinian, and Rota to islands located north of FDM (e.g., the Islands Unit) would potentially be impacted by designating a 12 NM danger zone around the FDM and limiting access to the area when the range is in use. A study conducted by the Pacific Islands Fisheries Science Center on fishing activity in the Islands Unit of the Marianas Trench Marine National Monument reported that vessels have historically traveled from the southern Mariana Islands to the Islands Unit (defined as the islands of Uracas, Maug, and Asuncion) an average of 3.8 times per year over the 30-year period from the years 1979 through 2009 (Kotowicz & Richmond, 2013). Travel to other islands north of FDM (e.g., Anatahan and Pagan) may be more frequent; however, the study did not address islands located south of the Islands Unit. Considering that trips between the populated island south of FDM and the Islands Unit would be relatively infrequent, the probability of military activities that temporarily limit access to ocean areas within 12 NM of FDM interfering with trips to the Islands Unit would be low. The most direct route between Saipan (the northernmost populated island) and Anatahan (the closest island north of FDM) passes more than 12 NM west of FDM. Furthermore, the military will continue to announce when FDM is not in use in addition to notifying mariners of planned activities via NOTMARs and NOTAMs at FDM as the Navy has done in the past, which will enable mariners to better plan trips to islands north of FDM, including the Islands Unit. See Section 3.12.3.1.1.2 (Commercial and Recreational Fishing) in the 2015 MITT Final EIS/OEIS.

- **Increased time and cost to transit around FDM because of the expanded restricted area around FDM** – Transiting between Guam, Saipan, Tinian, and Rota to islands located north of FDM (e.g., the Islands Unit) would potentially be impacted by designating a 12 NM danger zone around the FDM and limiting access to the area when the range is in use. A study conducted by the Pacific Islands Fisheries Science Center on fishing activity in the Islands Unit of the Marianas Trench Marine National Monument reported that vessels have historically traveled from the southern Mariana Islands to the Islands Unit (defined as the islands of Uracas, Maug, and Asuncion) an average of 3.8 times per year over the 30-year period from the years 1979 through 2009 (Kotowicz & Richmond, 2013). Travel to other islands north of FDM (e.g., Anatahan and Pagan) may be more frequent; however, the study did not address islands located south of the Islands Unit. Considering that trips between the populated island south of FDM and the Islands Unit would be relatively infrequent, the probability of military activities that temporarily limit access to ocean areas within 12 NM of FDM interfering with trips to the Islands Unit would be low. The most direct route between Saipan (the northernmost populated island) and Anatahan (the closest island north of FDM) passes more than 12 NM west of FDM. Furthermore, the military will continue to announce when FDM is not in use in addition to notifying mariners of planned activities via NOTMARs and NOTAMs at FDM as the Navy has done in the past, which will enable mariners to better plan trips to islands north of FDM, including the Islands Unit. See Section 3.12.3.1.1.2 (Commercial and Recreational Fishing) in the 2015 MITT Final EIS/OEIS.
- **Request for direct compensation or development of fishery infrastructure as mitigation for loss of access to fishing grounds** – As presented in Section 3.12 (Socioeconomic Resources) of the MITT Final EIS/OEIS, the military has been conducting training and testing activities within the Study Area for decades, and has taken and will continue to take measures to prevent

interruption of commercial and recreational fishing activities. The Navy limits fishing activities in only a small portion of the Study Area and only to the extent necessary to accommodate the training and testing activities. The military does not limit fishing activities from occurring in areas of the Study Area that are not being used for training and testing activities. To mitigate impacts to fishers and minimize potential interactions between military and civilian activities, the Navy will continue to publish scheduled training event times and locations on publicly accessible Navy websites and through U.S. Coast Guard issued Notices to Mariners, up to 6 months in advance of planned events. Press releases have been continuously provided to Guam and CNMI Mayors' offices and interested fishing organizations and fishers. When feasible, the military will use these same means of communication to notify the public of changes to previously published restrictions. Advanced planning on behalf of the military and effective communication of the military's plans attempt to maximize accessibility to desirable fishing locations and minimize the effect on commercial and recreational fishing activities. To the extent practicable, the Navy will continue to limit training and testing activities in and around the location of fish aggravating devices. The Navy will continue to consult with the public and local fishers on issues affecting commercial and recreational fishing in order to limit potential impacts associated with military activities. The issue of compensation to impacted fisheries is beyond the scope of the Navy's analysis in this SEIS/OEIS.

- **Displacement of fishermen from traditional fishing grounds** – Access to certain areas of the Study Area is restricted during potentially hazardous training and testing activities to ensure the safety of the public and military personnel. Most areas (with the notable exception of the 3 NM danger zone around FDM) are only restricted on a temporary basis and are accessible to the public when not in use by the military. See Section 3.12.2.1 (Accessibility [to the Ocean and Airspace]). See also Section 3.12.3.1 (Accessibility [to the Ocean and Airspace]) and Section 3.12.3.1.1.3 (Subsistence Use) in the 2015 MITT Final EIS/OEIS.
- **Impacts on traditional fishing practices** – Traditional fishers, including subsistence fishers, typically fish from the shore or from small vessels within 3 NM of shore. The majority of training and testing activities occur in offshore waters (beyond 3 NM and in many cases beyond 12 NM) where traditional fishing typically does not occur, reducing any potential overlap with military activities. The Navy understands that individual fishers may be temporarily impacted by a particular event. The Navy will continue to communicate with the public through multiple means to alert traditional fishers of upcoming activities that may limit access to popular fishing sites. Monitoring NOTMARs and other announcements for scheduled training and testing activities should avoid any conflicts and reduce socioeconomic impacts on traditional fishers. See Section 3.12.2.1 (Accessibility [to the Ocean and Airspace]). See also Section 3.12.3.1 (Accessibility [to the Ocean and Airspace]), Section 3.12.3.1.1.3 (Subsistence Use), and 3.12.3.3.1.1 (Commercial and Recreational Fishing/Subsistence Use) in the 2015 MITT Final EIS/OEIS.
- **Impacts from explosives on fish stocks and traditional fishers who rely on those stocks** – The analysis in Section 3.9 (Fishes) concludes that there would be no population-level effects on any fish species, including economically important species. See Section 3.12.2.4 (Secondary Stressors) and Section 3.12.3.1.1.3 (Subsistence Use) in the 2015 MITT Final EIS/OEIS.

# REFERENCES

Allen, S., and P. Bartram. (2008). Guam as a Fishing Community (Vol. 2011, pp. Administrative Report H–08–01). Honolulu, HI: Pacific Islands Fisheries Science Center.

Allen, S. (2013). Carving a niche or cutting a broad swath: Subsistence fishing in the western Pacific. *Pacific Science, 67*(3), 477–488.

Commonwealth Ports Authority. (2005). *Commonwealth Ports Authority*. Retrieved from http://www.cpa.gov.mp/default.asp.

Commonwealth Ports Authority. (2017). *Report on the Audit of Financial Statements in Accordance with the Uniform Guidance*. Saipan, Commonwealth of the Northern Mariana Islands: Deloitte.

Cuetos-Bueno, J., and P. Houk. (2014). Re-estimation and synthesis of coral-reef fishery landings in the Commonwealth of the Northern Mariana Islands since the 1950s suggests the decline of a common resource. *Reviews in Fish Biology and Fisheries, 25*(1), 179–194.

Cuetos-Bueno, J., and P. Houk. (2018). Disentangling economic, social, and environmental drivers of coral-reef fish trade in Micronesia. *Fisheries Research, 199*, 263–270.

Daleno, G. D. (2015). *Airport opens new interisland terminal*. Retrieved from https://www.guampdn.com/story/news/2015/10/01/airport-opens-new-interisland-terminal/73133388/#.

Federal Aviation Administration. (2015). *1050.1F Desk Reference*. Washington, DC: Office of Environment and Energy.

Guam Economic Development Authority. (2018). *United States Military*. Retrieved from http://www.investguam.com/economic-resources/military/.

Guam Visitors Bureau. (2014). *Tourism 2020: Vision 2020*. Tumon, Guam: Guam Visitors Bureau.

Guam Visitors Bureau. (2017). *The Olympics of Pacific Island Culture*. Tumon, Guam: Guam Visitors Bureau.

Hospital, J., and C. Beavers. (2012). *Economic and Social Characteristics of Guam's Small Boat Fisheries* (Administrative Report). Honolulu, HI: National Oceanic and Atmospheric Administration.

Hospital, J., and C. Beavers. (2014). *Economic and Social Characteristics of Small Boat Fishing in the Commonwealth of the Northern Mariana Islands* (Administrative Report H-14-02). Honolulu, HI: Pacific Island Fisheries Science Center.

Hovland, C., J. Aversa, and T. H. Joshua. (2017a). *Gross Domestic Product for Guam increases in 2016: Tourism spending increases for the third year in a row* (News Release BEA 17-44). Washington, DC: Bureau of Economic Analysis.

Hovland, C., J. Aversa, and T. H. Joshua. (2017b). *CNMI GDP increases in 2016: Growth led by gaming industry revenues and investments* (News Release BEA 17-55). Washington, DC: Bureau of Economic Analysis.

Kotowicz, D., and L. Richmond. (2013). *Traditional Fishing Patterns in the Marianas Trench Marine National Monument* (Administrative Report). Honolulu, HI: Pacific Islands Fisheries Science Center.

Marianas Visitors Authority. (2016). *Saipan, Tinian, Rota, Marianas Visitors Authority 2015 Annual Report*. Saipan, MP: Marianas Visitors Authority.

Office of Environmental Health Hazard Assessment. (1997). *Consumption of Fish and Shellfish in California and the United States*. *Chemicals in Fish, Report No. 1, Final Draft Report.* Retrieved from http://oehha.ca.gov/fish/special_reports/fishy.html.

Pacific Islands Fisheries Science Center. (2016a). Commercial Landings in CNMI (2010–2015). In M. Zickel (Ed.), *Dataset*.

Pacific Islands Fisheries Science Center. (2016b). Commercial Landings in Guam (2010–2015). In M. Zickel (Ed.), *Dataset*.

Port Authority of Guam. (2017). *Cargo Statistics and Graphs*. Retrieved from http://www.portofguam.com/about-us/financial-information-and-statistics/cargo-statistics-and-graphs.

Smith, S. H., and D. E. Marx, Jr. (2016). De-facto marine protection from a Navy bombing range: Farallon de Medinilla, Mariana Archipelago, 1997 to 2012. *Marine Pollution Bulletin, 102*(1), 187–198.

Starmer, J. (2005). *The State of Coral Reef Ecosystems of the Commonwealth of the Northern Mariana Islands*. Mariana Islands, Guam: Commonwealth of the Northern Marianas.

Thompson, A. R., D. C. Chen, L. W. Guo, J. R. Hyde, and W. Watson. (2017). Larval abundances of rockfishes that were historically targeted by fishing increased over 16 years in association with a large marine protected area. *Royal Society Open Science, 4*(170639), 1–13.

Tibbats, B., and T. Flores. (2012). *Chapter 2: Guam Fishery Ecosystem Report* (Archipelagic Fishery Ecosystem Annual Report). Honolulu, HI: Western Pacific Regional Fishery Management Council.

U.S. Census Bureau. (2018a). *2010 Guam Summary File*. Washington, DC: U.S. Census Bureau.

U.S. Census Bureau. (2018b). *2010 Commonwealth of the Northern Mariana Islands Summary File*. Washington, DC: U.S. Census Bureau.

U.S. Census Bureau. (2018c). *2010 Commonwealth of the Northern Mariana Islands Demographic Profile Data*. Washington, DC: U.S. Census Bureau.

U.S. Central Intelligence Agency. (2018a). *The World Factbook: Guam*. Retrieved from https://www.cia.gov/library/publications/resources/the-world-factbook/geos/gq.html.

U.S. Central Intelligence Agency. (2018b). *The World Factbook: Northern Mariana Islands*. Retrieved from https://www.cia.gov/library/publications/resources/the-world-factbook/geos/cq.html.

U.S. Department of the Navy. (2015). *Final Supplemental Environmental Impact Statement Guam and Commonwealth of the Northern Mariana Islands Military Relocation (2012 Roadmap Adjustments)*. Washington, DC: Naval Facilities Engineering Command Pacific.

U.S. Environmental Protection Agency. (2002). *Fish Consumption and Environmental Justice*. Seattle, WA: National Environmental Justice Advisory Council.

U.S. Environmental Protection Agency. (2016). *Promising Practices for EJ Methodologies in NEPA Reviews* (Report of the Federal Interagency Working Group on Environmental Justice & NEPA Committee). Washington, DC: U.S. Environmental Protection Agency.

Weijerman, M., I. Williams, J. Gutierrez, S. Grafeld, B. Tibbatts, and G. Davis. (2016). Trends in biomass of coral reef fishes, derived from shore-based creel surveys in Guam. *Fishery Bulletin, 114*(2), 237–256.

Western Pacific Regional Fishery Management Council. (2009). Fishery Ecosystem Plan for the Mariana Archipelago (Vol. 2011). Honolulu, HI: Western Pacific Regional Fishery Management Council.

World Port Source. (2012). *Port of Saipan Port of Call*. *World Port Source.* Retrieved from http://www.worldportsource.com/ports/portCall/MNP_Port_of_Saipan_171.php.

Yau, A., M. O. Nadon, B. L. Richards, J. Brodziak, and E. Fletcher. (2016). *Stock Assessment Updates of the Bottomfish Management Unit Species of American Samoa, the Commonwealth of the Northern Mariana Islands, and Guam in 2015 Using Data through 2013*. Honolulu, HI: National Oceanic and Atmospheric Administration Pacific Islands Fisheries Science Center.

Zeller, D., S. Harper, K. Zylich, and D. Pauly. (2014). Synthesis of underreported small-scale fisheries catch in Pacific island waters. *Coral Reefs, 34*(1), 25–39.

# 3.13 Public Health and Safety

# Supplemental Environmental Impact Statement/

# Overseas Environmental Impact Statement

# Mariana Islands Training and Testing

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There are no figures in this section.

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## 3.13 Public Health and Safety

### 3.13.1 Affected Environment

The purpose of this section is to supplement the analysis of impacts on public health and safety presented in the 2015 Mariana Islands Training and Testing (MITT) Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) with new information relevant to proposed changes in training and testing activities conducted at sea and on Farallon de Medinilla (FDM). Information presented in the 2015 MITT Final EIS/OEIS that remains valid is noted as such, and referenced in the appropriate sections. Any new or updated information describing the affected environment and analysis of impacts on public health and safety associated with the Proposed Action is provided in this section. Comments received from the public during scoping related to public health and safety are addressed in Section 3.13.3 (Public Scoping Comments).

#### 3.13.1.1 Existing Conditions

##### 3.13.1.1.1 Sea Space

Sea space accessibility within the MITT Study Area is the same as what is described in the 2015 MITT Final EIS/OEIS (Section 2.1.1.2, Sea and Undersea Space and Section 3.13.2.1.1, Sea Space). Only select areas have activity restrictions or prohibitions in accordance with Title 33 Code of Federal Regulations Part 334 (Danger Zone and Restricted Area Regulations). The National Oceanic and Atmospheric Association (NOAA) issues nautical charts that delineate these areas. The military conducts training and testing activities in operating areas away from commercially used waterways and inside special use airspace. Scheduled training and testing activities are published by the United States (U.S.) Coast Guard in Notices to Mariners (NOTMARs) to warn the public of upcoming and potentially hazardous activities. NOTMARs are available online,[1] and email notifications can be received by registering online. Data on the number of NOTMARs issued from 2010 through 2015 for FDM and W-517 is presented in Section 3.12 (Socioeconomic Resources). As with other activities, the Navy posts NOTMARs at least 72 hours in advance of potentially hazardous training and testing activities at FDM. NOTMARs may extend restrictions out to 12 nautical miles as needed for certain training and testing activities to ensure the safety and protection of the public and the military.

Other communication outlets available to the public include the Joint Region Marianas (JRM) Public Affairs Office, which posts press releases on the JRM website and on the JRM Facebook page.[2] Interested members of the public can also follow the JRM on Twitter. Posts to the JRM Facebook page activate a Twitter post. Naval Base Guam Public Affairs posts press releases on the Naval Base Guam Facebook page,[3] and Naval Facilities Engineering Command, Marianas Public Affairs posts press releases on their Facebook page.[4]

Non-military activities are not permitted on or near FDM, and aircraft and marine vessels are restricted from entering within 3 nautical miles of FDM. Even when live fire or other potentially hazardous activities are not occurring at FDM, the threat of unexploded ordnance is always present. The military

[1] https://www.navcen.uscg.gov/?pageName=lnmDistrict&region=14
[2] https://www.facebook.com/jrmguam/
[3] https://www.facebook.com/USNavalBaseGuam/
[4] https://www.facebook.com/navfacmarianas/

prevents civilians from entering FDM when the range is scheduled for use by using visual observers on vessels that scan for non-participants in accordance with standard operating procedures. More details on these procedures are available in Section 5.7.3 (Farallon de Medinilla Access Restrictions) of the 2015 MITT Final EIS/OEIS.

Marine protected areas (MPAs) are marine areas that restrict certain human activities for conservation purposes. The 2015 MITT Final EIS/OEIS describes five MPAs (Section 3.13.2.1.1, Sea Space); however, Table 3.13-1 lists other MPAs that are located within the Study Area along with their primary conservation focus and fishing restrictions. Although fishing restrictions would decrease boat traffic within the MPAs, they could force fishermen to travel further offshore, which is more dangerous and also has the potential to overlap with other training and testing activities.

**Table 3.13-1: Marine Protected Areas within the Study Area**

| Marine Protected Area | Primary Conservation Focus | Fishing Restriction | Location |
|---|---|---|---|
| War in the Pacific National Historic Park | Cultural Heritage | Commercial and Recreational | Guam |
| Tokai Maru | Cultural Heritage | Commercial | Guam |
| Cormoran | Cultural Heritage | Commercial | Guam |
| Aratama Maru | Cultural Heritage | Commercial | Guam |
| Orote Ecological Reserve Area | Natural Heritage | N/A | Guam |
| Guam National Wildlife Refuge | Natural Heritage | Commercial and Recreational | Guam |
| Haputo Ecological Reserve Area | Natural Heritage | N/A | Guam |
| Sasanhaya Fish Reserve | Natural Heritage | Commercial and Recreational | Northern Mariana Islands |
| Lighthouse Reef Trochus Reserve | Natural Heritage | Commercial | Northern Mariana Islands |
| Laulau Bay Sea Cucumber Reserve | Natural Heritage | Commercial and Recreational | Northern Mariana Islands |
| Bird Island Marine Sanctuary | Natural Heritage | Commercial and Recreational | Northern Mariana Islands |
| Bird Island Sea Cucumber Reserve | Natural Heritage | Commercial and Recreational | Northern Mariana Islands |
| Forbidden Island Marine Sanctuary | Natural Heritage | Commercial and Recreational | Northern Mariana Islands |
| Tank Beach Trochus Reserve | Natural Heritage | Commercial and Recreational | Northern Mariana Islands |
| Managaha Marine Conservation Area | Cultural Heritage | Commercial and Recreational | Northern Mariana Islands |

**Table 3.13-1: Marine Protected Areas within the Study Area (continued)**

| Marine Protected Area | Primary Conservation Focus | Fishing Restriction | Location |
|---|---|---|---|
| Mariana Arc of Fire National Wildlife Refuge | Natural Heritage | N/A | At Sea |
| Mariana Trench Marine National Monument | Natural Heritage | Commercial and Recreational | At Sea |

Source: National Oceanic and Atmospheric Administration (2017)

#### 3.13.1.2 Airspace

General information on airspace within the Study Area can be found in the 2015 MITT Final EIS/OEIS (Section 3.13.2.1.2, Airspace); however, there have been changes to special use airspace within the Study Area in order to enhance safety. Changes include the addition of one new restricted area and new warning areas (U.S. Department of the Navy, 2015). These changes further separate non-military and military aviation activities, thereby enhancing safety. The military also requests that the Federal Aviation Administration issue Notices to Airmen to warn the public of upcoming military activities requiring the exclusive use of airspace. Military activity areas and special use airspace are identified on nautical and aeronautical charts to inform surface vessels and aircraft that military activities occur in the area. When necessary, airspace used by the military is restricted for short periods of time (typically on the order of hours) to cover the timeframes of training and testing activities. The Navy posts Notices to Airmen when restrictions are in place prior to initiating a training and testing activity, and the military follows standard operating procedures to visually scan an area to ensure that non-participants (i.e., civilian vessels and aircraft) are not present. More details on these procedures are available in Section 2.3.3 (Standard Operating Procedures) of this Supplemental EIS (SEIS)/OEIS. If non-participants are present, the military delays, moves, or cancels its activity. Public accessibility is no longer restricted once the activity concludes.

#### 3.13.1.3 Safety and Inspection Procedures

As stated in the 2015 MITT Final EIS/OEIS (Section 3.13.2.2, Safety and Inspection Procedures), the Navy adheres to policies that ensure the safety and health of military personnel and the public. This is accomplished by utilizing communication and notification channels provided by the U.S. Coast Guard and Federal Aviation Administration as described above, considering the location when planning activities, and ensuring that training and testing activity areas are clear of non-participants before commencing.

As discussed in the 2015 MITT Final EIS/OEIS (Section 3.13.2.2, Safety and Inspection Procedures), some training and testing activities use ordnance, and the type of ordnance used would be the same as identified in the 2015 MITT Final EIS/OEIS. As such, the procedures for handling and storing of ordnance remain applicable and valid.

##### 3.13.1.3.1 Aviation Safety

Navy procedures and policies detailing aviation safety are outlined in the 2015 MITT Final EIS/OEIS (Section 3.13.2.2.1, Aviation Safety). These policies include the Chief of Naval Operations Instruction 3770.2L and Department of the Defense Directive 4540.1, which specify procedures for planning and managing special use airspace, conducting aircraft maneuvers, and for firing missiles and projectiles over the high seas. Additional measures involve aircrews being responsible for maintaining a lookout for non-participating aircraft while operating in warning areas and other special use airspace, as well as the implementation of the Bird/Animal Aircraft Strike Hazard program, which is discussed in detail in the 2015 MITT Final EIS/OEIS (Section 3.13.2.2.1, Aviation Safety). These procedures and policies remain applicable and valid.

#### 3.13.1.3.2 Submarine Navigation Safety

Methods for preserving submarine navigation safety are discussed in the 2015 MITT Final EIS/OEIS (Section 3.13.2.2.2, Submarine Navigation Safety). These methods include avoiding collisions while surfaced by using visual scans, radar scans, acoustic depth finders, and satellite navigational systems, as well as avoiding areas with surface vessels while submerged by using inertial navigational charts. These methods remain applicable and valid in this SEIS/OEIS.

#### 3.13.1.3.3 Surface Vessel Navigational Safety

The Navy's methods for ensuring navigational safety for surface vessels are discussed in the 2015 MITT Final EIS/OEIS (Section 3.13.2.2.3, Surface Vessel Navigational Safety) and can involve practicing the fundamentals of safe navigation, posting lookouts to scan for navigational hazards, or utilizing support boats to determine that all safety criteria are met. These safety methods remain applicable and valid.

#### 3.13.1.3.4 Sound Navigation and Sounding (Sonar) Safety

Surface vessel and submarine sonar use is described in the 2015 MITT Final EIS/OEIS (Section 3.13.2.2.4, Sound Navigation and Sounding [Sonar] Safety). The Navy adheres to Naval Sea Systems Command Instruction 3150.2, Appendix 1A, which provides guidance for protecting divers during active sonar use. Guidance for protecting divers remains applicable and valid.

#### 3.13.1.3.5 Electromagnetic Energy Safety

The electromagnetic spectrum and the applications of electromagnetic radiation are described in the 2015 MITT Final EIS/OEIS (Section 3.13.2.2.5, Electromagnetic Energy Safety). Military aircraft, ships, and submarines follow standard operating procedures, which prevent people, ordnance, or fuels from receiving levels of electromagnetic energy that exceed hazardous thresholds. The standard operating procedures that are described in Section 2.3.3 (Standard Operating Procedures) of this SEIS/OEIS remain applicable and valid.

#### 3.13.1.3.6 Laser Safety

Lasers produce a coherent beam of light energy. The Navy uses lasers for precision range finding, as target designation/illumination devices for engagement with laser-guided weapons, for mine detection, for mine countermeasures, and for non-lethal deterrent. Testing activities include high-energy laser weapons tests to evaluate the specifications, integration, and performance of a vessel- or aircraft-mounted high-energy laser. Information regarding low-energy lasers can be viewed in the 2015 MITT Final EIS/OEIS (Section 3.13.2.2.6, Laser Safety). High-energy lasers were not analyzed in the 2015 MITT Final EIS/OEIS. The high-energy laser would be used as a weapon to disable small surface vessels. The Office of the Chief of Naval Operations Instruction 5100.27B/Marine Corps Order 5104.1C, *Navy Laser Hazards Control Program*, prescribes Navy and Marine Corps policy and guidance in the identification and control of laser hazards. The Navy observes strict precautions and has written instructions in place for laser users to ensure that non-participants are not exposed to intense light energy. Laser safety procedures for aircraft require an initial pass over the target before laser activation to ensure that target areas are clear. During actual laser use, aircraft run-in headings are also restricted to avoid or reduce unintentional contact with personnel or non-participants. Personnel participating in laser activities are required to complete a laser safety course (U.S. Department of the Navy, 2008).

#### 3.13.1.3.7 High-Explosive Ordnance Detonation Safety

Safety measures for high explosive detonations, particularly underwater explosions, are discussed in the 2015 MITT Final EIS/OEIS (Section 3.13.2.2.7, High-Explosive Ordnance Detonation Safety) and remain valid. General underwater detonation procedures involve ensuring impact areas are clear before commencing hazardous activities, coordinating with submarine operational authorities, and firing in accordance with current safety instructions.

#### 3.13.1.3.8 Weapons Firing and Ordnance Expenditure Safety

The safety and inspection procedures discussed in the 2015 MITT Final EIS/OEIS remain applicable and valid to this analysis. Safety continues to be a primary concern for all training and testing activities, and all hazard areas must be clear of all non-participants prior to any use of ordnance. Training and testing activities are delayed, moved, or cancelled if there is any question about public safety.

### 3.13.2 Environmental Consequences

The 2015 MITT Final EIS/OEIS (Section 3.13.3, Environmental Consequences) analyzed training and testing activities currently occurring in the Study Area and considered all potential stressors related to public health and safety. Stressors applicable to public health and safety in the Study Area are the same stressors analyzed in the 2015 MITT Final EIS/OEIS with the exception of explosive stressors. In the 2015 MITT Final EIS/OEIS, explosives were addressed under acoustic stressors; however, for purposes of this analysis, explosives are analyzed as a separate stressor. The following stressors were analyzed for public health and safety. Following each stressor is a list of substressors that have been updated from the 2015 MITT Final EIS/OEIS (Section 3.13.3, Environmental Consequences):

- Underwater Energy (sonar and in-water explosives)
- In-Air Energy (radar, in-air explosives, and lasers)
- Physical Interactions (aircraft, vessels, in-water devices/targets, munitions, seafloor devices)
- Secondary Stressors (impacts on water quality from explosives [in-air explosives and in-water explosives] and explosion byproducts, metals, chemicals other than explosives, and other materials)

This section evaluates how and to what degree potential impacts on public health and safety from stressors described in Section 3.0 (Introduction) may have changed since the analysis presented in the 2015 MITT Final EIS/OEIS was completed. Tables 2.5-1 and 2.5-2 in Chapter 2 (Description of Proposed Action and Alternatives) list the proposed training and testing activities and include the number of times each activity would be conducted annually and the locations within the Study Area where the activity would typically occur under each alternative. The tables also present the same information for activities described in the 2015 MITT Final EIS/OEIS so that the proposed levels of training and testing activities under this SEIS/OEIS can be easily compared. The Navy conducted a review of federal and state regulations and standards relevant to public health and safety and reviewed literature published since 2015 for new information that could supplement the analysis presented in the 2015 MITT Final EIS/OEIS.

The analysis presented in this section also considers standard operating procedures which are discussed in Section 2.3.3 (Standard Operating Procedures) of this SEIS/OEIS. The Navy would implement these measures to avoid or reduce potential impacts on public health and safety from stressors associated with the proposed training and testing activities.

#### 3.13.2.1 Underwater Energy

Sources of underwater energy are the same as those discussed in the 2015 MITT Final EIS/OEIS (Section 3.13.3.1, Underwater Energy) and include active sonar, underwater explosions, air guns, vessel movements, aircraft overflights, mine warfare devices, and unmanned underwater vehicles. Only recreational swimmers and scuba divers who are underwater and within an unsafe distance of training and testing activities would potentially be exposed to the underwater energy produced by these stressors.

The effect of active sonar on humans varies with the sonar frequency. Generally, mid- to low-frequencies have the greatest effect since they fall within the range of human hearing (20 hertz to 20 kilohertz). In addition to acoustic stressors, underwater explosions produce pressure waves that can cause physical injury depending on the size, type, and depth of the explosive charge and the distance between the person and the explosive. Electromagnetic energy sources and their potential impacts on public health and safety are discussed in the 2015 MITT Final EIS/OEIS (Section 3.13.3.1, Underwater Energy) and remain applicable in this discussion. In addition, standard safety buffers that are specified in Department of Defense Instruction 6055.11, *Protecting Personnel from Electromagnetic Fields* (U.S. Department of Defense, 2009), and Military Standard 464A, *Electromagnetic Environmental Effects: Requirements for Systems* (U.S. Department of Defense, 2002), would continue to be implemented to ensure public safety.

##### 3.13.2.1.1 Impacts from Underwater Energy Stressors Under Alternative 1

While the frequency of certain activities would increase under Alternative 1, the analysis of impacts on public health and safety from underwater energy presented in this SEIS/OEIS is not dependent on the number of activities that occur. Instead, the analysis discusses how likely an activity is expected to impact public health and safety regardless of how often it occurs. Therefore, increases shown in Tables 2.5-1 and 2.5-2 for activities proposed under Alternative 1 would have no appreciable change on the impact analysis or conclusions for underwater energy as presented in the 2015 MITT Final EIS/OEIS.

Standard operating procedures, which are described in Section 2.3.3 (Standard Operating Procedures) of this SEIS/OEIS, are in place to ensure that military activities do not overlap with non-military activities (e.g., boating, swimming, and fishing). Since the only potential receptors of underwater energy stressors are recreational swimmers and divers, training and testing activities that could affect public health and safety are often held far from popular swimming and dive areas, reducing the potential for exposure. The military's safety procedures would ensure that the potential for training and testing activities to impact public health and safety under Alternative 1 would be unlikely.

##### 3.13.2.1.2 Impacts from Underwater Energy Stressors Under Alternative 2

Similar to Alternative 1, the frequency of certain activities would increase under Alternative 2 (see Table 2.5-1 and Table 2.5-2 to see changes in frequency of specific activities). However, as explained above, this analysis is not dependent on the frequency of activities but instead on how likely an activity is to produce underwater energy that would impact public health and safety. Since the only potential receptors of underwater energy stressors are recreational swimmers and divers, training and testing activities that could affect public health and safety are often held far from popular swim and dive areas, reducing the potential for exposure. Furthermore, the military has safety procedures to ensure that the potential for training and testing activities to impact public health and safety under Alternative 2 would be unlikely.

#### 3.13.2.1.3 Impacts from Underwater Energy Stressors Under No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Underwater energy stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer underwater energy stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for underwater energy impacts on public health and safety, but would not measurably improve public health and safety.

### 3.13.2.2 In-Air Energy

In-air energy stressors include sources of electromagnetic energy and lasers, such as radar, navigational aids, high-energy lasers, and electronic warfare systems. Current practices for protecting military personnel and the public are described in the 2015 MITT Final EIS/OEIS (Section 3.13.3.2) and remain applicable to this analysis. In addition, procedures for laser safety are described above in Section 3.13.1.3.6 (Laser Safety) as well as in Section 2.3.3.5 (Pierside Testing Safety). Training and testing activities that involve electromagnetic energy and lasers are described in the 2015 MITT Final EIS/OEIS and now also includes high-energy laser use.

High-energy lasers are used as weapons to disable surface targets. The Navy would operate high-energy laser equipment in accordance with procedures defined in the Office of the Chief of Naval Operations Instruction 5100.23G, Navy Safety and Occupational Health Program Manual (U.S. Department of the Navy, 2011). These high-energy light sources can cause eye injuries and burns if directly hit with the laser. A comprehensive safety program exists for the use of lasers. Current Navy safety procedures protect individuals from the hazard of injuries caused by laser energy. Laser safety requirements for aircraft and vessels mandate verification that target areas are clear before commencement of an exercise. In the case of aircraft, during actual laser use, the aircraft run-in headings are restricted to preclude inadvertent lasing of areas where the public may be present.

#### 3.13.2.2.1 Impacts from In-Air Energy Stressors Under Alternative 1

The frequency of activities that generate in-air energy would increase under Alternative 1. This increase would result in an increase in ionizing radiation, which can negatively impact public health and safety following chronic exposure and from direct contact. However, repeat exposure would be limited and the impact of each exposure would be minimized due to existing safety procedures. Therefore, increases shown in Tables 2.5-1 and 2.5-2 for activities proposed under Alternative 1 would have no appreciable change on the impact analysis or conclusions for in-air energy as presented in the 2015 MITT Final EIS/OEIS.

High-energy lasers would be used during testing activities that were not previously analyzed. It is unlikely that the public would be exposed to high-energy lasers from testing activities because the Navy would not conduct these activities in proximity to the public and they would only occur in designated areas of the Mariana Islands Range Complex. Explosives would continue to be used at FDM, but the energy produced from these explosives would be contained within their weapon danger zones, which are restricted to the public and would not have the potential to impact public health and safety. Although there would be a general increase to the frequency of in-air energy stressors, standard operating procedures for electromagnetic energy and lasers would prevent personnel and non-participants from being exposed to these stressors. The military's safety procedures would ensure that the potential for training and testing activities to impact public health and safety under Alternative 1 would be unlikely.

#### 3.13.2.2.2 Impacts from In-Air Energy Stressors Under Alternative 2

Under Alternative 2, the number of proposed training and testing activities that would generate in-air energy would increase as compared to Alternative 1 (see Table 3.0-10, Table 3.0-16, and Table 3.0-19). However, as explained in Alternative 1, the increase in ionizing radiation exposure that would occur from increases in training and testing activities would result in only limited exposure due to existing safety procedures. Alternative 2 would also include the introduction of high-energy lasers; however, the standard operating procedures that pertain to the use of high-energy lasers and other in-air energy sources would prevent any energy being generated from impacting public health and safety. Therefore, the implementation of Alternative 2 would have no appreciable change on the impact conclusions presented in the 2015 MITT Final EIS/OEIS.

#### 3.13.2.2.3 Impacts from In-Air Energy Stressors Under No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. In-air energy stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer in-air energy stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for in-air energy impacts on public health and safety, but would not measurably improve public health and safety.

### 3.13.2.3 Physical Interactions

As discussed in the 2015 MITT Final EIS/OEIS (Section 3.13.3.3, Physical Interactions), military aircraft, vessels, targets, munitions, towed devices, seafloor devices, and other expended materials have the potential to directly encounter recreational, commercial, institutional, and governmental aircraft, vessels, and users such as swimmers, divers, and anglers. Methods for providing notice to non-participants of Navy training and testing activities, procedures for minimizing encounters with military expended materials, and a discussion of unexploded ordnance are all outlined in the 2015 MITT Final EIS/OEIS (Section 3.13.3.3, Physical Interactions) as well as in previous sections 3.13.1.1.1 (Sea Space), 3.13.1.2 (Airspace), and 3.13.1.3 (Safety and Inspection Procedures).

#### 3.13.2.3.1 Impacts from Physical Interaction Stressors Under Alternative 1

Under Alternative 1, there would be a general increase in activities involving vessel movements, as shown in Table 3.0-12. Increases in the frequency of vessel movements would increase vessel traffic and the probability for a physical interaction to occur between naval vessels and non-participating vessels. However, standard operating procedures and safety and inspection procedures would be in place to reduce the potential for non-participants and personnel to be physically impacted by training and testing activities. The military's safety procedures are designed to ensure that the potential for training and testing activities to impact public health and safety under Alternative 1 would be unlikely.

#### 3.13.2.3.2 Impacts from Physical Interaction Stressors Under Alternative 2

Under Alternative 2, the number of training and testing activities involving vessel movement would increase as compared to Alternative 1. However, as described in Alternative 1, the standard operating procedures and safety inspection procedures that are in place would prevent the increase in frequency of vessel movements from impacting public health and safety. Therefore, under Alternative 2, increases shown in Tables 2.5-1 and 2.5-2 would have no appreciable change on the impact conclusions presented in the 2015 MITT Final EIS/OEIS.

#### 3.13.2.3.3 Impacts from Physical Interaction Stressors Under No Action Alternative

Under the No Action Alternative, proposed training and testing activities would not occur. Other military activities not associated with this Proposed Action would continue to occur. Physical interaction stressors as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer physical interaction stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for physical interactions to impact public health and safety, but would not measurably improve public health and safety.

#### 3.13.2.4 Secondary Stressors

As discussed in the 2015 MITT Final EIS/OEIS (Section 3.13.3.4, Secondary Impacts), public health and safety has the potential to 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, Commonwealth of the Northern Marianas Islands (CNMI), or federal standards or guidelines would be violated under any of the alternatives. Although a general increase in training and testing activities and military expended materials would occur, training and testing activities would not significantly degrade sediment or water quality or contaminate the food supply as discussed in Sections 3.1 (Sediments and Water Quality) and 3.9 (Fishes). In addition, because standards and guidelines are structured to protect human health, and no violations would occur, no secondary impacts on public health and safety would result from training and testing activities. Sections 3.9 (Fishes) and 3.12 (Socioeconomic Resources) discuss the impacts that the Proposed Action would have on fish and fisheries in the Study Area.

### 3.13.3 Public Scoping Comments

The public raised a number of issues during the scoping period in regard to public health and safety. The issues are summarized in the list below.

- **Impacts of sonar testing on human swimmers and divers –** Swimmers and recreational divers are not expected to be near training and testing activity locations where active sonar activities would occur because of the strict procedures for clearance of nonparticipants before conducting activities. As discussed in the 2015 MITT Final EIS/OEIS (Section 3.13.3.1, Underwater Energy), 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 dive at depths not exceeding 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. In addition, 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, dive boats are typically well marked, and diver-down flags would be visible from the Navy ships conducting training and testing activities. Therefore, co-occurrence of recreational divers and Navy activities is unlikely.

- **Potential risks from unexploded ordnance –** As discussed in the 2015 MITT Final EIS/OEIS (Section 3.13.3.3, Physical Interactions), munitions have low failure rates and generally 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 procedures 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. More information can be viewed at the following link: http://uxoinfo.com/blogcfc/client/enclosures/uxooverview.pdf.
- **Impacts on water quality from explosives, unexploded ordnance, and military expended materials –** As discussed in Section 3.1.4 (Summary of Potential Impacts [Combined Impact of All Stressors] on Sediments and Water Quality) of the 2015 MITT Final EIS/OEIS, additive impacts from explosives, explosive byproducts, metals, chemicals other than explosives, and miscellaneous other materials would be measureable but would not exceed applicable standards and guidelines, which indicate the levels where there would be an impact on human health. The impact analysis in Section 3.1 (Sediments and Water Quality) of this SEIS/OEIS addresses impacts on water quality from all sources associated with the Proposed Action and indicates that there would be no appreciable change from the environmental baseline.
- **Chemical exposure to humans from training and testing activities –** As discussed in Section 3.2.4 (Summary of Potential Impacts [Combined Impacts of All Stressors] on Air Quality) of the 2015 MITT Final EIS/OEIS, emissions associated with Study Area military operations primarily occur offshore. Fixed-wing aircraft emissions typically occur above the 3,000 feet (914 meters) mixing layer. Even though these stressors can co-occur in time and space, atmospheric dispersion would occur so that the impacts would be short term. Changes in criteria and hazardous air pollutant emissions are not expected to be detectable, so the air quality is expected to fully recover before a subsequent activity. For these reasons, impacts on air quality from combining these resource stressors are expected to be similar to the impacts on air quality for any of these stressors taken individually with no additive, synergistic, or antagonistic interactions.

- **Training and testing activity safety measures to prevent harm to the CNMI economy –** A number of standard operating procedures, which were described in Section 2.3.3 (Standard Operating Procedures) of this SEIS/OEIS as well as the safety and inspection procedures discussed in Section 3.13.1.3 (Safety and Inspection Procedures) above are in place to ensure that military activities do not interfere or pose health risks to the public. There are no known instances of harm to the economy within the Study Area that have been reported due to safety measures associated with current training and testing activities. Standard operating procedures allow fishermen to continue to use the ocean without fear and allow tourists to come to the CNMI without reservations.
- **Fishermen safety –** As discussed above in Section 3.13.1.1.1 (Sea Space), the Navy uses Local NOTMARs, NOTMARs, and Marine Broadcast NOTMARs to advise local mariners of scheduled training and testing activities to avoid encountering fishers and boaters. In addition, the Navy also follows standard operating procedures that prevent military activities from occurring in the presence of non-participants. These standard operating procedures include ensuring impact areas and targets are unpopulated prior to potentially dangerous activities, canceling or delaying activities if public or personnel safety is a concern, and implementing temporary access restrictions to training and testing areas when appropriate to ensure public safety.
- **Spills and accidental releases of fuel or other hazardous materials –** Navy policies and procedures identified in Navy instructions, such as the *Environmental Readiness Program Manual*, include directives regarding waste management, pollution prevention, and recycling. These instructions are mandatory and minimize the likelihood of spills or accidental releases of fuel or other hazardous materials.
- **Health risks from a contaminated food supply –** The Record of Decision for the 2015 MITT Final EIS/OEIS indicated that there would be a negligible impact on water quality and that it would not affect the marine environment. Since there would be no significant change in water quality, and fish would not ingest increased amounts of contaminants as discussed in Section 3.9 (Fishes), the food supply would not be contaminated from proposed activities.

# REFERENCES

National Oceanic and Atmospheric Administration. (2017). *The MPA Inventory*. Retrieved from https://marineprotectedareas.noaa.gov/dataanalysis/mpainventory/.

Professional Association of Diving Instructors. (2011). *Scuba Certification Frequently Asked Questions*. Retrieved from http://www.padi.com/scuba/scuba-diving-guide/start-scuba-diving/scuba-certification-faq/default.aspx.

U.S. Department of Defense. (2002). *Electromagnetic Environmental Effects: Requirements for Systems*. (MIL-STD-464A). Wright-Patterson Air Force Base, OH: U.S. Air Force/Aeronautical Systems Center.

U.S. Department of Defense. (2009). *Protecting Personnel from Electromagnetic Fields*. (DoD Instruction 6055.11). Washington, DC: Under Secretary of Defense for Acquisition, Technology, and Logistics.

U.S. Department of the Navy. (2008). *Navy Laser Hazards Control Program OPNAVINST 5100.27B/Marine Corps Order 5104.1C*. Washington, DC: Office of the Chief of Naval Operations and Headquarters United States Marine Corps.

U.S. Department of the Navy. (2011). *Navy Safety and Occupational Health Program Manual*. (OPNAVINST 5100.23G CH-1). Washington, DC: U.S. Department of the Navy.

U.S. Department of the Navy. (2015). *Draft Commonwealth of the Northern Mariana Islands Joint Military Training Environmental Impact Statement/Overseas Environmental Impact Statement*. Honolulu, HI: Department of Interior, Office of Insular Affairs, Federal Aviation Administration, International Broadcasting Bureau, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, and U.S. Army Corps of Engineers.

# 4 Cumulative Impacts

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# 4 Cumulative Impacts

## 4.1 Principles of Cumulative Impacts Analysis

The approach taken herein to analyze cumulative effects meets the objectives of the National Environmental Policy Act (NEPA) of 1969, Council on Environmental Quality (CEQ) regulations, and CEQ guidance, and has not changed from the approach as described in the 2015 Mariana Islands Training and Testing (MITT) Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) (Council on Environmental Quality, 1997; U.S. Department of the Navy, 2015a).

### 4.1.1 Determination of Significance

Per the CEQ's *Considering Cumulative Effects Under the NEPA* (Council on Environmental Quality, 1997), the "levels of acceptable change used to determine the significance of effects will vary depending on the type of resource being analyzed, the condition of the resource, and the importance of the resource as an issue." Furthermore, "this change is evaluated in terms of both the total threshold beyond which the resource degrades to unacceptable levels and the incremental contribution of the proposed action to reaching that threshold." In practice, "the analyst must determine the realistic potential for the resource to sustain itself in the future and whether the proposed action will affect this potential." In other words, for a proposed action to have a cumulatively significant impact on an environmental resource, two conditions must be met. First, the combined effects of all identified past, present, and reasonably foreseeable projects, activities, and processes on a resource, including the effects of the proposed action, must be significant. Second, the proposed action must make a measurable or meaningful contribution to that significant cumulative impact.

### 4.1.2 Identifying Region of Influence for Cumulative Impacts Analysis

The region of influence for analyses of cumulative impacts can vary for different resources and environmental media. CEQ guidance (Council on Environmental Quality, 1997) indicates that the region of influence for cumulative impacts almost always should be expanded beyond those for the project-specific analyses. This guidance continues, indicating that one way to evaluate the region of influence is to consider the distance an effect can travel, and it identifies potential cumulative assessment boundaries accordingly. For air quality, the potentially affected air quality regions are the appropriate boundaries for assessment of cumulative impacts from releases of pollutants into the atmosphere. For water resources and land-based effects, watershed boundaries may be the appropriate regional boundary. For wide-ranging or migratory wildlife, specifically marine mammals, fish, sea turtles, and marine birds, any impacts of the Proposed Action might combine with the impacts of other activities or processes within the range of the population.

The region of influence for evaluating the cumulative impacts of the Proposed Action are defined for each resource in Section 4.4 (Resource-Specific Cumulative Impacts). The basic geographic boundary for the majority of resources analyzed for cumulative impacts in this Supplemental EIS (SEIS)/OEIS is the entire MITT Study Area (Figure 2.1-1). The region of influence for cumulative impacts analysis for some resources are expanded to include activities outside the Study Area that might impact migratory or wide-ranging animals. Other activities potentially originating from outside the Study Area that are considered in this analysis include impacts associated with maritime traffic (e.g., vessel strikes and underwater noise) and commercial fishing (e.g., bycatch and entanglement).

## 4.2 Projects and Other Activities Analyzed for Cumulative Impacts

The cumulative analysis includes consideration of past, present, and reasonably foreseeable future actions that overlap in time and space with the Proposed Action. Actions and projects that have been added to this cumulative analysis since the 2015 MITT Final EIS/OEIS include the Saipan water system improvements project, the wastewater system for Saipan, the Saipan Resort Hotel, the Plumeria Resort and Casino, aquaculture, and undersea communications cables. For past actions, the cumulative impacts analysis only considers those actions or activities that have had ongoing impacts that may be additive to impacts of the Proposed Action. Likewise, present and reasonably foreseeable future actions selected for inclusion in the analysis are those that may have effects additive to the effects of the Proposed Action as experienced by specific environmental receptors.

The cumulative impacts analysis makes use of the best available data, quantifying impacts where possible and relying on the qualitative description and best professional judgment where detailed measurement is unavailable. Because specific information and data on past projects and actions are typically scarce, the analysis of past effects is often qualitative (Council on Environmental Quality, 1997). Likewise, analysis of ongoing actions is often inconsistent or unavailable. All likely future development or use of the region is considered to the greatest extent possible, even when a foreseeable future action is not planned in sufficient detail to permit complete analysis (Council on Environmental Quality, 1997).

The cumulative impacts analysis is not bound by a specific future timeframe. The Proposed Action includes general types of activities addressed by this SEIS/OEIS that are expected to continue indefinitely, and the associated impacts could 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., seismic surveys, maritime traffic, commercial fishing). While Navy training and testing activities requirements change over time in response to world events, 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, and the Navy anticipates preparing new or supplemental environmental planning documents covering changes in training and testing activities in the Study Area as necessary. These future environmental planning documents would include cumulative impacts analysis based on information available at that time.

Table 4.2-1 lists the other actions and other environmental considerations identified for the cumulative impacts analysis, including activities presented in the 2015 MITT Final EIS/OEIS with updated information. Descriptions of each action and environmental consideration carried forward for analysis are provided in the following sections. For the perspective of general project locations, please refer to Figures 2.1-1 through 2.1-4, which depict the Study Area, boundaries of individual training and testing activities locations, and large marine ecosystems and open ocean areas within and adjacent to the Study Area.

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| ***Military Mission, Testing, and Training Activities*** | | | | | | |
| CNMI Joint Military Training (CJMT) | Commonwealth of the Northern Mariana Islands | The Draft 2015 Commonwealth of the Northern Mariana Islands (CNMI) Joint Military Training (CJMT) EIS/OEIS (U.S. Department of the Navy, 2015b) evaluated the potential impacts associated with alternatives for meeting U.S. Pacific Command Service Components' unfilled unit-level training and combined level of military training requirements in the Western Pacific.<br>The proposed action would establish a series of live-fire and maneuver ranges and training areas, expand existing ranges and training areas, and construct new ranges and training areas within the CNMI including amphibious operations on Tinian. The Notice of Intent to complete the EIS/OEIS was published in the Federal Register on March 14, 2013. Following an in-depth review of public comments on the proposed construction of military training areas in CNMI, and consultation with CNMI Governor Ralph Torres, the Department of Defense (DoD) will issue a Revised Draft EIS for its proposed actions for the CJMT. The revision is expected to be released in Fall 2019, followed by another public comment period and public meetings. Following the subsequent public comment period, the DoD expects to have a signed Record of Decision in 2020. The resources evaluated that could contribute to cumulative impacts include geology and soils, water resources, air quality, noise, airspace, land and submerged land use, recreation, terrestrial biology, marine biology, cultural resources, visual resources, transportation, utilities, socioeconomics and environmental justice, hazardous materials and waste, and public health and safety. | Resource management measures include avoidance and minimization measures, best management practices, and standard operating procedures. | | | C/O |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| Divert Activities and Exercises | Saipan and Tinian | The U.S. Air Force proposed improvements to an existing airfields near the Philippine Sea in support of expanding mission requirements in the western Pacific, along with divert capabilities for current, emerging, and future training activities. A Draft EIS analyzing environmental impacts associated with the divert activities and exercises was published in June 2012, and found that there could be major adverse effects from the construction phase of the project on cultural resources, socioeconomics and environmental justice, and human health and safety within the project area. The U.S. Air Force published a Revised Draft Divert EIS in 2015 and released a Final EIS and Record of Decision in 2016 (U.S. Department of the Air Force, 2016).<br>The U.S. Air Force selected the preferred alternative, Alternative 2 - Modified Tinian Alternative and specifically the North Option as the location to implement the proposed action described in the Divert EIS. In spring of 2018 the U.S. Air Force published the intention to prepare a Supplemental EIS to assess the potential environmental consequences associated with proposed Tinian Divert Infrastructure Improvements. The U.S. Air Force now proposes to construct a fuel pipeline, and associated infrastructure at the seaport, to transport fuel from the seaport to the airport. Therefore, the U.S. Air Force also proposes to improve certain existing roads between the seaport and airport that would be used to support Divert-related projects. Additional information about the proposed action is provided on the project website. Therefore, this project may contribute to the cumulative impacts on natural, noise, cultural and socioeconomic resources in the Study Area. | Mitigation measures will be implemented to minimize, avoid, rectify, reduce, or compensate for potential impacts on specific resource areas. There are mitigation measures for noise during construction, air quality, airspace and airfield environment, geology and soils, water resources, terrestrial biological resources, cultural resources, land use, hazardous materials and wastes, infrastructure and utilities, socioeconomics and environmental justice, and human health and safety. | C | O | C/O |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| Foreign Navies Training and Testing Activities | Study Area | As the navies of the world increase their "blue water" capabilities, the presence of foreign military within the Study Area will also likely increase. Foreign military vessels currently transit through the Global Commons and international waters within the Study Area while in route to and from Guam, Hawaii, and other locations in and bordering the Pacific. As the extent of naval activities conducted by sovereign vessels and embarked aircraft while in the MITT is not quantified nor quantifiable, it is very likely that routine systems checks as well as opportunistic training and testing occurs. The resources impacted by ongoing and proposed MITT activities would also be exposed to similar stressors (e.g., acoustics from sonar and explosives, vessel strike) introduced by foreign vessels and aircraft conducting training and testing activities not related to the MITT Proposed Action. | | O | O | O |
| Guam and Commonwealth of the Northern Mariana Islands (CNMI) Military Relocation EIS/Guam CNMI Military Relocation (2012 Roadmap Adjustments) SEIS | Guam | In July 2015, the Final SEIS Guam and Commonwealth of the Northern Mariana Islands Military Relocation (2012 Roadmap Adjustments) was completed (U.S. Department of the Navy, 2015a). The Final SEIS analyzed the potential environmental impacts of five action alternatives for the family housing component of the proposed action and five action alternatives for the live-fire training range complex component, plus a no action alternative. The proposed action was to construct and operate a cantonment area, family housing, and a Live-Fire Training Range Complex on Guam to support the Marine Corps relocation. The Navy selected the preferred alternative as described in the Final 2015 SEIS. The preferred alternative included cantonment and family housing Alternative E with the U.S. Marine Corps cantonment to be located at Navy Computer and Telecommunications Station – Guam (Finegayan), | Mitigation measures will be implemented to minimize, avoid, rectify, reduce, or compensate for potential impacts on specific resource areas. There are mitigation measures for water resources, terrestrial biological resources, marine biological resources, cultural resources, utilities, | C | C | O |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| | | and family housing to be located at Andersen Air Force Base. The Live-Fire Training Range Complex option selected was Alternative 5, to be located at Andersen Air Force Base – Northwest Field. The Live-Fire Training Range Complex also includes a stand-alone hand grenade range at Andersen South. The Record of Decision for the SEIS includes cantonment and family housing at the Navy Computer and Telecommunications Station in the Finegayan area of Guam, and family housing to be located at Andersen AFB. The Live Fire Training Range Complex would be located at Andersen AFB, Northwest Field and includes a stand-alone hand grenade range at Andersen South (U.S. Department of the Air Force, 2016).<br><br>Potential impacts were analyzed for geological and soil resources, water resources, air quality, noise, airspace, land and submerged land use, recreational resources, terrestrial biological resources, marine biological resources, cultural resources, visual resources, ground transportation, marine transportation, utilities, socioeconomics and general services, hazardous materials and waste, public health and safety, and environmental justice. Continuing cumulative impacts could occur for water resources, air quality, noise, airspace, recreational resources, terrestrial biological resources, ground transportation, utilities, and socioeconomics and general services. | socioeconomics, and environmental justice and the protection of children. | | | |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| Surveillance Towed Array Sensor System Low Frequency Active Sonar | Pacific Ocean, Atlantic Ocean, Indian Ocean, and the Mediterranean Sea | The Navy utilizes Surveillance Towed Array Sensor System Low Frequency Active Sonar systems onboard several T-AGOS class vessels in the western and central North Pacific Ocean, not including polar waters, and the southwestern Indian Ocean. The Navy is currently conducting covered SURTASS LFA sonar activities pursuant to a National Defense Exemption (under the Marine Mammal Protection Act). This exemption expires in August 2019, and Navy is in the process of updating its relevant environmental planning and compliance documents. The underwater sound produced by this activity may contribute to the cumulative impacts on marine mammals and sea turtles in the Study Area (U.S. Department of the Navy, 2012). The underwater sound produced by this project may contribute to the cumulative impacts on marine mammals and sea turtles in the Study Area. | The objective of mitigation for the employment of Surveillance Towed Array Sensor System Low Frequency Active Sonar is to reduce or avoid 12 potential exposures of marine mammals, sea turtles, and human divers to Surveillance Towed Array Sensor System Low Frequency Active Sonar transmissions. | O | O | O |
| Terminal High-Altitude Area Defense (THAAD) Permanent Stationing in Guam | Andersen Air Force Base, Guam | The Environmental Assessment (EA) for this project documents the environmental impacts associated with the expeditionary (temporary) placement and operation of a THAAD ballistic missile defense battery at Andersen Air Force Base in Guam, and from the proposed permanent stationing of the THAAD battery at its current location on Northwest Field (NWF). As a secondary, connected action to the expeditionary deployment and proposed permanent stationing of the THAAD battery in Guam, this EA also analyzes the potential impacts from the expansion of the NWF cargo drop zone training area that was encumbered by THAAD operations (U.S. Army, 2015). | | C/O | O | O |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| ***Other Commercial Industries*** | | | | | | |
| Aquaculture | Oceans worldwide (including the Guam Aquaculture and Development Training Center in Mangilao [Fadian Hatchery]) | Aquaculture is the farming of aquatic organisms such as fish, shellfish, and plants. Globally, 29 percent of stocks are fished at biologically unsustainable levels, and aquaculture helps meet demand and offsets stress to wild populations (National Marine Fisheries Service, 2015a). Aquaculture production reached an all-time high of 97 million metric tons in 2013 and is the fastest-growing form of food production, at 6 percent per year globally. Forty-seven percent of aquaculture operations occur in the Pacific Ocean. On Guam, the largest and oldest aquaculture center in the Western Pacific, the Fadian Hatchery, has been operating since the 1970s. A recent bill would expand aquaculture in Guam and improve the facilities at the Fadian Hatchery.<br><br>The threats of aquaculture operations on wild fish populations include reduced water quality, competition for food, predation by escaped or released farmed fishes, the spread of disease and parasites, and reduced genetic diversity (Kappel, 2005). These threats become apparent when farmed fish escape and enter the natural ecosystem (Hansen & Windsor, 2006; Ormerod, 2003). The Marine Aquaculture Policy provides direction to enable the development of sustainable marine aquaculture (National Marine Fisheries Service, 2015a). | | C/O | C/O | C/O |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe<br>C = Construction<br>O = Operation<br>X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| Coastal Land Development and Tourism | Coastline | 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 non-point source pollution, concentrated recreational use, intensive ship traffic using major port facilities, and coastal tourism (e.g., hotels, resorts, restaurants, food industry, vacation homes, second homes) and supporting infrastructure (e.g., retail businesses, marinas, fishing tackle stores, dive shops, fishing piers, recreational boating harbors, beaches, recreational fishing facilities).<br>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.<br>Coastal development intensifies use of coastal resources through dune and nearshore habitat loss and disturbance, point and non-point source water pollution, entrainment in outflows and other structures, and air quality degradation.<br>Self-contained underwater breathing apparatus (SCUBA) and snorkeling have the potential to degrade reef systems through disturbance and collecting. Collisions between whale-watching ships and whales are common.<br>Temporary permits could be obtained from the CNMI Homeland Security and Emergency Management Office for various ecotourism activities. It is anticipated these activities would occur in the future (U.S. Department of the Navy, 2015b). | Site-specific mitigation often determined during Coastal Consistency Review by the Guam Coastal Management Program and the Commonwealth of the Northern Mariana Islands Coastal Zone Management Program | C/O | C/O | C/O |
| Commercial | Pacific Ocean | Commercial fishing constitutes an important and widespread use of the | Various bycatch | O | O | O |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe<br>C = Construction<br>O = Operation<br>X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| Fishing | | ocean resources throughout the Study Area, and can adversely affect marine species and habitats. Potential impacts 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 non-targeted 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.<br>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. The analysis concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance of coastal ecosystems, including pollution and anthropogenic climate 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). Therefore, commercial fishing may contribute to cumulative impacts on marine mammals, sea turtles, fish, and marine habitats in the Study Area. | mitigation technologies, quotas, and seasonal restrictions required per the fishery-specific permit process | | | |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| Grand Mariana Casino and Hotel Resort | Garapan | This project plans for potentially up to 2,000 hotel rooms in stages, beginning with a 250-room hotel and casino (U.S. Department of the Air Force, 2016). | | | | C/O |
| Maritime Traffic | Pacific Ocean | 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, the introduction of non-native species through ballast water, and underwater sound from ships and other vessels. Therefore, maritime traffic may contribute to the cumulative impacts on marine mammals and sea turtles in the Study Area.<br>Additionally, air and water quality in busy ports can be diminished due to engine emissions and fuel leaks. Secondary impacts include maintenance of port infrastructure, which often includes dredging requirements to maintain channel depths, and habitat loss and degradation in coastal habitats. | Continued adherence to state and federal marine traffic and operations regulations | O | O | O |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| Plumeria Resort and Casino | Tinian | Construction on this project is expected to begin in mid-2018 and is slated to occur into 2027. The hotel would include over 6,000 accommodation units and be built in three phases to include villas, a casino, golf course, water park, shops, restaurants, and new roads over 151 hectares of property at Puntan Diablo Cove on Tinian (U.S. Department of the Air Force, 2016). The resources evaluated that could contribute to cumulative impacts include water resources, air quality, cultural resources, geology and soils, terrestrial resources, and socioeconomic resources. | | | C | C/O |
| Project ATISA | Undersea between Guam, Saipan, Rota, and Tinian | The DoCoMo Pacific and NEC Corporation built a 175-mile optical fiber cable system that connects Guam and the CNMI and offers new wireless, cable TV, home phone, and broadband services. | | C | O | O |
| Recreational and Cultural Fishing | Pacific Ocean | Recreational and cultural fishing includes impacts from vessel traffic (e.g., strike, noise, water pollution, marine debris) and can compound impacts on fish stocks already experiencing exploitation. Recreational and cultural fishing and boat traffic usually occurs nearshore rather than in the deeper open ocean, and recreational/cultural traffic typically frequents popular locations, which can concentrate damage in these areas from anchors or other bottom-disturbing equipment. | Operational regulations, seasonal restrictions, licensing, and quotas used to manage to mitigate negative effects of recreational and cultural fishing | O | O | O |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| Saipan Resort Hotel | Saipan | The project entailed the construction of a 300-room resort hotel immediately north of the Pacific Islands Club on Saipan. Construction included a batching plant and warehouse and occurred between 2014 and 2016 (U.S. Department of the Air Force, 2016). The resources evaluated that could contribute to cumulative impacts include geology and soils, terrestrial resources, and socioeconomic resources. | | C | O | O |
| Saipan Water System Improvements | Saipan | The project will provide focus and direction for meeting a U.S. EPA stipulated order to meet Clean Water Act and the Safe Drinking Water Act requirements in Saipan on existing water quality outputs. Construction of the project began in 2012 and is expected to occur through 2020 (U.S. Department of the Air Force, 2016). The resources evaluated that could contribute to cumulative impacts include public health and safety, socioeconomic resources, and water quality. | | C | C | C/O |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| Seismic Surveys | Waters near the Study Area in the Territory of Guam and the Commonwealth of the Northern Mariana Islands | 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. Also, 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 referenced to 1 micropascal root mean square, which would in turn potentially result in temporary or permanent loss of hearing (Bureau of Ocean Energy Management, 2011). All seismic surveys conducted by U.S. vessels are subject to the Marine Mammal Protection Act (MMPA) authorization process administered by the National Marine Fisheries Service (NMFS), as well as the NEPA process associated with issuing MMPA authorizations. Currently, there is one MMPA authorization in the process for seismic surveys near the Study Area in the Territory of Guam and the Commonwealth of the Northern Mariana Islands for a Programmatic Environmental Assessment for Fisheries and Ecosystem Research conducted and funded by the Pacific Islands Fisheries Science Center. | | O | O | O |
| Tinian Airport Improvements | Airport on Tinian | The project includes (1) relocation of the Aircraft Rescue and Fire Fighting Facility building, (2) terminal improvements, (3) acquisition of a 1,500-gallon Aircraft Rescue and Fire Fighting Facility vehicle, and (4) a new water line (U.S. Department of the Air Force, 2016). | | C | C | O |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| Tinian Seaport Improvements | Seaport at Tinian | This project would include development of an immigration and customs facility, brown tree snake inspection area, and fire suppression pump house (U.S. Department of the Air Force, 2016). | | | | C |
| Undersea Communications Cables | Pacific Ocean/ Connections between Guam and Hawaii and Asia | Submarine cables provide the primary means of voice, data, and Internet connectivity between the mainland United States and the rest of the world (Federal Communications Commission, 2017). The Federal Communications Commission grants licenses authorizing cable applicants to install, own, and operate submarine cables and associated landing stations in the United States. Cables are installed by specialized boats across flat ocean surfaces and dug into the seabed in shallow areas. Over 550,000 miles of cables currently exist in the world's oceans.<br>SEA-US trans-Pacific cables will be routed to avoid congested earthquake prone regions and to optimize stable connectivity between the United States and Asia with landing stations in Hawaii and Guam. DoCoMo's ATISA network also is in operation and connects Guam, Saipan, Rota, and Tinian. Other telecom and consortiums continue to discuss the potential submarine cable projects in the region. Cable networks will continue to be updated in the future creating job opportunities and benefits to professions where cables connect users to the internet for less cost (Losinio, 2017).<br>Potential impacts of installation and maintenance activities would include noise and vessel strike from boat traffic and increased seafloor disturbance and sedimentation in localized areas where the cable is installed. Likewise, electromagnetic fields are generated by some cables that may be sensed by and affect the migration behavior of some fish, sharks, rays, and eels (Bureau of Ocean Energy Management, 2016). | Continued adherence to international marine construction and operational regulations | C/O | C/O | C/O |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| Wastewater System for Saipan | Guam | The project is updating the existing water/sewer system due to a U.S. Federal Court order. The rehabilitated water/sewer system will be compliant with U.S. Environmental Protection Agency (EPA) requirements. Construction of the project began in 2012 and is expected to occur through 2020 (U.S. Department of the Air Force, 2016). The resources evaluated that could contribute to cumulative impacts include public health and safety, socioeconomic resources, and water quality. | | C | C | C/O |
| ***Research and Conservation*** | | | | | | |
| Academic Research | Global | Wide-scale academic research is conducted in the Study Area by federal entities, such as the Navy and National Oceanic and Atmospheric Administration/NMFS, as well as state and private entities and other partnerships.<br>Although academic research aims to capture data without disturbing the ambient conditions of the ocean environment, vessels contribute to traffic, noise, and strike hazard; seismic activity contributes noise; and various other collection methods, such as trawling, could be disruptive to the ecosystems under observation. Impacts from academic research operations can be similar to the impacts expected from oil and gas airgun survey activities, when an airgun array that emits acoustic energy in timed intervals behind a research vessel is used. | NMFS and local government programs manage scientific research permits for certain activities | O | O | O |
| Pollution Prevention Grant | CNMI | The CNMI Bureau of Environmental and Coastal Quality provided this grant to support CNMI programs that reduce the environmental impact of local businesses significantly. The impacts of the programs the grant supported were to reduce pollution in air, water, and land during construction and operations by setting requirements and conditions for the Bureau of Environmental and Coastal Quality's permitting process. | | O | O | O |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe<br>C = Construction<br>O = Operation<br>X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| ***Ocean Pollution and Ecosystem Alteration*** | | | | | | |
| Noise | Global | Ambient noise is the collection of ever-present sounds of both natural and human origins. Ambient noise in the ocean is generated by sources that are natural such as physical (e.g., earthquakes, rainfall, waves breaking, and lightning hitting the ocean), biological (e.g., snapping shrimp and the vocalizations of marine mammals), and anthropogenic (human-generated) sources.<br>Anthropogenic sources have substantially increased ocean noise since the 1960s, and include commercial shipping, oil and gas exploration and production activities (including air gun, sonar, drilling, and explosive decommissioning), commercial and recreational fishing (including vessel noise, fish-finding sonar, fathometers, and acoustic deterrent and harassment devices), military (testing, training, and mission activities), shoreline construction projects (including pile driving), recreational boating and whale-watching activities, offshore power generation (including offshore wind farms), and research (including sound from air guns, sonar, and telemetry). The contribution of military and non-military vessel traffic to the underwater noise experienced in the Study Area is discussed in Section 3.0.4.1.2 (Vessel Noise). | | O | O | O |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| Marine Debris Section 3.1.1.1.1 (Marine Debris and Water Quality) | Global | 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 polychlorinated biphenyl and dichlorodiphenyltrichloroethane, which accumulate up to one million times more in plastic than in ocean water (Mato et al., 2001). Fish, marine animals, and birds can mistakenly consume these wastes that contain 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 12,000–24,000 U.S. tons of plastic debris a year (Davison & Asch, 2011). | | O | O | O |

### Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| Pollution (Section 3.1, Sediments and Water Quality) | Global | Common ocean pollutants are derived from land-based activities and 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 non-point sources (stormwater runoff from watersheds), point sources (wastewater treatment plant discharges), other land-based sources (windblown debris), spills, dumping, vessels, and atmospheric deposition. Bilgewater is a mix of water, oily fluids, lubricants, grease, cleaning fluids, and other wastes that are pumped out periodically from vessel holding tanks, either to a reception facility onshore or treated with a bilge oil-separator and discharged at sea. Discharging sewage is largely prohibited under the Clean Water Act. The main risk of oil or other petroleum product spills is from ships, whether carrying petroleum to and from ports or in fuel tanks, and from pipelines and onshore facilities that transport and store oil and gas. | | O | O | O |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe<br>C = Construction<br>O = Operation<br>X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| Climate Change (Section 3.2, Air Quality) | Global | Predictions of long-term negative environmental impacts, some of which have begun to occur at present, due to climate change include sea level rise; changes in ocean surface temperature, acidity/alkalinity, 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, fecundity, and productivity. A special report by the Intergovernmental Panel on Climate Change discussed the long-term warming trend observed since pre-industrial times (Intergovernmental Panel on Climate Change, 2018), and how higher than the global annual average temperatures are being experienced in many land regions and seasons. An example of the increase in the severity of storms occurred in October 2018. Typhoon Yutu had sustained winds of 180 miles per hour, and was the Earth's 10th Category 5 storm of 2018. It was the biggest storm to hit U.S. soil since 1935, as two people were killed, hundreds were injured, and over 3,000 houses were destroyed. In the aftermath much of Saipan and Tinian went without power for weeks afterwards and had severe water shortages (Wong & Cruz, 2018). | | X | X | X |

**Table 4.2-1: Past, Present, and Reasonably Foreseeable Actions (continued)**

| Factor/Project | Location | Project Description | Summary of Impact Minimization and Mitigation Measures[1] | Project Timeframe C = Construction O = Operation X = Other | | |
|---|---|---|---|---|---|---|
| | | | | Past | Present | Future |
| | | Anthropogenic greenhouse gas emissions have changed the physical and chemical properties of the oceans, including a 1-degree Celsius temperature rise, increased carbon dioxide absorption, decreased pH, alteration of carbonate chemistry, the decline in dissolved oxygen, and disruption of ocean circulation (Poloczanska et al., 2016). Observations of species responses that have been linked to anthropogenic climate change are widespread, and trends include shifts in species distribution to higher latitudes and deeper locations, earlier onset of spring and later arrival of fall, declines in calcification, and increases in the abundance of warm-water species. Climate change is expected to continue to impact the Study Area negatively and will contribute added stressors to all resources in the Study Area. | | | | |

[1] Some projects/activities did not list specific impacts minimization measures (such as avoidance techniques, standard operating procedures, or industry-best management practices) or mitigation requirements; either official documentation of project descriptions could not be obtained or did not specify these actions. In most cases, site-specific actions are to be developed as specific projects are developed.

Notes: CNMI = Commonwealth of the Northern Mariana Islands, EA = Environmental Assessment, EIS = Environmental Impact Statement, OEIS = Overseas Environmental Impact Statement, SCUBA = Self-Contained Underwater Breathing Apparatus, SEIS = Supplemental EIS, U.S. = United States.

## 4.3 Cumulative Impacts on Environmental Resources

Since the information available on past, present, and reasonably foreseeable actions varies in quality and level of detail, impacts of these actions were quantified where available data made it possible; otherwise, professional judgment was used to make a qualitative assessment of impacts. Due to the large scale of the area considered (the Study Area and overlapping areas of other actions) and multiple other activities interacting in the ocean environment (Table 4.2-1), the analysis of the incremental contribution to cumulative stress that the Proposed Action may have on a given resource is largely qualitative and speculative. Chapter 3 (Affected Environment and Environmental Consequences) includes a robust discussion of the "general threats," an analysis of aggregate project effects, and a broader level analysis specific to areas where impacts are concentrated (i.e., ranges/operating areas). The Chapter 3 (Affected Environment and Environmental Consequences) analysis is referenced and briefly summarized in each section below to provide context and perspective to the rationale for the conclusions that the Proposed Action would have an insignificant contribution to the cumulative stress experienced by these resources.

Cumulative impacts were analyzed for each resource addressed in Chapter 3 (Affected Environment and Environmental Consequences) for the Proposed Action in combination with past, present, and reasonably foreseeable future actions. The analysis was not separated by Alternative because the data available for the cumulative effects analysis was mostly qualitative and, from a landscape-level perspective, these qualitative impacts are expected to be similar.

Under Alternative 1 or Alternative 2 of the Proposed Action, the Navy would implement the mitigation detailed in Chapter 5 (Mitigation) to avoid or reduce impacts on biological, socioeconomic, and cultural resources in the Study Area.

## 4.4 Resource-Specific Cumulative Impacts

By CEQ guidance (Council on Environmental Quality, 1997), the following cumulative impacts analysis focuses on impacts that are "truly meaningful." The level of analysis for each resource is commensurate with the intensity of the impacts identified in Chapter 3 (Affected Environment and Environmental Consequences) and the level to which impacts from the Proposed Action are expected to mingle with impacts from existing activities. A full analysis of potential cumulative impacts is provided for marine mammals, sea turtles, and marine invertebrates. The rationale is also provided for an abbreviated analysis of the following resources: sediments and water quality, air quality, marine habitats, marine birds, marine vegetation, fishes, cultural resources, terrestrial species and habitats, socioeconomic resources, and public health and safety.

### 4.4.1 Sediments and Water Quality

In the 2015 MITT Final EIS/OEIS, the analysis in Section 3.1 (Sediments and Water Quality) indicated that training and testing activities under each alternative could result in local, short- and long-term changes in sediment and water quality. However, chemical, physical, or biological changes remained within standards, regulations, and guidelines. The short-term impacts arose from explosions and the byproducts of explosions and combusted propellants. The analysis in the 2015 MITT Final EIS/OEIS determined that it was unlikely that these short-term impacts would overlap in time and space with other future actions that produce similar constituents. Therefore, the short-term impacts did not contribute to cumulative impacts.

The long-term impacts arose from unexploded ordnance, non-combusted propellant, metals, and other materials. Long-term impacts of each alternative are cumulative with other actions that cause increases in similar constituents. However, the contribution of Alternative 1 or Alternative 2 in the 2015 MITT Final EIS/OEIS to long-term cumulative impacts was determined to be negligible because of the following:

- Most training and testing activities are widely dispersed in space and time.
- Where activities are concentrated (i.e., Farallon de Medinilla [FDM]), marine habitat conditions observed over multiple years through dive studies indicate that ecological services that maintain water quality have not been inhibited at FDM.
- 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.
- Potential areas of impacts would be limited to small zones immediately adjacent to the explosive, metals, or chemicals other than explosives.

Under this SEIS/OEIS, the contribution of proposed changes in training and testing activities under Alternative 1 or Alternative 2 would still be negligible based on the reasons presented above. While all of the additional projects since 2015 may be measurable and result in long-term and widespread changes in environmental conditions (e.g., nutrient loading, turbidity, salinity, or pH), any changes in sediment and water quality would be subject to applicable standards and guidelines. Given that impacts on water quality as a result of the proposed training and testing activities would be considered negligible, the incremental contribution to cumulative impacts on water quality would also be negligible.

### 4.4.2 Air Quality

In the 2015 MITT Final EIS/OEIS, the analysis in Section 3.2 (Air Quality) indicated that training and testing activities conducted under each alternative resulted in increased criteria pollutant emissions and hazardous air pollutant emissions throughout the Study Area. Sources of the emissions included vessels and aircraft and, to a lesser extent, munitions. Potential impacts included localized and temporarily elevated pollutant concentrations; however, recovery occurs quickly as emissions disperse. The analysis in the 2015 MITT Final EIS/OEIS concluded that the impacts of Alternatives 1 or 2 were cumulative with other actions that involve criteria air pollutant and hazardous air pollutant emissions. However, the incremental contributions, from implementing activities in accordance with the 2015 MITT Final EIS/OEIS Record of Decision (ROD), to cumulative impacts were low for the following reasons:

- Most training and testing activities-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 released the *Operational Energy Strategy: Implementation Plan*, which reduced demand, diversified energy sources, and integrated energy consideration into planning (Department of Defense 2012). Since then, the Navy has released the 2016 Operational Energy Strategy, which builds on the successes of the 2012 Operational Energy Strategy (U.S. Department of Defense, 2016).

Under this SEIS/OEIS, the contribution of proposed increases in training and testing activities under Alternative 1 or Alternative 2 would still result in negligible additional impacts based on the reasons presented above. In addition, the International Maritime Organization is set to impose a new 0.5 percent sulfur cap on marine fuel emissions (International Maritime Organization, 2017). Construction-related activities associated with the additional other projects in the area could generate increased air emissions; however, air quality in the region would remain below *de minimis* levels due to the quick dispersive nature of emissions. Based on the analysis presented in Section 3.2 (Air Quality) of this SEIS/OEIS and the reasons summarized above, the incremental contribution of Alternatives 1 or 2 to cumulative impacts on air quality would be negligible.

In addition to the cumulative effects of criteria and hazardous air pollutants, greenhouse gas emissions would increase under the Proposed Action. Greenhouse gases contribute to climate change, which are felt on a global scale, rather than having localized affects. Although the Proposed Action would result in an increase in greenhouse gas emissions, the Secretary of the Navy has released energy goals that aim to reduce the overall impact that the department has on climate change. Some of those goals involve using alternative energy sources for 50 percent of total consumption needs by 2020, having 50 percent of Navy and Marine Corps installations be net-zero emissions by 2020, and reducing petroleum use in the commercial fleet by 50 percent. These activities would more than offset the small increase in greenhouse gas emissions that would result from the implementation of Alternative 1 or 2.

### 4.4.3 Marine Habitats

In the 2015 MITT Final EIS/OEIS, the analysis presented in Section 3.3 (Marine Habitats) indicated that marine habitats were affected by explosive stressors (underwater detonations) and physical disturbance or strikes (vessels and in-water devices, military expended materials, or seafloor devices). Impacts included localized disturbance of the seafloor, cratering of soft bottom sediments, and structural damage to hard bottom habitats. Impacts on soft bottom habitats were determined to be short term, and impacts on the hard bottom were determined to be long term. Alterations to marine habitats that occurred under the alternatives in the 2015 MITT Final EIS/OEIS were found to be additive to those associated with other actions. The relative incremental contributions, from implementing activities in accordance with the 2015 MITT Final EIS/OEIS ROD, to the overall alterations of marine habitats within the Study Area were low for the following reasons:

- As stated in the 2015 MITT Final EIS/OEIS, training activities utilizing bottom placed detonations would only occur in the existing underwater detonation areas at Piti, Agat, and Outer Apra Harbor. Cobble, rocky reef, and other hard bottom habitat may be scattered throughout the area, but those areas would be avoided during training to the maximum extent practicable.
- Impacts were confined to a limited area, and recovery of soft bottom habitats occurs quickly.

It can reasonably be assumed that there may be impacts on marine habitats from other actions such as seismic surveys and commercial fishing, but no specific details regarding the impacts or effects can be determined with any specificity or certainty. Seismic surveys and commercial fishing may occur in any open area of the Study Area. Seismic surveys could temporarily disturb soft bottom sediment and would have no impacts on non-living hard-bottom habitats. Commercial fishing could temporarily disturb soft bottom sediment, and trawling or dragging the bottom of the seafloor could have moderately longer impacts on non-living hard-bottom habitats by movement of sediment; however, impacts would not change the nature of the habitat from non-living hard-bottom. For actions such as the Department of the Navy's Commonwealth of the Northern Mariana Islands Joint Military Training action, direct and indirect impacts could occur on Tinian; however, the Proposed Action is being revised to avoid or reduce direct impacts on marine habitats. Proposed training and testing activities under this SEIS/OEIS would result in minimal impacts on habitat on or around Tinian due to proposed activities such as amphibious assault; raid; noncombatant evacuation operation; humanitarian assistance/disaster relief operations; personnel insertion/extraction; parachute insertion; and intelligence, surveillance, and reconnaissance. These impacts would be minimal because proposed activities that could impact marine habitats, such as explosives, would not occur in the nearshore region of Tinian. Standard operating procedures, and mitigation measures would avoid or reduce impacts on marine habitat for the activities listed that occur near Tinian under the Proposed Action. 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. Therefore, further analysis of cumulative impacts on marine habitats is not warranted.

## 4.4.4 Marine Mammals

### 4.4.4.1 Region of Influence

The range and habitat for marine mammals extends well beyond the Study Area boundaries and for some species represents only a portion of the full extent of the species' range during their life cycle. Baleen whales (e.g., humpback and blue whales) and some toothed whales (e.g., sperm whales and killer whales) seasonally migrate great distances, including into and out of the Study Area. Many of the smaller toothed whales do not migrate in the strictest sense, but some do undergo seasonal shifts in distribution both within and outside of the Study Area.

Table 3.4-1 lists the current abundance of marine mammal species in the Study Area and the general occurrence locations within the Study Area where they may be encountered. There are 26 marine mammal species known to exist in the Study Area, including 7 mysticetes (baleen whales) and 19 odontocetes (dolphins and toothed whales). Populations are varied; while the average population of certain dolphin and some whale populations include thousands of individuals, other stock populations are unknown or estimated to be in the hundreds. As with other marine resources, distribution is patchy and can be temporarily concentrated in specific areas depending on the species.

### 4.4.4.2 Resource Trends

Relevant information on the status, distribution, population trends, and ecology is presented for each species and stock in the Study Area in Section 3.4.1 (Affected Environment). The current aggregate impacts of past human activities are significant for some marine mammal species, many of which were in serious decline across the world's oceans. In the Pacific and specifically where the Navy has been intensively training and testing activities for decades, many marine mammal populations seem to be trending towards an increase in abundance.

#### 4.4.4.3 Impacts of Other Actions

##### 4.4.4.3.1 Overview

Section 3.4.1.7 (General Threats) discusses threats within the affected environment that impact marine mammal populations in the Study Area, including water quality degradation (chemical pollution), commercial industries (fisheries bycatch, explosive pest deterrents, and other interactions), noise, hunting, vessel strike, marine debris, disease and parasites, and climate change. Potential impacts of actions that affect marine mammals include mortality, injury, disturbance, and reduced fitness (e.g., reduced reproductive, foraging, and predator avoidance success). The susceptibility of marine mammals to these impacts often depends on proximity, severity, or vulnerability to the stressor, and vulnerability can be increased as multiple stressors compound on an individual.

The activities as described in Table 4.2-1 each potentially create multiple stressors in the Study Area experienced by marine mammals, including vessel traffic, underwater noise, and water pollution. For example, most Navy actions include marine vessel operations, which contribute to underwater noise and the risk of vessel strikes, but Navy vessels are a negligible fraction of the overall vessel presence and, thus, vessel noise in the Study Area. Tens of thousands of cargo vessels annually transit through the Study Area to and from ports in Asia as part of the global network of commercial ship movement (Kaluza et al., 2010). Many human activities also contribute underwater noise from sources other than vessels, including commercial fishing, seismic surveys, construction activities, and other military operations. Bycatch and entanglement, the main threats to marine mammal populations, are chiefly associated with fishing (National Marine Fisheries Service, 2016; Read et al., 2006). While Table 4.2-1 discusses these stressors for individual actions, their aggregate impacts specific to marine mammals are detailed in Section 3.4.1.7 (General Threats) and further described below. Data availability is inconsistent between species and activities, but quantitative estimations are presented where available.

##### 4.4.4.3.2 Commercial Fishing

Several commercial foreign fisheries operate in the Study Area. Potential impacts from these activities include marine mammal injury and mortality due to bycatch and entanglement. Fisheries have also resulted in substantial changes to the structure and function of marine ecosystems that adversely affect marine mammals (National Marine Fisheries Service, 2016). As discussed below, 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.

###### 4.4.4.3.2.1 Bycatch

Potential impacts from commercial fishing activities include marine mammal injury and mortality from bycatch, when animals are caught in commercial fishing operations targeting a different species. In 1994, the MMPA was amended to formally require the development of a take reduction plan when U.S. bycatch exceeds a level that is considered unsustainable by the marine mammal population and will lead to marine mammal population decline for U.S. stocks of marine mammals. Although marine mammal bycatch associated with U.S. fisheries has generally declined since the implementation of take reduction measures, and new management practices and consistent regulatory oversight could result in future reductions, this only affects U.S. fisheries; bycatch is expected to remain a leading cause of mortality for the reasonably foreseeable future (Baker et al., 2006; Lent & Squires, 2017; Read et al., 2006; Song, 2017).

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

Fisheries operations also result in substantial changes to the structure and function of marine ecosystems that adversely affect marine mammals, including loss of prey species and alteration of benthic structure. Overfishing of many fish stocks results in significant changes in trophic structure, species assemblages, and pathways of energy flow in marine ecosystems (Jackson et al., 2001; Myers & Worm, 2003). These ecological changes may have important, and likely adverse, consequences for populations of marine mammals (DeMaster et al., 2001). For instance, depletion of preferred prey could lead to a less-nutritious diet and decreased reproductive success.

#### 4.4.4.3.2.2 Entanglement

As discussed in Section 3.4.1.7 (General Threats), entanglement in fishing gear, such as abandoned or partial nets, fishing line, and the ropes and lines connected to fishing gear, is another threat to marine mammals in the Study Area. The National Oceanic and Atmospheric Administration Marine Debris Program (2014) reports that abandoned, lost, or otherwise discarded fishing gear still constitutes the vast majority of mysticete entanglements.

#### 4.4.4.3.2.3 Hunting

With the enactment of the MMPA, hunting-related mortality has decreased over the last 40 years; however, unregulated harvests and extensive legal and illegal whaling activity still occur in areas outside of U.S. waters. Between 1948 and 1979, the Union of Soviet Socialist Republics' whale harvest totaled 195,783 in the North Pacific Ocean. Subsistence harvest of marine mammals by Russian and Alaska Natives occurs in the North Pacific, Chukchi Sea, and Bering Sea, affecting marine mammal stocks that may be present in the Study Area.

#### 4.4.4.3.3 Maritime Traffic and Vessel Strikes

Maritime traffic has increased over the past 50 years, and vessel traffic is expected to continue to increase in the Study Area due to continued economic globalization, widening of the Panama Canal, and increases in offshore energy development and other offshore activities (see for example (Kaluza et al., 2010)). While increased risks come with increased vessel traffic, risks of vessel strikes could be minimized by ongoing and future education and awareness, marine mammal reporting, and maritime traffic planning and management. 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 & Shaw, 2006; Nowacek et al., 2004). Marine mammals such as dolphins and porpoises, which can move quickly throughout the water column, are not as susceptible to vessel strikes.

#### 4.4.4.3.4 Ocean Pollution

As discussed in Table 4.2-1, multiple pollutants from numerous sources are present in, and continue to be released into, the oceans. These releases that affect marine mammals include water pollution as well as the discharge of marine debris and the proliferation of ambient as well as impulsive noise in the underwater ecosystem. Section 3.4.1.7 (General Threats) provides an overview of these potential impacts, which include morbidity and mortality from acute toxicity (although mortality has not yet specifically been shown in marine mammals); disruption of endocrine cycles and developmental processes causing reproductive failures or birth defects; suppression of immune system function; and metabolic disorders resulting in cancer or genetic abnormalities (Reijnders et al., 2009). The effects of exposure to and concentration of persistent organic pollutants in marine mammals, especially from pesticides, includes the accumulation of dichlorodiphenyltrichloroethane (DDT) and polychlorinated biphenyls (PCBs) in certain species, and high concentrations of organochlorines in tissues appear to have occurred with increasing frequency, based on disease outbreaks involving marine mammals. In addition, experimental and other evidence has shown that persistent contaminants often found in the tissues of marine mammals have deleterious effects on reproduction and the immune system (O'Shea et al., 1999).

#### 4.4.4.3.5 Ocean Noise

Ocean noise as a general stressor in modern oceans is described in Table 4.2-1 and as specific stressors to marine mammals in Section 3.4.1.7 (General Threats). Noise is of particular concern to marine mammals because many species use sound as a primary sense for navigating, finding prey, avoiding predators, and communicating with other individuals. Noise can cause behavioral disturbances; mask other sounds (including their own vocalizations); and may result in injury, including hearing loss in the form of temporary threshold shift or permanent threshold shift (PTS) or, in some cases, death.

Anthropogenic noise is generated from a variety of sources throughout the Study Area, including commercial shipping, oil and gas exploration and production activities (including air gun, drilling, and explosive decommissioning), commercial and recreational fishing (including vessel noise, fish-finding sonar, fathometers, acoustic deterrent, and harassment devices), shoreline construction projects (including pile driving), recreational boating and whale-watching activities, offshore power generation (including offshore windfarms), and research (including sound from air guns, sonar, and telemetry).

The military activities addressed in Table 4.2-1 include various training and testing operations that contribute vessel noise, in-water and in-air explosions, and sonar. While sonar activity can impact individual marine mammals, impacts on populations are not expected. Although various other training and testing activities involve surface or undersea detonations or gunnery exercises, these are generally mitigated through monitored exclusion zones and are infrequent, isolated events. As noted in Table 4.2-1, many activities incorporate best management practices or standard operating procedures to minimize noise generation; in particular, in-water construction at naval piers regularly utilizes dampening and attenuation technologies and other practices that reduce impacts on bottlenose dolphins and other sensitive receptors in the vicinity of pile-driving activities.

#### 4.4.4.3.6 Marine Debris and Ingestion

Interactions between marine mammals and marine debris, including derelict fishing gear (as discussed in Section 4.4.4.3.3.2, Entanglement) and plastics, are significant sources of injury and mortality (Baulch & Perry, 2014), and the percentage of marine mammal species with documented records of entanglement in or ingestion of marine debris has increased from 43 to 66 percent over the past 18 years (Bergmann et al., 2015). Ingestion of plastic bags and Styrofoam has been identified as a cause of injury or death of minke whales and deep-diving odontocetes, including beaked whales, pygmy sperm whales, pilot whales, and sperm whales.

#### 4.4.4.3.7 Disease and Parasites

Section 3.4.1.7.8 (Disease and Parasites) discusses the effects of disease and parasites in marine mammals. Just like humans, older animals are more likely to be affected by disease and likewise can spread disease through a population, affecting a significant number of otherwise healthy individuals. Mass die-off events can also occur as a result of toxic algal blooms, which may be increasing in frequency due to human nutrient input and climate change, and the spread of certain parasites from the feces of feral cats (toxoplasmosis, hookworms, lungworms, and thorny-headed worms) to marine mammals in storm runoff.

#### 4.4.4.4 Impacts of the Proposed Action that May Contribute to Cumulative Impacts

Impacts of the Proposed Action are detailed in Section 3.4 (Marine Mammals). Impacts that may contribute to cumulative impacts on marine mammals can be generally categorized as mortality, injury (Level A harassment under the MMPA), and behavioral responses and temporary threshold shift (TTS) (Level B harassment under the MMPA). These impacts would be associated with certain acoustic (sonar and other transducers), physical disturbance, and strike stressors. Although behavioral impacts are possible from the remaining stressors (as defined in Section 3.4.2, Environmental Consequences), these stressors are not expected to result in harassment, TTS, PTS, injury, or mortality of marine mammals.

The analysis presented in Section 3.4 (Marine Mammals) concluded that some stressors associated with the Proposed Action could impact individuals of certain marine mammal species, but impacts are not expected to decrease the overall fitness of any marine mammal population. Species most likely to be impacted by training and testing activities are dwarf sperm whales and pygmy sperm whales along with delphinids species (dolphins and small whales), which are the most abundant species in the Study Area. From a cumulative perspective, any potential impacts on species with small populations, especially Endangered Species Act (ESA)-listed species, are of particular concern, and the Navy will consult with the National Marine Fisheries Service, as required by Section 7(a)(2) of the ESA, in that regard. The Navy will implement mitigation to avoid or reduce impacts from acoustic, explosive, and physical disturbance and strike stressors on marine mammals, as described in Chapter 5 (Mitigation).

As determined in Section 3.4 (Marine Mammals), it is not anticipated that the Proposed Action would result in significant impacts on marine mammal populations. The majority of the proposed activities are unit-level training and testing activities, which are conducted in the open ocean. Unit-level events occur over a small spatial scale (one to a few square miles) and with few participants (usually one or two) or short duration (the order of a few hours or less). Additionally, training and testing activities are generally separated in space and time in such a way that it would be unlikely that any individual marine mammal would be exposed to stressors from multiple activities within a short timeframe. Furthermore, research and monitoring efforts have included before, during, and after-event observations and surveys, data collection through conducting long-term studies in areas of Navy activity, occurrence surveys over large geographic areas, biopsy of animals occurring in areas of Navy activity, and tagging studies where animals are exposed to Navy stressors. To date, the findings from the research and monitoring and the regulatory conclusions from previous analyses by the National Marine Fisheries Service (NMFS) (National Marine Fisheries Service, 2015b; National Oceanic and Atmospheric Administration, 2013) are that the majority of impacts from Navy training and testing activities are not expected to have deleterious impacts on the fitness of any individuals or long-term consequences to populations of marine mammals.

Mitigation measures discussed in Chapter 5 (Mitigation) are designed to avoid or reduce potential impacts of explosives, especially higher-order impacts such as injury and mortality to the greatest extent practicable. The acoustic analysis indicates that pressure waves resulting from explosive detonations would not lead to mortality for any of the marine mammals in the Study Area. The effectiveness of procedural mitigation measures is conservatively considered in the Navy's quantitative analysis process.

There are no records of a marine mammal ever being struck by a vessel during training and testing activities in the Study Area, and a vessel strike resulting from the Proposed Action is not anticipated.

#### 4.4.4.5 Cumulative Impacts on Marine Mammals

As discussed above, fishery bycatch, vessel strikes, and entanglement in marine debris are leading causes of direct mortality to marine mammals (Carretta et al., 2017; Helker et al., 2017; Lent & Squires, 2017; National Marine Fisheries Service, 2016; National Oceanic and Atmospheric Administration Marine Debris Program, 2014; Read et al., 2006). Although Navy activities are mitigated to the greatest extent practicable, the Proposed Action could also result in injury and mortality to individuals of some marine mammal species from in-water explosions and vessel strikes. Implementation of measures discussed in Chapter 5 (Mitigation) would help avoid or reduce, but not absolutely eliminate, the risk for potential impacts, and any incidence of injury and mortality that might occur under the Proposed Action could be additive to injury and mortality associated with other actions in the Study Area. While it is more likely that an individual of an abundant, common stock or species would be affected, there is a chance that a less abundant stock could be affected.

Ocean noise, globally and specifically in the Study Area, is already significantly elevated over historic, natural levels, and acoustic stressors (in-water explosions and sonar, as well as increased Navy vessel noise) associated with the Proposed Action could also result in additive acoustic impacts on marine mammals. However, sonar is not known to make up a significant portion of the overall ocean noise budget (Bassett et al., 2010; Baumann-Pickering et al., 2010; International Council for the Exploration of the Sea, 2005; McDonald et al., 2006). Other current and future actions such as construction, and operation of offshore energy projects; seismic surveys; and construction, operation, and removal of offshore energy facilities could result in underwater sound levels that could cause behavioral harassment, TTS, PTS, or, to a less extent, injury or mortality. Additionally, the constant elevation in ambient noise may produce physiological stress in individuals to which the Proposed Action would contribute.

Sounds from many of these sources travel over long distances, and it is possible that some would overlap in time and space with sounds from in-water explosions or Navy sonar use, in particular commercial shipping noise, which is more widespread and continuous. It is not known whether the co-occurrence of shipping noise and sounds associated with in-water explosions and sonar use would result in harmful additive impacts on marine mammals. However, these training and testing activities are widely dispersed, the sound sources are intermittent, and mitigation measures would be implemented. Furthermore, standard operating procedures would preclude some training and testing activities in the immediate vicinity of other actions, further reducing the likelihood of simultaneous or overlapping exposure. For these reasons, it is unlikely that an individual marine mammal would be simultaneously exposed to sound levels from multiple actions that could cause behavioral harassment, TTS, PTS, or injury.

If the health of an individual marine mammal were compromised, it is possible this condition could alter the animal's expected response to stressors associated with the Proposed Action. The behavioral and physiological responses of any marine mammal to a potential stressor, such as underwater sound, could be influenced by various factors, including disease, dietary stress, body burden of toxic chemicals, energetic stress, percentage body fat, age, reproductive state, 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 & Pouyatos, 2005). While the response of a previously stressed animal might be different from the response of an unstressed animal, no data are available at this time that accurately predict how stress caused by various ocean pollutants would alter a marine mammal's response to stressors associated with the Proposed Action.

In summary, the aggregate impacts of past, present, and other reasonably foreseeable future actions continue to have significant impacts on some marine mammal species in the Study Area. The Proposed Action could contribute incremental stressors to individuals, which would both further compound effects on a given individual already experiencing stress and, in turn, have the potential to further stress populations, some of which may already be in significant decline or in the midst of stabilization and recovery.

Furthermore, the regulatory process administered by NMFS, which includes Stock Assessments for all marine mammals, as well as five-year reviews for all ESA-listed species, provides a backstop that informs decisions on take authorizations and Biological Opinions. Stock Assessments include estimates of Potential Biological Removal that stocks of marine mammals can sustainably absorb. MMPA take authorizations require the minimization of adverse effects and are explicitly limited to small numbers, with no more than a negligible impact on species and stocks of marine mammals. MMPA authorizations are reinforced by monitoring and reporting requirements so that NMFS is kept informed of deviations from what has been approved. Biological Opinions for federal and non-federal actions are similarly grounded in status reviews and conditioned to avoid jeopardy and to allow continued progress toward recovery. These processes help to ensure that, through compliance with these regulatory requirements, the Navy's Proposed Actions would not have a measurable effect on the resource.

## 4.4.5 Sea Turtles

### 4.4.5.1 Region of Influence

The general region of influence for sea turtles includes open ocean and coastal water off Guam, Rota, Tinian, Saipan, and FDM. The 2015 MITT Final EIS/OEIS analyzes amphibious landings on the beaches of Guam, Rota, and Tinian where sea turtles are known to nest. As this SEIS/OEIS only addresses sea-based training and testing activities in the Study Area, the impacts of amphibious landings on sea turtle nesting and other land-based impacts of amphibious landings are not addressed or analyzed in this SEIS/OEIS. The sea turtle species occurring in the Study Area include green sea turtles (*Chelonia mydas*) (Central West Pacific DPS), hawksbill sea turtle (*Eretmochelys imbricata*), loggerhead sea turtle (*Caretta caretta*), olive ridley sea turtle (*Lepidochelys olivacea*), and leatherback sea turtle (*Dermochelys coriacea*). In general, sea turtles spend most of their time at sea, with female turtles returning to land to nest and often migrating long distances between feeding grounds and nesting beaches. As with other marine resources, distribution is patchy and can be concentrated in specific areas depending on the species, season, habitat, activity, and age of the individuals.

#### 4.4.5.2 Resource Trends

All sea turtles in the Study Area have experienced significant decline in population numbers over the past hundred years and are ESA-listed (Table 3.5-1). Because sea turtles are so long-lived, and because reliable data are only available for approximately the past 20 years, it is not possible to determine a reliable trend in abundance for most species. In addition, leatherback sea turtles, loggerhead sea turtles, and olive ridley sea turtles are not expected to occur in nearshore waters of the Study Area, increasing the difficulty of tracking trends of these species in pelagic waters. Recent information, however, shows significant increases of green sea turtles and hawksbill sea turtles in nearshore waters of Guam. Jones and Martin (2016) analyzed five decades of aerial surveys (from 1962 through 2012), calculated a population growth rate of approximately 90 percent over the past five decades for these two species, and estimated that 85 percent of the sea turtles were green sea turtles, and 15 percent were hawksbill sea turtles. The Navy is currently funding in-water tagging of sea turtles to further understand resource trends in waters off of Guam, Tinian, and Saipan. Since November 2015 when tagging began, Falcone et al. (2017) report that the majority of sea turtles observed or captured (65 of 68 total sea turtles observed, or 96 percent) have been green sea turtles.

#### 4.4.5.3 Impacts of Other Actions

##### 4.4.5.3.1 Overview

Section 3.5.1.5 (General Threats) discusses the specific stressors within the affected environment that impact sea turtle populations in the Study Area, which include water quality (marine debris and chemical contaminants), commercial industries (fisheries bycatch and other interactions), hunting/exploitation, vessel strike, oil and gas development, wind energy development, shoreline development and recreation, dredging, military activities, invasive species, disease, habitat destruction (loss of seagrass habitat and nesting beaches), and climate change. Potential impacts of actions that affect sea turtles include mortality, injury, disturbance, and reduced fitness, including reproductive, foraging, and predator avoidance success.

The susceptibility of sea turtles to these outcomes often depends on proximity, severity, or vulnerability to the stressor, and vulnerability can be increased as multiple stressors compound on an individual. The abundance of the species, potential impacts that may affect localized nesting sites, and individual fatalities could have considerable impacts in localized populations.

The activities as described in Table 4.2-1 each potentially contribute multiple stressors in the Study Area experienced by sea turtles, including vessel traffic, underwater noise, and water pollution. For example, most actions include the operation of marine vessels, which contribute to vessel strikes and underwater noise. Bycatch and entanglement, among the main threats to sea turtle populations in the Study Area, are chiefly associated with fishing and are discussed separately. While Table 4.2-1 discusses these stressors for individual actions, their aggregate impacts specific to sea turtles are detailed in Section 3.5.1.5 (General Threats) and further described below.

##### 4.4.5.3.2 Commercial Fishing and Harvest

Past and present commercial fishing activities have had a global effect on the recovery and conservation of marine turtle populations and, despite continued improvements in bycatch avoidance and the implementation of regulatory efforts, fisheries interactions continue to be the primary human-related source of mortality for most sea turtles (National Research Council of the National Academies, 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). In United States' fisheries, bycatch resulted in 71,000 sea turtle deaths per year prior to effective protective sea turtle regulations (enacted in the mid-1990s); but current mortality estimates are 94 percent lower than pre-regulation estimates (Finkbeiner et al., 2011).

Globally, large-scale commercial exploitation also contributes to global decline in marine turtle populations. Currently, 42 countries and territories allow some form of take of turtles and collectively remove in excess of 42,000 turtles per year, the majority of which (more than 80 percent) are green sea turtles (Humber et al., 2014). Illegal fishing for turtles and nest harvesting also continues to be a major cause of sea turtle mortality, both in countries that allow sea turtle take and in countries that outlaw the practice (Lam et al., 2011; Maison et al., 2010). For example, Humber et al. (2014) estimated that 65,000 sea turtles have been illegally harvested in Mexico since 2000. The authors, however, have seen legal and illegal direct take of sea turtles trending downward over the past three decades—citing a more than 40 percent decline in green sea turtle take since the 1980s, a more than 60 percent decline in hawksbill and leatherback take, and a more than 30 percent decline in loggerhead take (Humber et al., 2014).

#### 4.4.5.3.3 Maritime Traffic and Vessel Strikes

Maritime traffic has increased over the past 50 years, and vessel traffic is expected to continue to increase in the Study Area in response to continued economic globalization, increases in energy development, and other offshore activities. Vessel strike has been identified as one of the important mortality factors in several nearshore turtle habitats worldwide. Precise data are lacking for sea turtle mortalities directly caused by ship strikes; however, live and dead turtles are often found with deep cuts and fractures indicative of collision with a boat hull or propeller (Hazel et al., 2007; Lutcavage et al., 1997). Some vessel strikes could cause temporary impacts, such as diverting the turtle from its previous activity or causing minor injury. Major strikes could 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. 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. While increased risks come with increased vessel traffic, risks of vessel strikes could be minimized by ongoing and future education and awareness, ship-speed reduction measures, and maritime traffic planning and management.

#### 4.4.5.3.4 Coastal Land Development

Although sea turtle nesting sites within the Mariana Islands are not included in the Study Area for this SEIS/OEIS, impacts on sea turtle nesting sites from activities not associated with training and testing activities may impact overall populations of sea turtles within the region of influence for this SEIS/OEIS.

Female sea turtles migrate to their natal beaches to lay eggs, and pervasive coastal development often interferes with successful nesting at these locations. Shared use between turtles and human interests on increasingly populated and utilized beach areas has intensified the tendency for female turtles and their hatchlings to encounter various barriers and hazards accessing, nesting, and leaving these beaches. The following factors prevent beach access and emigration of sea turtles: beachfront construction of homes, hotels, restaurants, roads, seawalls, and shoreline armoring; beach erosion; ports and marinas; beach replenishment; nearshore dredging; and oil and gas activities. Beach-going vehicles and watercraft cause injury and mortality to sea turtles. Abandoned debris and equipment are often insurmountable obstacles for both mother and offspring (SeeTurtles.org, 2017). Populated areas also often have excess nighttime lighting that confuses hatchlings' instincts to orient toward the moon to arrive at the ocean, and in this journey they often fall into and can remain trapped within pits and scars left on the beach. Conservation awareness has increased on many popular U.S. beaches and tourist destinations, but nesting success remains imperiled in many others.

#### 4.4.5.3.5 Ocean Pollution

As discussed in Table 4.2-1, multiple pollutants from numerous sources are present in, and continue to be released into, the oceans. Section 3.5.2 (Environmental Consequences) provides an overview of these potential impacts on sea turtles, which include the ingestion of and entanglement in marine debris as well as toxicity from bisphenol-A, phthalates, and heavy metals. Sea turtles often mistake debris for prey; one study found 37 percent of dead leatherback turtles had ingested various types of plastic (Mrosovsky et al., 2009). Other marine debris, including derelict fishing gear and cargo nets, can entangle and drown turtles in all life stages.

#### 4.4.5.3.6 Ocean Noise

Ocean noise as a general stressor in modern oceans is described in Table 4.2-1. Anthropogenic noise is generated from a variety of sources throughout the Study Area, including commercial shipping, oil and gas exploration and production activities (including air gun, drilling, explosive decommissioning), commercial and recreational fishing (including vessel noise, fish-finding sonar, fathometers, acoustic deterrent and harassment devices), shoreline construction projects (including pile driving), recreational boating and whale-watching activities, offshore power generation (including offshore windfarms), and research (including sound from air guns, sonar, telemetry). The military activities addressed in Table 4.2-1 include various training and testing activities that also contribute vessel noise, in-air and in-water explosions, and sonar; however, due to the low risk of encounter and the implementation of required mitigation measures, the Surveillance Towed Array Sensor System Low Frequency Active Sonar training and testing activities are not expected to result in mortality to any sea turtles, and minimal injury or behavioral changes are anticipated.

In general, the potential concerns associated with ocean noise and sea turtles are not as well defined as those for marine mammals. While it is well known that many species of marine mammals use sound as a primary sense for navigating, finding prey, and communicating with other individuals, little is known about how sea turtles use sound in their environment. Based on knowledge of their sensory biology (Bartol & Musick, 2003; Bartol & Ketten, 2006; Ketten & Moein-Bartol, 2006; Levenson et al., 2004), there is evidence that sea turtles may be able to detect objects within the water column (e.g., vessels, prey, predators) via some combination of auditory and visual cues. However, research examining the ability of sea turtles to avoid collisions with vessels shows they may rely more on their vision than auditory cues (Hazel et al., 2007). Similarly, while sea turtles may rely on acoustic cues from breaking waves to identify nesting beaches, they also appear to rely on other non-acoustic cues for navigation, such as magnetic fields (Lohmann & Lohmann, 1992, 1996) and light (Avens, 2003). Additionally, sea turtles are not known to produce sounds underwater for communication. As a result, sound may play a limited role in a sea turtle's environment.

Nonetheless, as discussed in Section 3.5.2.1 (Acoustic Stressors), sea turtles could experience a range of impacts from ocean noise, depending on the sound source. The impacts could include permanent or temporary hearing loss, changes in behavior, physiological stress, and auditory masking. In addition, potential impacts from use of explosives could range from physical discomfort to non-lethal and lethal injuries.

#### 4.4.5.4 Impacts of the Proposed Action That May Contribute to Cumulative Impacts

The cumulative impacts analysis includes green, hawksbill, olive ridley, leatherback, and loggerhead turtles, all of which are ESA-listed species. The analysis presented in Section 3.5 (Sea Turtles) concludes that some stressors associated with the Proposed Action could impact individuals of certain sea turtle species, but impacts are not expected to decrease the overall fitness of any sea turtle population. From a cumulative perspective, potential impacts on listed species are of particular concern, and mitigation measures designed to avoid or reduce the potential impacts are discussed in Chapter 5 (Mitigation).

Impacts from the Proposed Action that may contribute to cumulative impacts on sea turtles can be generally categorized as behavioral responses, temporary and PTSs, non-auditory injury (modeled as slight lung injury and gastrointestinal tract injury), and mortality. As summarized below, these impacts would be associated with certain acoustic and physical strike stressors. The use of sonar and other transducers may result in behavioral responses, and temporary and PTSs in sea turtles, including ESA-listed sea turtles. Explosives may result in behavioral responses, TTS, PTS, injury, and mortality in sea turtles, including ESA-listed sea turtles. Vessel strikes may cause injury or mortality in sea turtles, including ESA-listed sea turtles.

The remaining acoustic stressors (noise from air guns, weapons firing/launch/impact, aircraft overflight, vessels), energy stressors (electromagnetic, high energy lasers), physical disturbance and strike stressors (in-water devices, military expended materials, seafloor devices), entanglement stressors (cables, wires, decelerators/parachutes), ingestion stressors (military expended materials – munitions and military expended materials – other than munitions), and secondary stressors are not expected to result in temporary or PTSs, injury, or mortality of sea turtles under the Proposed Action, including ESA-listed sea turtles. The Proposed Action would not introduce significant light sources that would disorient nesting turtles or their hatchlings. Because the Navy's training and testing activities covered under this SEIS/OEIS do not co-occur with nesting activities, it is unlikely that stressors presented to sea turtles would contribute to other anthropogenic threats not caused by Navy activities.

Although sea turtles could be exposed to sound and energy from explosive detonations throughout the Study Area, the estimated impacts on individual sea turtles are unlikely to impact populations. Injured sea turtles could suffer reduced fitness and long-term survival. Sea turtles that experience temporary or PTSs may have reduced ability to detect relevant sounds such as predators or prey, although some with temporary threshold shift would recover quickly, possibly in a matter of minutes. It is uncertain whether some permanent hearing loss over a part of a sea turtle's hearing range would have long-term consequences for that individual because the sea turtle hearing range is already limited (Section 3.5.2.1, Acoustic Stressors). Any significant behavioral reactions to acoustic stimuli could lead to a sea turtle expending energy and missing opportunities to secure resources. However, most individuals are not likely to experience long-term consequences from behavioral reactions because exposures would be intermittent and widely spaced, allowing exposed individuals to recover. Since long-term consequences for most individuals are unlikely, long-term consequences for populations are not expected.

In summary and as determined in Section 3.5 (Sea Turtles), it is not anticipated that the Proposed Action would result in significant impacts on sea turtles. Due to the wide dispersion of stressors, speed of the platforms, and general dynamic movement of many training and testing activities, it is very unlikely that a sea turtle would remain in the potential impact range of multiple sources or sequential exercises. Additionally, the majority of the proposed activities are unit-level training and small testing activities, which are conducted in the open ocean. Unit-level exercises occur over a small spatial scale (one to a few square miles) and with few participants (usually one or two) or short duration (the order of a few hours or less). Likewise, training and testing activities are generally separated in space and time in such a way that it would be unlikely that any individual sea turtle would be exposed to stressors from multiple activities within a short timeframe. Furthermore, research and monitoring efforts have included before, during, and after-event observations and surveys; data collection through conducting long-term studies in areas of Navy activity; occurrence surveys over large geographic areas; biopsy of animals occurring in areas of Navy activity; and tagging studies where animals are exposed to Navy stressors. To date, the findings from the research and monitoring and the regulatory conclusions from previous analyses by NMFS (National Marine Fisheries Service, 2015b; National Oceanic and Atmospheric Administration, 2013) are that majority of impacts from Navy training and testing activities are not expected to have deleterious impacts on the fitness of any individuals or long-term consequences to populations of sea turtles.

#### 4.4.5.5 Cumulative Impacts on Sea Turtles

The fact that all five species of sea turtles occurring in the Study Area are ESA-listed provides a clear indication that the current aggregate impacts of past human activities are significant for sea turtles. Bycatch, vessel strikes, coastal land development, and ocean pollution are the leading causes of mortality and population decline for sea turtles, and, although mitigated/avoided to the greatest extent practicable, the Proposed Action could result in stress, injury, and mortality to individuals of some sea turtle species from in-water explosions and vessel strikes. Implementation of observation and delay measures discussed in Chapter 5 (Mitigation) would help avoid or reduce, but not absolutely eliminate, the risk for potential impacts, and any incidence of injury and mortality that might occur under the Proposed Action could be additive to injury and mortality associated with other actions in the Study Area.

According to scientific studies, sea turtles may rely primarily on senses other than hearing for interacting with their environment and appear to recover quickly from noise stressors (Section 3.5.2.1, Acoustic Stressors); thus, the acoustic stressors produced by Navy activities are anticipated to have minimal cumulative impact on sea turtles. The Proposed Action would not affect turtle nesting habitat, and contaminants and debris discharged into the marine environment are expected to be negligible and not persistent (Section 4.4.1, Sediments and Water Quality). Effects from the Proposed Action to sea turtle food sources are avoided or insignificant (Section 4.4.7, Marine Vegetation, and Section 4.4.8, Marine Invertebrates). Likewise, Navy actions generally would not overlap in space and time with other stressors as they occur as dispersed, infrequent, and isolated events that do not last for extended periods.

The potential exists for the impacts of ocean pollution (disease, malnourishment), injury, nesting habitat loss, starvation, and the composite increased underwater noise environment to contribute multiple stressors to an individual, and it is possible that the response of a previously stressed animal to impacts associated with the Proposed Action could be more severe than the response of an unstressed animal, or impacts from the Proposed Action could make an individual more susceptible to other stressors. For example, if a Navy vessel were to strike and injure an otherwise healthy sea turtle, exposure to multiple other stressors in the area may hinder the individual’s recovery from any injury sustained in the accident. Likewise, a sea turtle near an in-water explosion or sonar activity may become stressed or disoriented, and the time to recover may be increased if that individual is likewise experiencing disease, malnutrition, or other strike injury that may increase its vulnerability to predation or decrease its ability to forage.

In summary, the aggregate impacts of past, present, and other reasonably foreseeable future actions continue to have significant impacts on all sea turtle species in the Study Area. The Proposed Action could contribute incremental stressors to individuals, which would both further compound effects on a given individual already experiencing stress and in turn has the potential to further stress populations in significant decline or recovery efforts thereof. Additionally, as with marine mammals, the NMFS regulatory process includes Stock Assessments and five-year reviews for all ESA-listed species, which provides a backstop that informs decisions on take authorizations and Biological Opinions. Biological Opinions for federal and non-federal actions are grounded in status reviews and conditioned to avoid jeopardy and to allow continued progress toward recovery. This process helps to ensure that, through compliance with these regulatory requirements, the Navy's Proposed Action would not have a measurable effect on the resource into the future.

### 4.4.6 Marine Birds

In the 2015 MITT Final EIS/OEIS, the analysis in Section 3.6 (Marine Birds) indicated that birds were impacted by acoustic stressors (sonar and other transducers, in-water 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 – munitions and military expended materials – other than munitions). Potential responses included 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 occurs quickly, and impacts are localized. Some stressors, including in-water explosions, physical strikes, and ingestion of plastic military expended materials, result in mortality. However, the number of individual birds affected was expected to be low, and no population-level impacts were expected. The impacts of the alternatives were determined to be cumulative with other actions that caused short-term behavioral and physiological impacts and mortality to birds. However, the incremental contribution of those alternatives to cumulative impacts on birds were determined to be low for the following reasons:

- Most of the proposed activities were 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 was low.
- As discussed in Section 3.6 (Marine Birds), there have been no statistically significant declines in numbers of indicator species that nest on FDM, despite a long history of military use of FDM.
- It is unlikely that training and testing activities influenced nesting because most activities take place in water and away from nesting habitats on land. Alternatives 1 or 2 did not result in destruction or loss of nesting habitat.
- For most stressors, impacts were short term and localized, and recovery occurs quickly.
- While a limited amount of mortality could occur, no population-level impacts were expected.
- None of the alternatives were likely to adversely affect ESA-listed bird species.

Under this SEIS/OEIS, the contribution of proposed increases in training and testing activities under Alternative 1 or Alternative 2 would still be negligible based on the reasons presented above. While all of the additional projects since 2015 may be measurable and contribute to the cumulative impacts on marine birds, the number of individual marine birds affected is expected to be low, and no population-level impacts are expected. Based on the analysis presented in Section 3.6 (Marine Birds) 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 marine birds is not warranted.

### 4.4.7 Marine Vegetation

In the 2015 MITT Final EIS/OEIS, the analysis presented in Section 3.7 (Marine Vegetation) indicated that marine vegetation was affected by explosive stressors (in-water explosions), physical stressors (vessels and in-water devices, military expended materials, or seafloor devices), and secondary stressors (impacts associated with sediments and water quality) and is still valid in this SEIS/OEIS analysis. Potential impacts included localized disturbance and mortality. As discussed in the 2015 MITT Final EIS/OEIS, the analysis indicated that recovery would occur quickly, and population-level impacts were not anticipated. Impacts of the alternatives in the 2015 MITT Final EIS/OEIS were considered to be cumulative with other actions that caused disturbance and mortality of marine vegetation.

The current aggregate impacts of past, present, and reasonably foreseeable future actions presented in Table 4.2-1 may affect marine vegetation. Aggregate impacts from vessel strikes, increased sedimentation, and other stressors associated with other actions discussed in Table 4.2-1 could result in injury and mortality. Although this SEIS/OEIS does address some of these projects, developments, and actions listed in Table 4.2-1, many of these other actions and their associated cumulative impacts on marine vegetation cannot be determined with any specificity or certainty. However, it can reasonably be assumed that there may be marine vegetation that could be affected by these actions, but no specific details are known regarding the impacts or effects to individuals or populations. Alternatives 1 or 2 could also result in injury and mortality to marine vegetation from in-water explosions and strikes. Injury and mortality that might occur would be additive to injury and mortality associated with other actions. However, the relative contribution of Alternatives 1 or 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 historically affected marine vegetation. For example, Alternatives 1 or 2 would not increase nutrient loading, which can cause algal blooms, decrease light penetration, and impact photosynthesis of seagrasses.

Under this SEIS/OEIS, the contribution of proposed increases in training and testing activities under Alternative 1 or Alternative 2 would still be low, based on the reasons presented above. Impacts on marine vegetation from projects such as pollution, and climate change could result in long-term or widespread changes in secondary stressors to the environment that would change environmental conditions, such as turbidity, salinity, pH, or water temperature that would impact marine vegetation. However, these impacts are expected to be localized, recovery would occur quickly, and no population-level impacts would be expected. Based on the analysis presented in Section 3.7 (Marine Vegetation) and the reasons summarized above, the incremental contribution of Alternatives 1 or 2 to cumulative impacts on marine vegetation would be negligible. Therefore, further analysis of cumulative impacts on marine vegetation is not warranted.

### 4.4.8 Marine Invertebrates

#### 4.4.8.1 Region of Influence

The region of influence for invertebrates includes the entire Study Area as invertebrates occur in all habitats and depths, including both the water column and benthic habitat, and many species have pelagic larvae, such as corals, that can drift in the ocean currents until they settle on reefs. Invertebrate groups in the Study Area are listed in Section 3.8 (Marine Invertebrates) and include microscopic zooplankton that drift with currents (e.g., invertebrate larvae, copepods, protozoans), larger invertebrates living in the water column (e.g., jellyfish, shrimp, squid), and benthic invertebrates that live on or in the seafloor (e.g., clams, corals, crabs, worms).

#### 4.4.8.2 Resource Trends

As discussed in Section 3.8.1.2 (General Threats), marine invertebrates are ecologically and economically crucial, performing essential ecosystem services such as coastal protection, nutrient recycling, food for other animals, and habitat, as well as providing income from tourism and commercial fisheries. The health and abundance of marine invertebrates are vital to the marine ecosystem and the sustainability of the world's fisheries. Invertebrates are fished for food (e.g., shrimps, lobsters, and crabs; scallops, clams, and oysters; sea urchins, sea cucumbers, squids, and octopuses); harvested for jewelry, curios, and the aquarium trade; and some are known to secrete medicinal compounds of interest to the health industry.

Corals occur throughout the Study Area and include three species (*Acropora globicep*s, *A. retusa*, and *Seriatopora aculeata*) that are listed under the ESA. Raymundo et al. (2017) reported a catastrophic mass mortality event of more than 50 percent in shallow staghorn (*Acropora*) coral in Guam that was initiated in 2013 by anomalous warm sea surface temperatures.

In 2017, NMFS determined that seven species of giant clam (*Hippopus, H. porcellanus, Tridacna costata, T. derasa, T. gigas, T. squamosa*, and *T. tevoroa*) were candidates that may warrant listing under the ESA (82 Federal Register 28946). A status review is currently being done for these species. Two species, *H hippopus* and *T. gigas*, have historically been found in the Study Area but are believed to have been locally extirpated (Meadows, 2016).

#### 4.4.8.3 Impacts of Other Actions

Section 3.8.1.2 (General Threats) includes an extensive discussion of the existing stressors to marine invertebrates, including overexploitation and destructive fishing practices, habitat degradation resulting from pollution and coastal development, disease, invasive species, oil spills, noise, global climate change, and ocean acidification. Stressors specific to reef-building corals, which are generally located in more shallow zones with adequate sunlight penetration and a mean annual water temperature more than about 64 degrees Fahrenheit, include thermal stress, disease, tropical storms, coastal development and pollution, erosion and sedimentation, tourism/recreation, fishing, trade in coral and live reef species, vessel anchoring or groundings, marine debris, predation, invasive species, and hydrocarbon exploration. Primary threats to deep-water or cold-water corals include bottom fishing, hydrocarbon exploration and extraction, petroleum contamination, cable and pipeline installation, and other various bottom-disturbing activities. Deep corals are susceptible to physical disturbance due to the branching and fragile growth form of some species, slow growth rate (colonies can be hundreds of years old), and low reproduction and recruitment rates. All activities described in Table 4.2-1 have the potential to impact marine invertebrates due to their ubiquitous presence and relative vulnerability.

#### 4.4.8.3.1 Climate Change

The primary threat to corals is global climate change, which has and is projected to continue to seriously impact coral reefs in the near and known future. The effects of climate change include increased water temperature, ocean acidification, increased frequency or intensity of cyclonic storm events, and sea level rise, which can cause direct damage to these crucial and sensitive ecosystems as well as increase their susceptibility to and decrease their resilience from encounters with all other threats, including disease, pathogens, and genetic disorders.

Increases in ocean temperature can lead to coral stress, bleaching, and mortality. Coral and other marine invertebrate (e.g., anemones, giant clams) bleaching, which occurs when corals expel the symbiotic algae living in their tissues, is a stress response often tied to atypically high sea temperatures or changes in light availability but also can be attributed to nutrients, toxicants, and pathogens (National Oceanic and Atmospheric Administration, 2017). Bleaching events have increased in frequency in recent decades, and coral bleaching on a global scale has occurred during the summers of 2014, 2015, and 2016. Likewise, ocean acidification has the potential to reduce calcification and growth rates in species with calcium carbonate skeletons, including shellfish, corals, and sponges, and possibly even lobsters and sea cucumbers. In addition to physical effects, increased acidity may result in behavioral changes in some species, such as burrowing behavior and juvenile dispersal patterns of the soft-shell clam and reduction in the loudness and number of snaps in the snapping shrimp.

Although the potential effects that climate change could have on future storm activity are uncertain, numerous researchers suggest that rising temperatures could result in little change to the overall number of storms, but that storm intensity could increase. Increased storm intensity could result in increased physical damage to individual corals and reefs constructed by the corals (which support numerous other invertebrate taxa), overturning of coral colonies, and a decrease in structural complexity (due to disproportionate breakage of branching species). However, large storms such as hurricanes may also have positive impacts on corals, such as lowering the water temperature and removing less resilient macroalgae from reef structures, which can overgrow corals.

Sea level rise could affect invertebrates by modifying or eliminating habitat, particularly estuarine and intertidal habitats bordering steep and artificially hardened shorelines. Likewise, changes in ocean circulation patterns could affect the planktonic food supply of filter- and suspension-feeding invertebrates. Cumulative effects of threats from fishing, pollution, and other human disturbance may reduce the tolerance of corals and other invertebrates to global climate change.

### 4.4.8.4 Impacts of the Proposed Action That May Contribute to Cumulative Impacts

The analysis presented in Section 3.8 (Marine Invertebrates) indicates that the Proposed Action could impact marine invertebrates through acoustic stressors (sonar and other transducers, air guns, vessel noise, weapons noise), explosives, energy stressors (in-water electromagnetic devices, high-energy lasers), physical disturbance or strikes (vessels and in-water devices, military expended materials, seafloor devices, pile driving), entanglement (wires and cables, decelerators/parachutes), and ingestion of military expended materials. Potential impacts include short-term behavioral and physiological responses (Celi et al., 2015; Edmonds et al., 2016; Roberts et al., 2016). Some stressors could also result in injury or mortality to a relatively small number of individuals. The potential for impacts on ESA-listed corals would be avoided by mitigation designed to avoid locations where they are present, except at designated locations and nearshore training areas where seafloor resources will be avoided to the maximum extent practicable. For example, the Navy will not conduct certain activities within a specified distance of shallow-water coral reefs, live hard bottom, artificial reefs, and shipwrecks (Chapter 5, Mitigation) as much as is practicable. Employment of these measures will help avoid or reduce potential impacts on invertebrates that inhabit these areas.

#### 4.4.8.5 Cumulative Impacts on Marine Invertebrates

Some direct impacts on invertebrates are expected, and the impacts of the Proposed Action could be cumulative with other actions that cause disturbance and mortality of marine invertebrates. However, it is anticipated that the incremental contribution of the proposed alternatives would be insignificant for the following reasons:

- Invertebrates are generally abundant and relatively short-lived; thus, with the exception of sessile species located near areas of repeated Navy activities (e.g., pierside locations), few individuals would likely be affected repeatedly by the same event.
- Invertebrates generally have high reproductive rates, short reproductive cycles, and resilient dispersal mechanisms; thus, local communities are likely to reestablish quickly.
- Most of the proposed activities would occur over dispersed, deep water areas where marine invertebrates are more sparsely distributed but not at the same specific point each time and, therefore, would be unlikely to affect the same individual invertebrates.
- Marine invertebrates are not particularly susceptible to energy, entanglement, or ingestion stressors resulting from Navy activities, and none of the alternatives would result in or interact with impacts that have been historically significant to marine invertebrates, such as overfishing, nutrient loading, disease, or the presence of invasive species.
- None of the alternatives would result in long-term or widespread changes in environmental conditions, such as turbidity, salinity, pH, or water temperature that could impact marine habitats or interact with existing trends affecting these parameters.
- The Navy will not conduct certain activities within a specified distance of shallow coral reefs, live hard bottom, artificial reefs, or submerged cultural resources such as shipwrecks (except designated locations, where these resources will be avoided to the maximum extent practicable). Underwater detonations that would occur in the nearshore areas are only conducted in designated locations and away from known seafloor resources such as shallow coral reefs, live hard bottom, artificial reefs, or submerged cultural resources such as shipwrecks, to the maximum extent practicable. All features that have been identified are included in Chapter 5 (Mitigation).

Although the aggregate impacts of other stressors in the ocean environment continue to have significant impacts on some marine invertebrate species in the Study Area, particularly the effects of global climate change on corals, the Proposed Action is not likely to incrementally contribute to population-level stress and decline of the resource. Due to the effects of global climate change, corals may be less resilient to additional stressors; however, it is not anticipated that the Navy will cause direct effects to coral reef systems. As impacts would be isolated, localized, and not likely to overlap with other relevant stressors, it is anticipated that the incremental contribution of the Proposed Action, when added to the impacts of all other past, present and reasonably foreseeable future actions, would not result in measurable additional impacts on marine invertebrates in the Study Area or beyond.

### 4.4.9 Marine Fishes

In the 2015 MITT Final EIS/OEIS, the analysis presented in Section 3.9 (Fishes) indicated that fishes, including ESA-listed scalloped hammerhead sharks, oceanic whitetip sharks, and giant manta rays could be affected by acoustic stressors (sonar and other transducers, explosives, swimmer defense air guns; 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 (military expended materials – munitions and military expended materials – other than munitions) and remains valid in this SEIS/OEIS.

Overfishing is discussed as a threat to marine fishes in the Study Area in the Socioeconomics analysis in this SEIS/OEIS (Section 3.12.1.4.1.1, Guam, and 3.12.1.4.1.2, Commonwealth of the Northern Mariana Islands). While target fish species may be less available, which may have a greater impact on the success of traditional practices like subsistence fishing, overall traditional fishing practices on Guam and in the Commonwealth of the Northern Mariana Islands have not changed appreciably since the 2015 MITT Final EIS/OEIS, and the analysis in the 2015 MITT Final EIS/OEIS remains valid. Refer to Section 3.12.2.3 (Subsistence Use) of the 2015 MITT Final EIS/OEIS for a discussion of subsistence fishing practices on Guam and in the Commonwealth of the Northern Mariana Islands.

The current aggregate impacts of past, present, and reasonably foreseeable future actions presented in Section 4.2 (Projects and Other Activities Analyzed for Cumulative Impacts) may potentially affect fishes, including ESA-listed scalloped hammerhead sharks, oceanic whitetip sharks, and giant manta rays. Aggregate impacts associated with the other actions discussed in Section 4.2 (Projects and Other Activities Analyzed for Cumulative Impacts) and Table 4.2-1 could result in injury and mortality. Although this SEIS/OEIS does address some of these other actions listed in Section 4.2 (Projects and Other Activities Analyzed for Cumulative Impacts), 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 no specific details are known regarding the impacts or effects to individuals or populations. Alternatives 1 or 2 could also result in injury and mortality to fish from in-water explosions, entanglement, and strikes. Injury and mortality that might occur under Alternatives 1 or 2 would be additive to injury and mortality associated with other actions. However, the relative contribution of Alternatives 1 or 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 in injury or mortality would be to a relatively small number of individuals.
- No population-level impacts are anticipated.

Under this SEIS/OEIS, the contribution of proposed increases in training and testing activities under Alternative 1 or Alternative 2 would still be negligible based on the reasons presented above. Based on the analysis presented in Section 3.9 (Fishes) 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 fishes is not warranted.

### 4.4.10 Terrestrial Species and Habitats

The only terrestrial location included in the region of influence for this SEIS/OEIS is FDM. Military use of FDM as a bombing range has occurred for decades, with the lease agreement formalized with the newly formed CNMI in 1983 (United States of America and Commonwealth of the Northern Mariana Islands, 1983). Since the late 1990s, the Navy has established restrictions on the types of ordnance used on FDM and where ordnance can be targeted in compliance with past biological opinions and Sikes Act obligations. These measures confine the impacts on discrete impact zones on the island, in contrast to island-wide targeting prior to the establishment of restrictions. By establishing these restrictions, the impacts of decades of military use of the island are reduced (e.g., not targeting a remnant forest patch on the north end of the island and allowing its recovery), and current and future ordnance use on the island are confined to discrete impact zones on the island. The activities that only occur on FDM other than training activities described in this SEIS/OEIS and the 2015 MITT Final EIS/OEIS include: (1) range maintenance activities and periodic ordnance cleanup actions (U.S. Department of the Navy, 2013), and (2) ecological monitoring of natural resources on the island. Both of these activities are interrelated. For example, range clearance activities are required to maintain a suitable training environment on the range (e.g., ordnance cleanup, target maintenance). Surveys are conducted on the island in compliance with biological opinions and Sikes Act obligations associated with military use of the island. All of these activities are authorized and scheduled by the Navy, and entrance rights are conveyed to the Navy through the lease agreement with CNMI. In summary, there are no additional actions that would occur on FDM; therefore, an analysis of cumulative impacts is not warranted.

### 4.4.11 Cultural Resources

In the 2015 MITT Final EIS/OEIS, Alternatives 1 or 2 concluded that 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 historic properties within U.S. territorial waters or 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 Mariana Islands Range Complex Programmatic Agreement.

The contribution of proposed increases in training and testing activities under Alternative 1 or Alternative 2 in this SEIS/OEIS would be negligible because the Navy routinely avoids locations of known obstructions, which includes submerged cultural resources, to prevent damage to sensitive Navy equipment and vessels and to avoid or reduce impacts on known submerged resources. The current aggregate impacts of past, present, and reasonably foreseeable future actions presented in Section 4.2 (Projects and Other Activities Analyzed for Cumulative Impacts) may have an effect on cultural resources. Actions that would contribute to cumulative impacts on cultural resources would involve some form of disturbance to the ocean bottom in areas where cultural resources are present. Actions that would disturb the ocean bottom could impact submerged cultural resources if those resources are not avoided.

Other actions that result in ocean bottom disturbance require federal agencies to take into account the effects of their undertakings on historic properties. If it is determined that there would be an adverse effect to a cultural resource that qualifies for the National Register, the federal agency would work to avoid, minimize, or mitigate the adverse effect. For example, the Bureau of Ocean Energy Management has procedures in place to identify the probability of the presence of submerged historic properties shoreward from the 148-foot (45-meter) isobaths, informing the Navy to avoid locations of known obstructions, which includes submerged cultural resources. 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, but are greatly reduced when avoidance measures are put in place.

Effects to submerged historic properties from other actions would typically be avoided or mitigated through compliance with federal regulations. However, impacts could occur if avoidance measures were not implemented or if inadvertent disturbance or destruction of the characteristics or the historic property that qualify it for inclusion on the National Register occurs. Disturbance or destruction of submerged historic properties, including shipwrecks, would diminish the overall record for these properties and decrease the potential for meaningful research. When considered with other actions, Alternatives 1 or 2 would not contribute to cumulative impacts on submerged historic properties because the Navy routinely avoids locations of known obstructions, which includes submerged cultural resources.

### 4.4.12 Socioeconomic Resources

In Section 3.12 (Socioeconomic Resources) of the 2015 MITT Final EIS/OEIS, the analysis determined that training and testing activities under Alternatives 1 or 2 would limit public access to certain nearshore areas used for commercial and recreational fishing, certain tourism activities, and subsistence fishing. However, limits on accessibility to these areas were not expected to significantly impact socioeconomic resources, because the majority of restrictions would be temporary, lasting hours, with the exception of the 3 NM danger zone surrounding FDM, which is permanently closed to ensure public safety. Other surface danger zones and temporary exclusion areas would be accessible to the public for fishing, transiting, or other activities when military activities are not occurring. When an area is closed for a training and testing activity, mariners are permitted to transit directly through a danger zone to a destination outside of the danger zone but are not allowed to anchor or loiter within the danger zone. Military activities utilizing the danger zone or restricted area would be halted until the danger zone or restricted area is cleared of transiting vessels.

Under this SEIS/OEIS, cumulative impacts on fishing may occur from frequent or extended, but temporary, closures of restricted areas and danger zones in the Study Area. The Navy attempts to mitigate these impacts by using a variety of communication methods (e.g., Notices to Mariners [NOTMARs], e-mails, Facebook posts) to inform the public of upcoming events that may limit access to certain areas. Dates and times of scheduled closures are provided in announcements to allow fishers, tour boat operators, and any other commercial or recreational vessels that may be in the area to plan accordingly.

As a result of previous discussions with fishers, the Navy no longer restricts access to the northern portion of W-517 while military activities are conducted in the southern portion of the warning area, which allows fishers to access popular fishing sites south of Guam. The Navy also informs the public of extended periods of time when the restricted area (beyond 3 NM from shore) surrounding FDM will be accessible. The military will continue to collaborate with local communities and stakeholders to develop efficient and effective communication with the public. The goals of these on-going and evolving efforts are (1) to reduce socioeconomic impacts associated with limiting access to areas used by the public, and (2) to ensure the safety of the public and military personnel. Under this SEIS/OEIS, the contribution of proposed increases in training and testing activities under Alternative 1 or Alternative 2 would still be negligible based on the analysis summarized above and described in greater detail in the 2015 MITT Final EIS/OEIS, Section 3.12 (Socioeconomic Resources).

#### 4.4.12.1 Resource Trends

Trends in commercial transportation and shipping are described in Section 3.12.1.1 (Commercial Transportation and Shipping) and indicate that commercial shipping has remained consistent over the past five years. Trends in commercial fishing and tourism are described in Section 3.12.1.2 (Commercial and Recreational Fishing) and Section 3.12.1.3 (Tourism), respectively. Commercial fisheries landing in Guam declined steadily from 2010 through 2015 mainly due to the declining abundance of reef fish around the island, which make up a large percentage of the target species (Weijerman et al., 2016). Trends in commercial fisheries around the CNMI are less clear. Landings from 2010 through 2015 were highest in 2013 and 2014 but declined to their lowest totals in 2015. Tourism trends are mixed for both Guam and the CNMI. The number of visitors from Japan, the largest market, has been declining in recent years, but tourism from other Asian nations, particularly China, has increased and is expected to continue to grow. Trends in recreational fishing are partially driven by trends in tourism. While both recreational fishing and subsistence fishing by residents of Guam and the CNMI remain popular, there are no data that indicate specific trends in either resource.

#### 4.4.12.2 Impacts of Other Actions

The impacts of actions related to coastal development and infrastructure development listed in Table 4.2-1 would generally contribute positively to socioeconomic conditions on Guam and in the CNMI. Water quality and wastewater treatment on Saipan should improve; additional jobs in tourism and retail are likely with further coastal development; and tourism, the largest economic driver, should also be supported by these projects. Other military activities that limit access to popular fishing sites could increase cumulative socioeconomic impacts on commercial, recreational, and subsistence fishers beyond impacts associated with the Proposed Action. Increases in marine debris and pollution (Table 4.2-1) in waters surrounding Guam and the CNMI would potentially impact tourism and fisheries and contribute to cumulative impacts on socioeconomic resources or restrict vessel movement in the Study Area. The effects of climate change on the marine environment could have similar, long-term, cumulative impacts on fisheries and tourism in the region if the marine resources that support these industries are diminished.

#### 4.4.12.3 Cumulative Impacts on Socioeconomic Resources

The current aggregate impacts of past, present, and reasonably foreseeable future actions have the potential to result in significant cumulative impacts on certain socioeconomic resources in the Study Area. The impacts would be considered significant if they resulted in extensive limitations on accessibility by residents, businesses, and tourists to ocean areas needed for commercial, recreational, and subsistence fishing and tourism. If tourism continues to expand, the desire to transit to and access popular ocean areas may also increase. Maintaining efficient and effective communication methods with the public is expected to avoid or reduce conflicts between military and civilian activities in the Study Area.

### 4.4.13 Public Health and Safety

In the 2015 MITT Final EIS/OEIS, the analysis presented in Section 3.13 (Public Health and Safety) indicated that the impacts of Alternatives 1 or 2 on public health and safety would be negligible. Under this SEIS/OEIS, Alternatives 1 or 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 of Cumulative Impacts

Marine mammals, sea turtles, marine invertebrates, and socioeconomic resources are the primary resources of concern for cumulative impacts analysis:

- Past human activities have impacted these resources to the extent that several marine mammals, sea turtles, and marine invertebrates occurring in the Study Area are ESA listed. Several marine mammal species and stocks are also classified as strategic stocks under MMPA.
- The use of sonar and other non-impulsive sound sources under Alternative 1 and Alternative 2 has the potential to disturb or injure marine mammals and sea turtles.
- Explosive detonations under Alternative 1 and Alternative 2 have the potential to disturb, injure, or kill marine mammal, and sea turtle species.
- Under Alternative 1 or Alternative 2, proposed danger zones could potentially restrict access to fishing and recreational areas when ranges are in use.

In summary, based on the analysis presented in Sections 3.4 (Marine Mammals), 3.5 (Sea Turtles), 3.8 (Marine Invertebrates), and 3.12 (Socioeconomic Resources), the current aggregate impacts of past, present, and other reasonably foreseeable future actions are not significantly different than the assessment in the 2015 MITT Final EIS/OEIS. For marine mammals, sea turtles, and marine invertebrates Alternatives 1 or 2 would contribute to an increase cumulative impacts, but the relative contribution would be low compared to other actions. Cumulative effects on socioeconomic resources may have short-term impacts on accessibility to public services, fishing sites, and tourism resources, but they are not expected to have long-term negative impacts on these resources or the economy of Guam and the CNMI. No new information or circumstances are significant enough to warrant further cumulative impact review.

## 4.6 Public Scoping Comments

The public raised a number of issues during the scoping period in regard to cumulative impacts. The issues are summarized in the list below.

- **Analyze the cumulative effects of all Department of Defense actions in the Mariana Islands, including CNMI Joint Military Training EIS –** The CNMI Joint Military Training EIS would establish a series of live-fire and maneuver ranges and training areas within the CNMI and include amphibious operations on Tinian. The proposed action for the CNMI Joint Military Training EIS is to expand existing ranges and training areas and construct new ranges and training areas within the CNMI. The resources evaluated that could contribute to cumulative impacts include geology and soils, water resources, air quality, noise, airspace, land and submerged land use, recreation, terrestrial biology, marine biology, cultural resources, visual resources, transportation, utilities, socioeconomics and environmental justice, hazardous materials and waste, and public health and safety. The Navy is drafting a revised EIS that would reduce impacts on resources as a result of the proposed action. The analysis of cumulative impacts contained in this chapter addresses cumulative effects of all Department of Defense actions on the Mariana Islands, including the CNMI Joint Military Training EIS.

- **Cumulative impacts from military-expended material and debris on water quality and marine biology –** The analysis of cumulative impacts on water quality from military expended material and debris concluded that although military expended material would occur in the Study Area as a result of training and testing activities, the Navy has defined standard operating procedures and committed to mitigation measures to offset potential impacts from military training and testing to sediment and water quality in the Study Area. The impact analysis conducted on marine biology (e.g., marine mammals, sea turtles, marine birds, marine vegetation, marine invertebrates, and fish) from military expended material and debris concluded that the military expended material and debris would not have a significant impact on water quality or habitat, therefore it would not have a significant impact on marine biology in the Study Area. Further analysis of cumulative impacts on water quality can be found in Section 4.4.1 (Sediments and Water Quality). Further analysis of cumulative impacts on marine biology can be found in Sections 4.4.4 through 4.4.9 (Marine Mammals, Sea Turtles, Marine Birds, Marine Vegetation, Marine Invertebrates, and Marine Fishes).
- **Cumulative impacts on marine mammals from use of explosives and sonar –** The cumulative impact analysis for marine mammals from the use of explosives and sonar concluded that the aggregate impacts of past, present, and other reasonably foreseeable future actions continue to have significant impacts on some marine mammal species in the Study Area. Proposed training and testing activities could result in additional stressors to individuals, which would both further compound effects on a given individual already experiencing stress and, in turn, have the potential to further stress populations, some of which may already be in significant decline or in the midst of stabilization and recovery. However, implementation of standard operating procedures would reduce the likelihood of overlap in time and space with other stressors, and implementation of mitigation measures would further reduce the likelihood of impact. Therefore, the incremental stressors anticipated from proposed training and testing activities are not anticipated to be significant. Further analysis of cumulative impacts on marine mammals can be found in Section 4.4.4 (Marine Mammals).
- **Cumulative impacts on seagrass, coral reef, and other invertebrate from sedimentation around FDM, military expended materials as marine debris, and sonar disrupting larval recruitment –** The cumulative impact analysis on seagrass and marine vegetation concludes that sedimentation around FDM and military expended materials as marine debris would have minimal impacts on seagrass and marine vegetation in the Study Area. Based on the analysis presented in Section 3.7 (Marine Vegetation) and the reasons summarized above, the incremental contribution of Alternatives 1 or 2 to cumulative impacts would be negligible. Further cumulative impact analysis on seagrass and marine vegetation can be found in Section 4.4.7 (Marine Vegetation). The cumulative impact analysis on coral reef and other invertebrates from sedimentation around FDM, military expended materials as marine debris, and sonar disrupting larval recruitment concluded that although the aggregate impacts of other stressors in the ocean environment continue to have significant impacts on some marine invertebrate species in the Study Area, particularly the effects of global climate change on corals, proposed training and testing activities are not likely to incrementally contribute to population-level stress and decline of the resource. Further cumulative impact analysis on marine invertebrates can be found in Section 4.4.8 (Marine Invertebrates).

- **Cumulative impacts on sea turtles, fish populations and their habitat –** The cumulative impacts analysis on sea turtles concluded that the aggregate impacts of past, present, and other reasonably foreseeable future actions continue to have significant impacts on all sea turtle species in the Study Area. Proposed training and testing activities could contribute incremental stressors to individuals, which would both further compound effects on a given individual already experiencing stress and in turn has the potential to further stress populations in significant decline or recovery efforts thereof. The cumulative impacts analysis on fish populations concluded that based on the analysis presented in Section 3.9 (Fishes) and the reasons summarized above, the incremental contribution of Alternatives 1 or 2 to cumulative impacts would be negligible. The cumulative impacts analysis on marine habitat concluded that based on the analysis presented in Section 3.3 (Marine Habitats) and the reasons summarized in Section 4.4.3 (Marine Habitats), the incremental contribution of Alternatives 1 or 2 to cumulative impacts would be negligible. Further analysis for cumulative impacts on sea turtles and fish can be found in Section 4.4.5 (Sea Turtles) and 4.4.9 (Fish) respectively.
- **Cumulative impact on the loss of access to FDM for traditional fishing practices –** The socioeconomic resources section analyzes traditional fishing practices that were identified by residents of Guam and the CNMI as having the potential to be impacted by the proposed training and testing activities occurring at sea and on FDM. Training and testing activities have the potential to temporarily limit access to areas of the ocean, which has the potential to impact traditional fishing practice in the Study Area. The military requests that the U.S. Coast Guard issue NOTMARs to warn the public of upcoming training and testing activities requiring the exclusive use of sea space and to ensure the safety of the public and military personnel. Data on the number of NOTMARs issued from the years 2013 through 2017 for FDM and W-517 were added to the previous three years of data presented in the 2015 MITT Final EIS/OEIS. The number of days affected by activities occurring at FDM and W-517 has varied over the eight-year period from the years 2010 through 2017. The data indicate a slightly increasing trend in affected days and potential impacts on accessibility; however, the peak totals are not substantially different from the previous eight years, and the trend appears to be cyclical (increases followed by decreases). Access to waters around FDM between 3 and 12 NM was restricted for an average of 160 days per year (peak of 201 in the year 2012), and access to waters under W-517 was restricted for an average of 91 days per year (peak of 136 in the year 2016). Access to waters within 3 NM of FDM is restricted at all times to ensure public safety during military activities using explosive munitions (33 Code of Federal Regulations 334, Danger Zone and Restricted Area Regulations).

  Traditional fishers in Guam and the CNMI would also be impacted by temporary restrictions limiting access to certain areas where traditional fishing practices take place. As described in Section 3.12.1.4.1 (Traditional Fishing Practices), many fishers identifying as traditional fishers also participate in recreational and commercial fishing, and it is not clear when fishers are engaging in traditional fishing, which has communal and cultural significance, and when they are fishing for financial gain or leisure or some combination of one or more of these motivations, which can occur even on a single fishing trip (Allen, 2013). These data suggest that traditional fishing likely occurs in the same locations as commercial and recreational fishing, and that traditional fishers would not be disproportionately impacted by temporary limits on access to fishing sites. Other fishing sites in the Study Area would be available to traditional fishers, and significant impacts on traditional fishing in the Study Area are not anticipated. Further cumulative analysis for socioeconomic resources can be found in Section 4.4.12 (Socioeconomic Resources).

- **Cumulative impact on reduced fishing access, recreational fishing, commercial fishing and transport between the Mariana Islands from the restricted areas –** Access to certain areas of the Study Area around islands and in the open ocean is temporarily restricted during potentially hazardous training and testing activities to ensure the safety of the public and military personnel. Danger zones may result from other Department of Defense actions in Guam and the Mariana Islands such as the Guam and Commonwealth of the Northern Mariana Islands Military Relocation and CNMI Joint Military Training. These other actions would occur mainly on land and around Tinian. As a result of the training and testing activities associated with this SEIS/OEIS, areas within 3 NM of FDM are permanently restricted to maintain public safety. Even when hazardous activities are not occurring at FDM, the potential occurrence of unexploded ordnance in waters surrounding the island is a constant threat to public safety. Transiting between Guam, Saipan, Tinian, or other islands located to the south of FDM and the Islands Unit (Northern Mariana Islands) would potentially be impacted by limiting access to the 12 NM danger zone around FDM. Considering that an average of 3.8 trips per year has occurred over the past 30 years (as stated in Section 3.12.3, Public Scoping Comments), the probability of military activities interfering with trips to the Islands Unit is low. Furthermore, the military will announce when FDM is not in use in addition to notifying mariners of planned activities at FDM, which will enable mariners to better plan trips to the Islands Unit. Further analysis can be found for recreational and commercial fishing and transport in Section 4.4.12 (Socioeconomic Resources).
- **Cumulative effects analysis of the ocean as an ecosystem –** The cumulative impacts analysis for water resources concluded that 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 or 2 to cumulative impacts would be low and further analysis of cumulative impacts is not warranted. Further analysis of the ocean as an ecosystem and cumulative impacts can be found in Section 4.4.1 (Sediments and Water Quality) and Section 4.4.3 (Marine Habitats).
- **Assess cumulative effects to consider a resource response to change and capacity to withstand stress –** Stressors are considered in the cumulative effects analysis for each resource. These resources are analyzed in Sections 4.4.1 through 4.4.13.
- **Cumulative effects analysis should reflect the beach landing activity addressed in the 2015 MITT ROD (no Amphibious Assault Vehicle or Landing Craft Air Cushion landing on Tinian beaches) –** Beach landing activities would continue as discussed in the 2015 MITT Final EIS/OEIS. This SEIS/OEIS is an update to the in-water activities in the Study Area. Land activities are addressed in the 2015 MITT Final EIS/OEIS and can be found in Section 3.5 (Sea Turtles) of that document.
- **Cumulative impacts assessing the length and frequency of each individual training activity and the potential rate of resource recovery –** The cumulative impacts assessment takes into account the length and frequency of each training and testing activity and resource recovery as they are analyzed in their individual resource sections (Sections 3.1 through 3.13).

- **Utilize Caltrans/Federal Highways Administration cumulative impacts methodology/eight-step process –** The Caltrans/Federal Highways Administration cumulative impacts eight-step methodology is very similar to the cumulative impacts chapter analysis used in this document. The similarities are as follows: (step 1) The Navy has identified resources to consider; (step 2) defined the region of influence for each resource; (step 3) described the current health and historical context of each resource in Chapter 3 (Affected Environment and Environmental Consequences); (step 4) identified the direct and indirect impacts of the Proposed Action in the Environmental Consequences section of Chapter 3; (step 5) identified current and reasonably foreseeable future actions or projects in Table 4.2-1; (step 6) assessed the potential cumulative impacts in this chapter; (step 7) reported the results of the cumulative impact analysis in this chapter; and (step 8) assessed the need for mitigation and recommendations for actions by other agencies in Chapter 5 (Mitigation).

# REFERENCES

Allen, S. (2013). Carving a niche or cutting a broad swath: Subsistence fishing in the western Pacific. *Pacific Science, 67*(3), 477–488.

Avens, L. (2003). Use of multiple orientation cues by juvenile loggerhead sea turtles *Caretta caretta*. *The Journal of Experimental Biology, 206*(23), 4317–4325.

Baker, C. S., V. Lukoschek, S. Lavery, M. L. Dalebout, M. Yong-un, T. Endo, and N. Funahashi. (2006). Incomplete reporting of whale, dolphin and porpoise 'bycatch' revealed by molecular monitoring of Korean markets. *Animal Conservation, 9*(4), 474–482.

Bartol, S. M., and J. A. Musick. (2003). Sensory Biology of Sea Turtles. In P. L. Lutz, J. A. Musick, & J. Wyneken (Eds.), *The Biology of Sea Turtles* (Vol. 2, pp. 16). Boca Raton, FL: CRC Press Books.

Bartol, S. M., and D. R. Ketten. (2006). *Turtle and Tuna Hearing* (NOAA Technical Memorandum NMFS-PIFSC-7). Honolulu, HI: Pacific Islands Fisheries Science Center.

Bassett, C., J. Thomson, and B. Polagye. (2010). *Characteristics of Underwater Ambient Noise at a Proposed Tidal Energy Site in Puget Sound*. Seattle, WA: Northwest National Marine Renewable Energy Center.

Baulch, S., and C. Perry. (2014). Evaluating the impacts of marine debris on cetaceans. *Marine Pollution Bulletin, 80*(1–2), 210–221.

Baumann-Pickering, S., L. K. Baldwin, A. E. Simonis, M. A. Roche, M. L. Melcon, J. A. Hildebrand, E. M. Oleson, R. W. Baird, G. S. Schorr, D. L. Webster, and D. J. McSweeney. (2010). *Characterization of Marine Mammal Recordings from the Hawaii Range Complex*. Monterey, CA: Naval Postgraduate School.

Bergmann, M., L. Gutow, and M. Klages. (2015). *Marine Anthropogenic Litter*. New York, NY and London, United Kingdom: Springer.

Bureau of Ocean Energy Management. (2011). *Proposed Outer Continental Shelf Oil & Gas Leasing Program 2012–2017*. Washington, DC: U.S. Department of the Interior, Bureau of Ocean Energy Management.

Bureau of Ocean Energy Management. (2016). *Fact Sheet: Environmental Studies–Electromagnetic Fields*. Sterling, VA: U.S. Department of the Interior, Bureau of Ocean Energy Management. Retrieved from www.boem.gov.

Carretta, J. V., M. M. Muto, J. Greenman, K. Wilkinson, D. Lawson, J. Viezbicke, and J. Jannot. (2017). *Sources of Human-Related Injury and Mortality for U.S. Pacific West Coast Marine Mammal Stock Assessments, 2011–2015* (NOAA Technical Memorandum NMFS-SWFSC-579). La Jolla, CA: Southwest Fisheries Science Center.

Celi, M., F. Filiciotto, M. Vazzana, V. Arizza, V. Maccarrone, M. Ceraulo, S. Mazzola, and G. Buscaino. (2015). Shipping noise affecting immune responses of European spiny lobster (*Palinurus elephas*). *Canadian Journal of Zoology, 93*, 113–121.

Council on Environmental Quality. (1997). *Considering Cumulative Effects Under the National Environmental Policy Act*. Washington, DC: The Council on Environmental Quality.

Davison, P., and R. G. Asch. (2011). Plastic ingestion by mesopelagic fishes in the North Pacific Subtropical Gyre. *Marine Ecological Progress Series, 432*, 173–180.

DeMaster, D. P., C. W. Fowler, S. L. Perry, and M. F. Richlen. (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.

Edmonds, N. J., C. J. Firmin, D. Goldsmith, R. C. Faulkner, and D. T. Wood. (2016). A review of crustacean sensitivity to high amplitude underwater noise: Data needs for effective risk assessment in relation to UK commercial species. *Marine Pollution Bulletin, 108*, 5–11.

Falcone, E. A., G. S. Schorr, S. L. Watwood, S. L. DeRuiter, A. N. Zerbini, R. D. Andrews, R. P. Morrissey, and D. J. Moretti. (2017). Diving behaviour of Cuvier's beaked whales exposed to two types of military sonar. *Royal Society Open Science, 4*(170629), 1–21.

Fechter, L. D., and B. Pouyatos. (2005). Ototoxicity. *Environmental Health Perspectives, 113*(7), 443–444.

Federal Communications Commission. (2017). *Submarine Cables*. Retrieved from https://www.fcc.gov/submarine-cables.

Finkbeiner, E. M., B. P. Wallace, J. E. Moore, R. L. Lewison, L. B. Crowder, and A. J. Read. (2011). Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between 1990 and 2007. *Biological Conservation, 144*(11), 2719–2727.

Geijer, C. K. A., and A. J. Read. (2013). Mitigation of marine mammal bycatch in U.S. fisheries since 1994. *Biological Conservation, 159*, 54–60.

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.

Hansen, L. P., and M. L. Windsor. (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.

Hazel, J., I. R. Lawler, H. Marsh, and S. Robson. (2007). Vessel speed increases collision risk for the green turtle *Chelonia mydas*. *Endangered Species Research, 3*, 105–113.

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. (2017). *Human-Caused Mortality and Injury of NMFS-Managed Alaska Marine Mammal Stocks, 2011–2015* (NOAA Technical Memorandum NMFS-AFSC-354). Seattle, WA: Alaska Fisheries Science Center.

Humber, F., B. J. Godley, and A. C. Broderick. (2014). So excellent a fishe: A global overview of legal marine turtle fisheries. *Diversity and Distributions, 20*(5), 579–590.

Intergovernmental Panel on Climate Change. (2018). Summary for Policymakers. In V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, & T. Waterfield (Eds.), Global warming of 1.5°C (Vol. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty pp. 32). Geneva, Switzerland: World Meteorological Organization.

International Council for the Exploration of the Sea. (2005). *Report of the Ad-Hoc Group on the Impact of Sonar on Cetaceans*. Copenhagen, Denmark: Conseil International pour l’Exploration de la Mer.

International Maritime Organization. (2017). *Current Awareness Bulletin*. London, United Kingdom: Maritime Knowledge Centre.

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. *Science, 293*, 629–638.

Jones, T. T., and S. L. Martin. (2016). *Sea Turtle Tagging in the Mariana Islands Training and Testing (MITT) Study Area*. Silver Spring, MD: National Oceanic and Atmospheric Administration, Fisheries Marine Turtle Biology and Assessment Program Protected Species Division.

Kaluza, P., A. Kölzsch, M. T. Gastner, and B. Blasius. (2010). The complex network of global cargo ship movements. *Proceedings of the Royal Society, 7*(48), 11.

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.

Ketten, D. R., and S. Moein-Bartol. (2006). *Functional Measures of Sea Turtle Hearing*. Woods Hole, MA: Woods Hole Oceanographic Institution.

Laist, D. W., and C. Shaw. (2006). Preliminary evidence that boat speed restrictions reduce deaths of Florida manatees. *Marine Mammal Science, 22*(2), 472–479.

Lam, T., Lingxu, S. Takahashi, and E. A. Burgess. (2011). *Market Forces: An Examination of Marine Turtle Trade in China and Japan*. Hong Kong, China: TRAFFIC East Asia.

Law, K. L., S. Moret-Ferguson, N. A. Maximenko, G. Proskurowski, E. E. Peacock, J. Hafner, and C. M. Reddy. (2010). Plastic accumulation in the North Atlantic Subtropical Gyre. *Sciencexpress, 329*, 1–8.

Lent, R., and D. Squires. (2017). Reducing marine mammal bycatch in global fisheries: An economics approach. *Deep-Sea Research II: Topical Studies in Oceanography, 140*, 268–277.

Levenson, D. H., S. A. Eckert, M. A. Crognale, J. F. Deegan, II, and G. H. Jacobs. (2004). Photopic spectral sensitivity of green and loggerhead sea turtles. *Copeia, 4*, 908–914.

Lohmann, K. J., and C. M. F. Lohmann. (1992). Orientation to oceanic waves by green turtle hatchlings. *The Journal of Experimental Biology, 171*, 1–13.

Lohmann, K. J., and C. M. F. Lohmann. (1996). Orientation and open-sea navigation in sea turtles. *The Journal of Experimental Biology, 199*, 73–81.

Losinio, L. (2017). Cabling the islands into the future. *Pacific Island Times*. Retrieved from http://www.pacificislandtimes.com/single-post/2017/05/03/Cabling-the-islands-into-the-future.

Lutcavage, M. E., P. Plotkin, B. Witherington, and P. L. Lutz. (1997). Human impacts on sea turtle survival. In P. L. Lutz & J. A. Musick (Eds.), *The Biology of Sea Turtles* (pp. 387–409). New York, NY: CRC Press.

Maison, K. A., I. K. Kelly, and K. P. Frutchey. (2010). *Green Turtle Nesting Sites and Sea Turtle Legislation throughout Oceania* (National Oceanic and Atmospheric Administration Technical Memorandum NMFS-F/SPO-110). Silver Spring, MD: Scientific Publications Office.

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

McDonald, M. A., J. A. Hildebrand, and S. M. Wiggins. (2006). Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California. *The Journal of the Acoustical Society of America, 120*(2), 711–718.

Meadows, D. W. (2016). *Petition to List the Tridacninae Giant Clams (Excluding Tridacna rosewateri) as Threatened or Endangered Under the Endangered Species Act*. Ellicott City, MD: Giant Clam Petition.

Minerals Management Service. (2007). *Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf: Final Environmental Impact Statement*. New Orleans, LA: Gulf of Mexico OCS Region.

Mrosovsky, N., G. D. Ryan, and M. C. James. (2009). Leatherback turtles: The menace of plastic. *Marine Pollution Bulletin, 58*(2), 287–289.

Myers, R. A., and B. Worm. (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*. Lafayette, LA: Southeast Regional Office, Protected Resources Division.

National Marine Fisheries Service. (2015a). *Marine Aquaculture Strategic Plan FY 2016–2020*. Silver Spring, MD: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

National Marine Fisheries Service. (2015b). *Reinitiated Biological Opinion and Conference Report on U.S. Navy Hawaii-Southern California Training and Testing*. Washington, DC: The United States Navy and National Oceanic and Atmospheric Administration's National Marine Fisheries Service, Office of Protected Resources' Permits and Conservation Division.

National Marine Fisheries Service. (2016). *U.S. National Bycatch Report First Edition Update 2*. Silver Spring, MD: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Retrieved from http://www.st.nmfs.noaa.gov/observer-home/first-edition-update-2.

National Oceanic and Atmospheric Administration. (2013). Takes of Marine Mammals Incidental to Specified Activities; U.S. Navy Training and Testing Activities in the Hawaii-Southern California Training and Testing Study Area; Final Rule. *Federal Register, 78*(247), 78106–78158.

National Oceanic and Atmospheric Administration. (2017). *Coral Bleaching and Disease*. Retrieved from https://www.pifsc.noaa.gov/cred/coral_bleaching_and_disease.php.

National Oceanic and Atmospheric Administration Marine Debris Program. (2014). *Report on the Entanglement of Marine Species in Marine Debris with an Emphasis on Species in the United States*. Silver Spring, MD: National Oceanic and Atmospheric Administration.

National Research Council of the National Academies. (1990). *Decline of the Sea Turtles: Causes and Prevention*. Washington, DC: The National Academies Press.

Nowacek, D., M. Johnson, and P. Tyack. (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.

O'Shea, T. J., R. R. Reeves, and A. K. Long. (1999). *Marine Mammals and Persistent Ocean Contaminants.* Paper presented at the Marine Mammal Commission Workshop October 12–15 1998. Keystone, CO.

Ormerod, S. J. (2003). Current issues with fish and fisheries: Editor's overview and introduction. *Journal of Applied Ecology, 40*(2), 204–213.

Poloczanska, E. S., M. T. Burrows, C. J. Brown, J. G. Molinos, B. S. Halpern, O. Hoegh-Guldberg, C. V. Kappel, P. J. Moore, A. J. Richardson, D. S. Schoeman, and W. J. Sydeman. (2016). Responses of marine organisms to climate change across oceans. *Frontiers in Marine Science, 3*(62), 1–21.

Raymundo, L. J., D. Burdick, V. A. Lapacek, R. J. Miller, and V. Brown. (2017). Anomalous temperatures and extreme tides: Guam staghorn *Acropora* succumb to a double threat. *Marine Ecology Progess Series, 564*, 47–55.

Read, A., P. Drinker, and S. Northridge. (2006). Bycatch of marine mammals in U.S. and global fisheries. *Conservation Biology, 20*(1), 163–169.

Reijnders, P. J. H., A. Aguilar, and A. Borrell. (2009). Pollution and marine mammals. In W. F. Perrin, B. Wursig, & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 890–898). Cambridge, MA: Academic Press.

Roberts, L., S. Cheesman, M. Elliott, and T. Breithaupt. (2016). Sensitivity of *Pagurus bernhardus* (L.) to substrate-borne vibration and anthropogenic noise. *Journal of Experimental Marine Biology and Ecology, 474*, 185–194.

SeeTurtles.org. (2017). *Coastal Development and Sea Turtles*. Retrieved from http://www.seeturtles.org/coastal-development/.

Song, K.-J. (2017). Bycatch of cetaceans on Korea fisheries in the East Sea. *Fisheries Research, 197*, 7–9.

U.S. Army. (2015). *Draft Environmental Assessment Terminal High-Altitude Area Defense (THAAD) Permanent Stationing in Guam*. Huntsville, AL: 94th Army Air and Missile Defense Command.

U.S. Department of Defense. (2016). *2016 Operational Energy Strategy*. Washington, DC: U.S. Department of Defense.

U.S. Department of the Air Force. (2016). *Final Environmental Impact Statement for Divert Activities and Exercises, Commonwealth of the Northern Mariana Islands*. Joint Base Pearl Harbor-Hickam, HI: U.S. Air Force.

U.S. Department of the Navy. (2012). *Final Supplemental Environmental Impact Statement/Supplemental Oversea Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar*. Arlington, VA: Chief of Naval Operations.

U.S. Department of the Navy. (2013). *Operational Range Clearance Plan for the Mariana Islands Range Complex/Farallon de Medinilla*. Pearl Harbor, HI: Naval Facilities Engineering Command Pacific.

U.S. Department of the Navy. (2015a). *Final Supplemental Environmental Impact Statement Guam and Commonwealth of the Northern Mariana Islands Military Relocation (2012 Roadmap Adjustments)*. Washington, DC: Naval Facilities Engineering Command, Pacific.

U.S. Department of the Navy. (2015b). *Draft Commonwealth of the Northern Mariana Islands Joint Military Training Environmental Impact Statement/Overseas Environmental Impact Statement*. Honolulu, HI: Department of Interior, Office of Insular Affairs, Federal Aviation Administration, International Broadcasting Bureau, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, and U.S. Army Corps of Engineers.

United States of America and 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*. Washington, DC: United States Code.

Wallace, B. P., R. L. Lewison, S. L. McDonald, R. K. McDonald, C. Y. Kot, S. Kelez, R. K. Bjorkland, E. M. Finkbeiner, S. Helmbrecht, and L. B. Crowder. (2010). Global patterns of marine turtle bycatch. *Conservation Letters, 3*(3), 131–142.

Weijerman, M., I. Williams, J. Gutierrez, S. Grafeld, B. Tibbatts, and G. Davis. (2016). Trends in biomass of coral reef fishes, derived from shore-based creel surveys in Guam. *Fishery Bulletin, 114*(2), 237–256.

Wong, A., and L. Cruz. (2018). The Media Barely Covered One of the Worst Storms to Hit U.S. Soil. *Science*. Retrieved from https://www.theatlantic.com/science/archive/2018/11/super-typhoon-yutu-mainstream-media-missed-northern-mariana-islands/575692/.

# 5 Mitigation

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# 5 Mitigation

## 5.1 Introduction

This chapter describes the mitigation measures that the United States (U.S.) Department of the Navy (Navy) will implement to avoid or reduce potential impacts from the Mariana Islands Training and Testing (MITT) Supplemental Environmental Impact Statement (SEIS)/Overseas Environmental Impact Statement (OEIS) Proposed Action. This chapter has been updated in its entirety since Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) of the 2015 MITT Final Environmental Impact Statement (EIS)/OEIS (U.S. Department of the Navy, 2015). This SEIS/OEIS was prepared in coordination with the U.S. Air Force and U.S. Coast Guard, and these Services will implement applicable mitigation measures developed by the Navy for the Proposed Action. Under the Proposed Action, military readiness activities would be conducted at sea or on Farallon de Medinilla (FDM). Therefore, several mitigation measures developed for the 2015 MITT Final EIS/OEIS, such as mitigation for invasive species control and training activities conducted on the islands of Guam, Rota, Tinian, and Saipan, are outside the scope of this SEIS/OEIS. The Navy will continue implementing these mitigation measures in accordance with the U.S. Fish and Wildlife Service (2015) Biological Opinion. For additional information, see Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) of the 2015 MITT Final EIS/OEIS.

The Navy will also implement standard operating procedures specific to training and testing activities conducted under the Proposed Action. In many cases, standard operating procedures provide a benefit to environmental and cultural resources, some of which have high socioeconomic value in the Study Area. Standard operating procedures differ from mitigation measures because standard operating procedures are designed to provide for safety and mission success, whereas mitigation measures are designed specifically to avoid or reduce potential environmental impacts. An example of a standard operating procedure is that ships operated by or for the Navy have personnel assigned to stand watch at all times when underway. Watch personnel monitor their assigned sectors for any indication of danger to the ship and the personnel on board, such as a floating or partially submerged object or piece of debris, periscope, surfaced submarine, wisp of smoke, flash of light, or surface disturbance. The Navy also avoids known navigation hazards that appear on navigational charts, such as submerged wrecks and obstructions. As a standard collision avoidance procedure, watch personnel monitor for marine mammals that have the potential to be in the direct path of the ship. The standard operating procedures to avoid collision hazards are designed for safety of the ship and the personnel on board. This is different from mitigation measures for vessel movement, which require vessels to maneuver to avoid marine mammals by specified distances to avoid or reduce the potential for physical disturbance and strike of marine mammals, as described in Section 5.3.4.1 (Vessel Movement). In this example, the benefit of the mitigation measure for vessel movement is additive to the benefit of the standard operating procedure for vessel safety. Standard operating procedures that apply to the Proposed Action and are generally consistent with those included in the 2015 MITT Final EIS/OEIS are described in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) of that document. Standard operating procedures that apply to the Proposed Action and were not included in, or require a clarification from, the 2015 MITT Final EIS/OEIS are discussed in Section 2.3.3 (Standard Operating Procedures) of this SEIS/OEIS.

In addition to the mitigation measures and standard operating procedures specific to the Proposed Action, the Navy has existing routine operating instructions (e.g., training manuals), local installation instructions (e.g., Integrated Natural Resource Management Plans), and programmatic agreements that were developed to meet other safety and environmental compliance requirements or initiatives. For example, the Naval Air Training and Operating Procedures Standardization (NATOPS) General Flight and Operating Instructions Manual (CNAF M-3710.7) contains naval air training procedures pertaining to safe operations of aircraft, which includes requirements to minimize the disturbance of wildlife. Aviation units are required to avoid noise-sensitive areas, such as breeding farms, resorts, beaches, national parks, national monuments, and national recreational areas. They are also required to avoid disturbing wild fowl in their natural habitats and to avoid firing directly at large fish, whales, or other wildlife. Additionally, The Programmatic Agreement for military relocation to Guam and the Commonwealth of the Northern Mariana Islands contains procedures pertaining to military readiness activities and other Department of Defense projects (U.S. Department of Defense, 2011). For example, the Navy agreed to avoid certain training exercises within particular areas. Applicable maps are updated annually and disseminated to military planners who coordinate and execute training exercises. If previously unknown cultural resources are discovered during applicable activities, the Navy has agreed to notify the appropriate Cultural Resources Manager and implement reasonable measures to avoid, minimize, or mitigate impacts to those resources. These requirements are in addition to mitigation measures developed for the Proposed Action. The Navy will continue complying with applicable operating instructions, local installation instructions, and programmatic agreements within the Study Area, as appropriate.

### 5.1.1 Benefits of Mitigation

The Chapter 3 (Affected Environment and Environmental Consequences) environmental analyses indicate that certain acoustic, explosive, and physical disturbance and strike stressors have the potential to impact certain biological or cultural resources. The Navy developed mitigation measures for those stressors and will implement the mitigation for either action alternative. The Navy considered the benefits of mitigation in the environmental analyses for both Alternative 1 and Alternative 2 of the Proposed Action in this Draft SEIS/OEIS. In addition to analyzing mitigation measures pursuant to the National Environmental Policy Act (NEPA), the Navy designed its mitigation measures to achieve one or more benefits, such as the following:

- Effect the least practicable adverse impact on marine mammal species or stocks and their habitat, and have a negligible impact on marine mammal species and stocks (as required under the Marine Mammal Protection Act [MMPA]);
- Ensure that the Proposed Action does not jeopardize the continued existence of endangered or threatened species (as required under the Endangered Species Act [ESA]);
- Avoid or minimize adverse effects on essential fish habitat (as required under the Magnuson-Stevens Fishery Conservation and Management Act); and
- Avoid adversely impacting shipwrecks (as required under the Abandoned Shipwreck Act and National Historic Preservation Act).

The Navy will coordinate its mitigation with the appropriate regulatory agencies, including the National Marine Fisheries Service (NMFS), through the consultation and permitting processes. The Final SEIS/OEIS, Navy and NMFS Records of Decision, MMPA Regulations and Letter of Authorization, and ESA Biological Opinion will document all mitigation measures that the Navy will implement under the Proposed Action. The final suite of mitigation measures that will be included in the Final SEIS/OEIS will represent the maximum level of mitigation that is practical for the Navy to implement when balanced against impacts to safety, sustainability, and the ability to continue meeting its mission requirements. Should the Navy require a change in how it implements mitigation based on national security concerns, evolving readiness requirements, or other factors (e.g., significant changes in the best available science), the Navy will engage the appropriate agencies and reevaluate its mitigation through adaptive management or the appropriate consultations. The Navy's adaptive management approach is discussed in Section 5.1.2.2.1.1 (Adaptive Management). This approach will be coordinated with NMFS during the consultation and permitting processes and will be included in the MMPA Regulations and Letter of Authorization.

## 5.1.2 Compliance Initiatives

To disseminate its mitigation requirements to the appropriate personnel and meet other compliance requirements for the MMPA and ESA, the Navy will continue using the Protective Measures Assessment Protocol and its ongoing monitoring and reporting initiatives, as described in the sections below.

### 5.1.2.1 Protective Measures Assessment Protocol

To disseminate requirements to the personnel who are required to implement mitigation during training and testing activities, the Navy will continue inputting its mitigation measures into the Protective Measures Assessment Protocol and appropriate governing instructions. The Protective Measures Assessment Protocol is a software tool that serves as the Navy's comprehensive data source for at-sea mitigation. The software tool provides personnel with notification of the required mitigation measures and a visual display of the planned training or testing activity location overlaid with relevant environmental data (e.g., mapped locations of shallow-water coral reefs). Navy policy requires applicable personnel to access the Protective Measures Assessment Protocol during the event planning process. This helps ensure that personnel receive mitigation instructions prior to the start of training and testing activities and that mitigation is implemented appropriately.

### 5.1.2.2 Monitoring, Research, and Reporting Initiatives

Many of the Navy's monitoring programs, research programs, and reporting initiatives have been ongoing for more than a decade and will continue as a compliance requirement for the MMPA or ESA, or both. The Navy and NMFS use the information contained within monitoring, research, activity, and incident reports when evaluating the effectiveness and practicality of mitigation and determining if adaptive adjustments to mitigation may be appropriate. These reports also facilitate better understandings of the biological resources that inhabit the Study Area and the potential impacts of the Proposed Action on those resources.

#### 5.1.2.2.1 Marine Species Research and Monitoring Programs

Through its marine species research and monitoring programs, the Navy is one of the nation's largest sponsors of scientific research on and monitoring of marine species. Detailed information on these programs is provided in Section 3.0.1.1.1 (Marine Species Monitoring and Research Programs). Navy research programs focus on investments in basic and applied research that increase fundamental knowledge and advance naval technological capabilities. Navy monitoring programs focus on the potential impacts of training and testing activities on biological resources. Monitoring reports are available to the public on the U.S. Navy Marine Species Monitoring webpage (https://www.navymarinespeciesmonitoring.us/). The Navy will post future reports online as they become available. Specific details regarding the content of the reports will be coordinated with the appropriate agencies through the consultation and permitting processes. Additional information about the U.S. Navy Marine Species Monitoring Program, including its adaptive management and strategic planning components, is provided in the sections below.

##### 5.1.2.2.1.1 Adaptive Management

Adaptive management is an iterative process of decision-making that accounts for changes in the environment and scientific understanding over time through a system of monitoring and feedback. Within the natural resource management community, adaptive management involves ongoing, real-time learning and knowledge creation, both in a substantive sense and in terms of the adaptive process itself (Williams et al., 2009). Adaptive management focuses on learning and adapting, through partnerships of natural resource managers, scientists, and other stakeholders. Adaptive management helps managers maintain flexibility in their decisions and provides them the latitude to change direction to improve understanding of ecological systems and achieve management objectives. Taking action to improve progress toward desired outcomes is another function of adaptive management.

The Navy's adaptive management review process and reporting requirements serve as the basis for evaluating performance and compliance. The process involves technical review meetings and ongoing discussions between the Navy, NMFS, the Marine Mammal Commission, and other experts in the scientific community. An example of a revision to the compliance monitoring structure as a result of adaptive management is the development of the Strategic Planning Process, which is a planning tool for the selection and management of monitoring investments (U.S. Department of the Navy, 2013a). Through adaptive management, the Strategic Planning Process has been incorporated into the Integrated Comprehensive Monitoring Program, which is described below.

##### 5.1.2.2.1.2 Integrated Comprehensive Monitoring Program

The Navy developed an Integrated Comprehensive Monitoring Program to serve as the overarching framework for coordinating its marine species monitoring efforts and as a planning tool to focus its monitoring priorities pursuant to ESA and MMPA requirements (U.S. Department of the Navy, 2010). The purpose of the Integrated Comprehensive Monitoring Program is to coordinate monitoring efforts across regions and to allocate the most appropriate level and type of monitoring effort for each range complex based on a set of standardized objectives, regional expertise, and resource availability. The Integrated Comprehensive Monitoring Program does not identify specific field-work or individual projects. It is designed to provide a flexible, scalable, and adaptable framework using adaptive management and the Strategic Planning Process to periodically assess progress and reevaluate objectives.

The Integrated Comprehensive Monitoring Program is evaluated through the adaptive management review process to: (1) assess progress, (2) provide a matrix of goals and objectives, and (3) make recommendations for refinement and analysis of monitoring and mitigation techniques. This process includes conducting an annual adaptive management review meeting where the Navy and NMFS jointly consider the prior year's goals, monitoring results, and related scientific advances to determine if monitoring plan modifications are warranted to address program goals more effectively. Modifications to the Integrated Comprehensive Monitoring Program that result from annual adaptive management review discussions are incorporated by an addendum or revision to the Integrated Comprehensive Monitoring Program as needed. The Integrated Comprehensive Monitoring Program will be routinely updated as the program evolves and progresses.

The Strategic Planning Process serves to guide the investment of resources to most efficiently address Integrated Comprehensive Monitoring Program objectives and intermediate scientific objectives. Navy-funded monitoring projects relating to the impact of Navy training and testing activities on protected marine species are designed to accomplish one or more of the following top-level goals, as described in the Integrated Comprehensive Monitoring Program charter:

- Increase the understanding of the likely occurrence of marine mammals and ESA-listed marine species in the vicinity of the action (e.g., presence, abundance, distribution, density).
- Increase the understanding of the nature, scope, or context of the likely exposure of marine mammals and ESA-listed marine species to any of the potential stressors associated with the action (e.g., acoustics, explosives, physical disturbance and strike of military expended materials) through a better understanding of one or more of the following: (1) the nature of the action and its surrounding environment (e.g., sound-source characterization, propagation, ambient noise levels), (2) the affected species (e.g., life history, dive patterns), (3) the likely co-occurrence of marine mammals and ESA-listed marine species with the action (in whole or part), and (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).
- Increase the understanding of how individual marine mammals or ESA-listed marine species respond behaviorally or physiologically to the specific stressors associated with the action and in what context (e.g., at what distance or received level).
- Increase 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).
- Increase the understanding of the effectiveness of mitigation and monitoring.
- Improve the understanding and record of the manner in which the Navy complies with its Incidental Take Authorizations and Incidental Take Statements.
- Increase the probability of detecting marine mammals through improved technology or methods within the mitigation zones (to improve mitigation effectiveness) and generally (to better achieve monitoring goals).

The Navy established a Scientific Advisory Group in 2011 with the initial task of evaluating current Navy monitoring approaches under the Integrated Comprehensive Monitoring Plan and existing MMPA Regulations and Letters of Authorization. The Scientific Advisory Group was also tasked with developing objective scientific recommendations that would form the basis for the Strategic Plan. While recommendations were fairly broad and not specifically prescriptive, the Scientific Advisory Group did provide specific programmatic recommendations that serve as guiding principles for the continued evolution of the Integrated Comprehensive Monitoring Program. Key recommendations included:

- 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 effort-based compliance metrics (e.g., completing a pre-determined amount of survey hours or days), with the intent to design and conduct monitoring projects according to scientific objectives rather than effort expended.
- Approaching the monitoring program holistically and selecting projects that offer the best opportunity to advance understanding of the issues, as opposed to establishing range-specific requirements.

###### 5.1.2.2.1.3 Strategic Planning Process

The U.S. Navy Marine Species Monitoring Program has evolved and improved as a result of adaptive management review and the Strategic Planning Process through changes that include:

- Recognizing the limitations of effort-based compliance metrics;
- Developing a strategic approach to monitoring based on recommendations from the Scientific Advisory Group;
- Shifting focus to projects based on scientific objectives that facilitate generation of statistically meaningful results upon which natural resources management decisions may be based;
- Focusing on priority species or areas of interest as well as best opportunities to address specific monitoring objectives to maximize return on investment; and
- Increasing transparency of the program and management standards, improving collaboration among participating researchers, and improving accessibility to monitoring data and results.

As a result of the changes outlined above due to the implementation of the Strategic Planning Process, the U.S. Navy Marine Species Monitoring Program has undergone a transition. Intermediate scientific objectives now serve as the basis for developing and executing new monitoring projects across Navy training and testing areas in the Atlantic and Pacific Oceans. Implementation of the Strategic Planning Process involves coordination among fleets, system commands, Chief of Naval Operations Energy and Environmental Readiness Division, NMFS, and the Marine Mammal Commission with five primary steps:

- **Identify overarching intermediate scientific objectives.** Through the adaptive management process, the Navy coordinates with NMFS and the Marine Mammal Commission to review and revise the list of intermediate scientific objectives that guide development of individual monitoring projects. Examples include addressing information gaps in species occurrence and density, evaluating behavioral responses of marine mammals to Navy training and testing activities, and developing tools and techniques for passive acoustic monitoring.
- **Develop individual monitoring project concepts.** This step generally takes the form of soliciting input from the scientific community in terms of potential monitoring projects that address one or more of the intermediate scientific objectives. This can be accomplished through a variety of forums, including professional societies, regional scientific advisory groups, and contractor support.
- **Evaluate, prioritize, and select monitoring projects.** Navy technical experts and program managers review and evaluate monitoring project concepts and develop a prioritized ranking. The goal of this step is to establish a suite of monitoring projects that address a cross-section of intermediate scientific objectives spread over a variety of range complexes.
- **Execute and manage selected monitoring projects.** Individual projects are initiated through appropriate funding mechanisms and include clearly defined objectives and deliverables, such as data, reports, or publications.

- **Report and evaluate progress and results.** Progress on individual monitoring projects is updated through the U.S. Navy Marine Species Monitoring Program website as well as annual monitoring reports submitted to NMFS. Both internal review and discussions with NMFS through the adaptive management process are used to evaluate progress toward addressing the primary objectives of the Integrated Comprehensive Monitoring Program and serve to periodically recalibrate the focus of the monitoring program.

These steps serve three primary purposes: (1) to facilitate the Navy in developing specific projects addressing one or more intermediate scientific objectives, (2) to establish a more structured and collaborative framework for developing, evaluating, and selecting monitoring projects across areas where the Navy conducts training and testing activities, and (3) to maximize the opportunity for input and involvement across the research community, academia, and industry. This process is designed to integrate various elements, including:

- Integrated Comprehensive Monitoring Program top-level goals,
- Scientific Advisory Group recommendations,
- Integration of regional scientific expert input,
- Ongoing adaptive management review dialog between NMFS and the Navy,
- Lessons learned from past and future monitoring of Navy training and testing, and
- Leveraging of research and lessons learned from other Navy-funded science programs.

The Strategic Planning Process will continue to shape the future of the U.S. Navy Marine Species Monitoring Program and serve as the primary decision-making tool for guiding investments. Information on monitoring projects currently underway in the Atlantic and Pacific oceans, as well as results, reports, and publications, can be accessed through the U.S. Navy Marine Species Monitoring Program website.

##### 5.1.2.2.2 Training and Testing Activity Reports

The Navy developed a classified data repository known as the Sonar Positional Reporting System to maintain an internal record of underwater sound sources (e.g., active sonar) used during training and testing. The Sonar Positional Reporting System facilitates reporting pursuant to the Navy's MMPA Regulations and Letters of Authorization. Using data from the Sonar Positional Reporting System and other relevant sources, the Navy will continue to provide the NMFS Office of Protected Resources with classified or unclassified (depending on the data) annual reports on the training and testing activities that use underwater sound sources. In its annual training and testing activity reports, the Navy will describe the level of training and testing conducted during the reporting period. For major training exercises, the reports will also include information on each individual marine mammal sighting related to mitigation implementation. Unclassified annual training and testing activity reports that have been submitted to NMFS can be found on the NMFS Office of Protected Resources and U.S. Navy Marine Species Monitoring Program webpages.

##### 5.1.2.2.3 Incident Reports

The Navy's mitigation measures and many of its standard operating procedures are designed to prevent incidents involving biological and cultural resources, such as aircraft strikes, vessel strikes, and impacts on submerged historic properties and seafloor resources. The Navy has been collecting data on such incidents (if they have occurred) for more than a decade and will continue doing so under the Proposed

Action. To provide information on incidents involving biological or cultural resources, the Navy will submit reports to the appropriate management authorities as described below:

- **Birds and Bats:** As described in Section 5.1.2 (Aircraft Safety) of the 2015 MITT Final EIS/OEIS, animal strikes present an aviation safety risk for aircrews and aircraft. The Navy will report all bird and bat strikes per standard operating procedures.
- **Marine Mammals, Sea Turtles, and ESA-Listed Species:** The Navy will notify the appropriate regulatory agency (e.g., NMFS) immediately or as soon as operational security considerations allow if it observes the following that is (or may be) attributable to Navy activities: (1) a vessel strike of a marine mammal or sea turtle during training or testing, (2) a stranded, injured, or dead marine mammal or sea turtle during training or testing, or (3) an injured or dead marine mammal, sea turtle, or ESA-listed species during post-explosive event monitoring. The Navy will provide relevant information pertaining to the incident (e.g., vessel speed). Additional details on these incident reporting requirements will be included in the Notification and Reporting Plan. The Navy will continue to provide the appropriate personnel with training on marine species incidents and their associated reporting requirements to aid the data collection and reporting processes (see Section 5.3.1, Environmental Awareness and Education). Information on marine mammal strandings is included in the *Marine Mammal Strandings Associated with U.S. Navy Sonar Activities* technical report (U.S. Department of the Navy, 2017a).
- **Corals:** The Navy will submit annual reports to NMFS on the levels and types of ordnance (e.g., explosive bombs, non-explosive practice munition bombs) expended on FDM. The Navy will also report any occurrences of a military expended material being deployed on a land target but ricocheting or otherwise entering the waters surrounding FDM in a location where shallow-water coral reefs are known to occur. The Navy will provide NMFS with reports of any associated in-water effects (e.g., crater size, mortality) to corals observed as a result of high-explosive bomb detonations on FDM to facilitate a better understanding of how these land detonations could potentially impact corals in various water depths around the island.
- **Cultural Resources:** In the event the Navy impacts a historic property (e.g., archaeological resource, shipwreck), it will commence consultation with the appropriate State Historic Preservation Officer in accordance with 36 Code of Federal Regulations section 800.13(b)(3).

## 5.2 Mitigation Development Process

The Navy, in coordination with the appropriate regulatory agencies, developed its initial suite of mitigation measures for Phase I of environmental planning (2010–2015) and subsequently revised those mitigation measures for the 2015 MITT Final EIS/OEIS in Phase II (2015–2020). For this Draft SEIS/OEIS (which represents Phase III of environmental planning), the Navy is working collaboratively with the appropriate regulatory agencies to develop and refine its mitigation, which will be finalized through the consultation and permitting processes. The mitigation development process involves reanalyzing existing mitigation measures implemented under the 2015 MITT Final EIS/OEIS and analyzing new mitigation recommendations received from Navy and NMFS scientists, other governmental agencies, the public, and non-governmental organizations during the NEPA, consultation, and permitting processes. The Navy conducted a detailed review and assessment of each potential mitigation measure individually and then all potential mitigation measures collectively to determine if, as a whole, mitigation will effectively avoid or reduce potential impacts from the Proposed Action and will be practical to implement. The Navy operational community (i.e., leadership from the aviation, surface, subsurface, and special warfare communities; leadership from the research and acquisition community; and training and testing experts), environmental planners, and scientific experts provided input on the effectiveness and practicality of mitigation implementation. Navy Senior Leadership reviewed and approved the mitigation measures included in this Draft SEIS/OEIS.

Mitigation measures that the Navy will implement under the Proposed Action are organized into three categories: procedural mitigation measures for at-sea activities, at-sea mitigation areas, and terrestrial mitigation measures for activities on FDM. The sections below provide definitions of mitigation terminology, background information pertinent to the mitigation development process, and information about the mitigation effectiveness and practicality criteria. Additional activity or stressor-specific details, such as the level of effect to which an at-sea procedural mitigation measure is expected to mitigate and if a measure has been modified from the 2015 MITT Final EIS/OEIS is provided throughout Section 5.3 (At-Sea Procedural Mitigation to be Implemented), Section 5.4 (At-Sea Mitigation Areas to be Implemented), and Section 5.5 (Terrestrial Mitigation Measures to be Implemented). A draft biological assessment and operational analysis of mitigation areas that the Navy considered for marine mammals and sea turtles is provided in Appendix I (Geographic Mitigation Assessment). The Navy will finalize development of its mitigation areas during the consultation and permitting processes and will summarize any approved measures in Section 5.4 (At-Sea Mitigation Areas to be Implemented) of the Final SEIS/OEIS. Section 5.6 (Measures Considered but Eliminated) contains information on measures that did not meet the appropriate balance between being effective and practical to implement, and therefore will not be implemented under the Proposed Action.

### 5.2.1 At-Sea Procedural Mitigation Development

Procedural mitigation is mitigation that the Navy will implement whenever and wherever training or testing activities involving applicable acoustic, explosive, and physical disturbance and strike stressors take place within the at-sea portion of the Study Area. Procedural mitigation generally involves: (1) the use of one or more trained Lookouts to observe for specific biological resources within a mitigation zone, (2) requirements for Lookouts to immediately communicate sightings of specific biological resources to the appropriate watch station for information dissemination, and (3) requirements for the watch station to implement mitigation until a pre-activity commencement or during-activity recommencement condition has been met. Procedural mitigation primarily involves Lookouts observing for marine mammals and sea turtles. For some activities, Lookouts may also be required to observe for additional biological resources, such as ESA-listed fish species or jellyfish aggregations that can be an indicator of potential sea turtle presence.

To consider the benefits of procedural mitigation to marine mammals and sea turtles within the MMPA and ESA impact estimates, the Navy conservatively factored mitigation effectiveness into its quantitative analysis process, as described in the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018). The Navy's quantitative analysis assumes that Lookouts will not be 100 percent effective at detecting all individual marine mammals and sea turtles within the mitigation zones for each activity. This is due to the inherent limitations of observing marine species and because the likelihood of sighting individual animals is largely dependent on observation conditions (e.g., time of day, sea state, mitigation zone size, observation platform) and animal behavior (e.g., the amount of time an animal spends at the surface of the water). This is particularly true for sea turtles, small marine mammals, and marine mammals that display cryptic behaviors (e.g., surfacing to breathe with only a small portion of their body visible from the surface). Throughout Section 5.3 (At-Sea Procedural

Mitigation to be Implemented), discussions about the likelihood that a Lookout would observe a marine mammal or sea turtle pertain specifically to animals that are available to be observed (i.e., on, above, or just below the water's surface). The benefits of procedural mitigation measures for species that were not included in the quantitative analysis process (e.g., fish) are discussed qualitatively.

Data inputs for assessing and developing procedural mitigation included operational data as described in Section 5.2.4 (Practicality of Implementation), the best available science discussed in Chapter 3 (Affected Environment and Environmental Consequences), published literature, data on marine mammal and sea turtle impact ranges obtained through acoustic modeling, marine species monitoring and density data, and the most recent guidance from NMFS. Background information on the data that were used to develop the ranges to effect for marine mammals and sea turtles (such as hearing threshold metrics) is provided in Section 3.4 (Marine Mammals) and Section 3.5 (Sea Turtles).

#### 5.2.1.1 Lookouts

Lookouts perform similar duties as the standard watch personnel described in Section 5.1.1 (Vessel Safety) of the 2015 MITT Final EIS/OEIS, such as personnel on the bridge watch team and personnel stationed for man-overboard precautions. Lookouts are designated the responsibility of helping meet the Navy's mitigation requirements by visually observing mitigation zones. The number of Lookouts designated for each training or testing activity is dependent upon the number of personnel involved in the activity (i.e., manning restrictions) and the number and type of assets available (i.e., equipment and space restrictions).

Depending on the activity, a Lookout may be positioned on a ship (i.e., surface ships and surfaced submarines), on a small boat (e.g., rigid-hull inflatable boat), in an aircraft, or on a pier. Certain platforms, such as aircraft and small boats, have manning or space restrictions; therefore, the Lookout on these platforms is typically an existing member of the aircraft or boat crew who is responsible for other essential tasks (e.g., a pilot who is responsible for navigation). Some platforms are minimally manned and are therefore either physically unable to accommodate more than one Lookout or divert personnel from mission-essential tasks, including safe and secure operation of propulsion, weapons, and damage control systems that ensure the safety of the ship and the personnel on board. The number of Lookouts specified for each activity in Section 5.3 (At-Sea Procedural Mitigation to be Implemented) represents the maximum number of Lookouts that can be designated for those activities without requiring additional personnel or reassigning duties. The Navy is unable to position Lookouts on unmanned surface vehicles, unmanned aerial systems, unmanned underwater vehicles, and submerged submarines, or have Lookouts observe during activities that use systems deployed from or towed by unmanned platforms.

When Lookouts are positioned in a fixed-wing aircraft or rotary-wing aircraft (i.e., helicopter), mission requirements determine the flight parameters (altitude, flight path, and speed) for that aircraft. For example, most fixed-wing aircraft sorties occur above 3,000 feet (ft.), while most rotary-wing sorties associated with mine countermeasure activities occur at altitudes as low as 75–100 ft. Similarly, when Lookouts are positioned on a vessel, mission requirements determine the operational parameters (course and speed) for that vessel.

The Navy's passive acoustic devices (e.g., remote acoustic sensors, expendable sonobuoys, passive acoustic sensors on submarines) can complement visual observations for marine mammals when passive acoustic assets are already participating in an activity. The passive acoustic devices can detect vocalizing marine mammals within the frequency bands already being monitored by Navy personnel.

Marine mammal detections from passive acoustic devices can alert Lookouts to possible marine mammal presence in the vicinity. Lookouts can use the information from passive acoustic detections to assist their visual observations of the mitigation zone. Based on the number and type of passive acoustic devices that are typically used, passive acoustic detections do not provide range or bearing to a detected animal in order to determine its location or confirm its presence in a mitigation zone. Therefore, it is not practical for the Navy to implement mitigation in response to passive acoustic detections alone (i.e., without a visual sighting of an animal within the mitigation zone). Additional information about passive acoustic devices is provided in Section 5.6.3 (Active and Passive Acoustic Monitoring Devices).

#### 5.2.1.2 Mitigation Zones

Mitigation zones are areas at the surface of the water within which applicable training or testing activities will be ceased, powered down, or modified to protect specific biological resources from an auditory injury (permanent threshold shift [PTS]), non-auditory injury (from impulsive sources), or direct strike (e.g., vessel strike) to the maximum extent practicable. Mitigation zones are measured as the radius from a stressor. Implementation of procedural mitigation is most effective when mitigation zones are appropriately sized to be realistically observed during typical training and testing activity conditions.

The Navy customized its mitigation zone sizes and mitigation requirements for each applicable training and testing activity category or stressor. The Navy developed each mitigation zone to be the largest area that (1) Lookouts can reasonably be expected to observe during typical activity conditions (i.e., most environmentally protective), and (2) the Navy can commit to implementing mitigation without impacting safety, sustainability, or the ability to meet mission requirements. The Navy designed the mitigation zones for most acoustic and explosive stressors according to its source bins. As described in Section 3.0.4.1.1 (Sonar and Other Transducers), sonars and other transducers are grouped into classes that share an attribute, such as frequency range or purpose of use. Classes are further sorted by bins based on the frequency or bandwidth, source level, and when warranted, the application in which the source would be used. As described in Section 3.0.4.2.1.1 (Explosions in Water), explosives detonated in water are binned by net explosive weight. Mitigation does not pertain to stressors that do not have the potential to impact biological resources (e.g., *de minimis* acoustic and explosive sources that do not have the potential to impact marine mammals).

Discussions throughout Section 5.3 (At-Sea Procedural Mitigation to be Implemented) about the level of effect that will likely be mitigated for marine mammals and sea turtles are based on a comparison of the mitigation zone size to the predicted impact ranges for the applicable source bins with the longest average ranges to PTS. These conservative discussions represent the worst-case scenario for each activity category or stressor. The mitigation zones will oftentimes cover all or a larger portion of the predicted average ranges to PTS for other comparatively smaller sources with shorter impact ranges (e.g., sonar sources used at a lower source level, explosives in a smaller bin). The discussions are primarily focused on how the mitigation zone sizes compare to the ranges to PTS; however, depending on the activity category or stressor, the mitigation zones are oftentimes large enough to also mitigate within a portion of the ranges to temporary threshold shift (TTS). TTS is a threshold shift that is recoverable. Background information on PTS, TTS, and marine mammal and sea turtle hearing groups is presented in the U.S. Department of the Navy (2017b) technical report titled *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*.

#### 5.2.1.3 Procedural Mitigation Implementation

The Navy takes several courses of action in response to a sighting of an applicable biological resource in a mitigation zone. First, a Lookout will communicate the sighting to the appropriate watch station. Next, the watch station will implement the prescribed mitigation, such as delaying the initial start of an activity, powering down sonar, ceasing an explosive detonation, or maneuvering a vessel. For sightings of marine mammals, sea turtles, and other specified biological resources within a mitigation zone prior to the initial start of or during applicable activities, the Navy will continue mitigating until one of the five conditions listed below has been met. The conditions are designed to allow a sighted animal to leave the mitigation zone before the initial start of an activity or before an activity resumes.

- The animal is observed exiting the mitigation zone;
- The animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the stressor source;
- The mitigation zone has been clear from any additional sightings for a specific wait period;
- For mobile activities, the stressor source has transited or has been relocated a distance equal to double that of the mitigation zone size beyond the location of the last sighting; or
- For activities using hull-mounted sonar, the ship concludes that dolphins are deliberately closing in on the ship to ride the ship's bow wave and are therefore out of the main transmission axis of the sonar (and there are no other marine mammal sightings within the mitigation zone).

To supplement the implementation of procedural mitigation, the Navy has agreed to undertake reporting initiatives for certain activities or resources based on previous consultations with NMFS, as summarized in Section 5.1.2.2 (Monitoring, Research, and Reporting Initiatives) and detailed where applicable in Section 5.3 (At-Sea Procedural Mitigation to be Implemented). For some activities, the Navy also agreed during previous consultations with NMFS to adapt some of its procedural mitigation for particular resources at certain locations and plans to continue those mitigation measures for the Proposed Action. For example, the Navy will continue implementing mitigation for ESA-listed scalloped hammerhead sharks within the Mariana Islands Range Complex during explosive mine neutralization activities involving Navy divers, as discussed in Section 5.3.3.8 (Explosive Mine Neutralization Activities Involving Navy Divers).

### 5.2.2 At-Sea Mitigation Area Development

Mitigation areas are geographic locations within the at-sea portion of the Study Area where the Navy will implement mitigation measures to: (1) avoid or reduce potential impacts on biological or cultural resources that are not observable by Lookouts from the water's surface (i.e., resources for which procedural mitigation cannot be implemented), (2) in combination with procedural mitigation, to effect the least practicable adverse impact on marine mammal species or stocks and their habitat, or (3) in combination with procedural mitigation, ensure that the Proposed Action does not jeopardize the continued existence of endangered or threatened species.

The Navy conducted an extensive assessment of the Study Area to develop the mitigation areas included in this SEIS/OEIS. The Navy reanalyzed existing mitigation areas implemented under the 2015 MITT Final EIS/OEIS; assessed additional habitat areas suggested by the public, NMFS, other governmental agencies, and non-governmental organizations; and considered other habitats identified internally by the Navy. Data inputs for mitigation area assessment and development included the operational information described in Section 5.2.4 (Practicality of Implementation), the best available science discussed in Chapter 3 (Affected Environment and Environmental Consequences), published literature, predicted activity impact footprints, and marine species monitoring and density data.

A summary of the seafloor resource mitigation areas developed for this Draft SEIS/OEIS is presented in Section 5.4 (At-Sea Mitigation Areas to be Implemented). A draft biological assessment and operational analysis of mitigation areas that the Navy considered for marine mammals and sea turtles is provided in Appendix I (Geographic Mitigation Assessment). The appendix includes background information and additional details for each of the areas considered, such as areas identified during the NEPA scoping process. The Navy will finalize development of its mitigation areas during the consultation and permitting processes and will summarize its final mitigation measures in Section 5.4 (At-Sea Mitigation Areas to be Implemented) of the Final SEIS/OEIS.

The Navy considers a mitigation area to be effective if it meets the following criteria:

- **The mitigation area is a key area of biological or ecological importance or contains cultural resources:** The best available science suggests that the mitigation area contains submerged cultural resources (e.g., shipwrecks) or is particularly important to one or more species or resources for a biologically important life process (e.g., foraging, migration, reproduction) or ecological function (e.g., shallow-water coral reefs that provide critical ecosystem functions); and
- **The mitigation will result in an avoidance or reduction of impacts:** Implementing the mitigation will likely avoid or reduce potential impacts on: (1) species, stocks, or populations of marine mammals based on data regarding their seasonality, density, and behavior; or (2) other biological or cultural resources based on their distribution and physical properties. Furthermore, implementing the mitigation will not shift or transfer adverse effects from one species to another (e.g., to a more vulnerable or sensitive species).

The benefits of mitigation areas are considered qualitatively and have not been factored into the quantitative analysis process or reductions in take for MMPA and ESA impact estimates. Mitigation area benefits are discussed in terms of the context of impact avoidance or reduction.

### 5.2.3 Terrestrial Mitigation Measure Development

Terrestrial mitigation measures are measures that the Navy will implement during applicable military readiness activities that take place on land. FDM is the only terrestrial portion of the Study Area that the Navy plans to use under the Proposed Action. The Navy's mitigation measures on FDM primarily involve access, targeting, and ordnance restrictions, as detailed in Section 5.5 (Terrestrial Mitigation Measures to be Implemented). The terrestrial mitigation measures discussed in this SEIS/OEIS were originally developed for past environmental compliance documents in coordination with the U.S. Fish and Wildlife Service. Data inputs for assessing and developing terrestrial mitigation included the operational data described in Section 5.2.4 (Practicality of Implementation), the best available science discussed in Chapter 3 (Affected Environment and Environmental Consequences), published literature, and guidance from the U.S. Fish and Wildlife Service. Terrestrial mitigation measures are designed to avoid or reduce potential impacts on ESA-listed species that inhabit FDM or could occur at the island during migrations. The benefits of terrestrial mitigation measures are discussed qualitatively.

### 5.2.4 Practicality of Implementation

Mitigation measures are expected to have some degree of impact on the training and testing activities that implement them (e.g., modifying where and when activities occur, ceasing an activity in response to a sighting). The Navy is able to accept a certain level of impact on its military readiness activities because of the benefit that mitigation measures provide for avoiding or reducing impacts on environmental and cultural resources. The Navy's focus during mitigation assessment and development is that mitigation measures must meet the appropriate balance between being effective and practical to implement. To evaluate practicality, the Navy operational community conducted an extensive and comprehensive assessment to determine how and to what degree potential mitigation measures would be compatible with planning, scheduling, and conducting training and testing activities under the Proposed Action in order to meet the Navy's Title 10 requirements.

#### 5.2.4.1 Assessment Criteria

The purpose and need of the Proposed Action is to ensure that the Navy meets its mission to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. The Navy is statutorily mandated to protect U.S. national security by being ready, at all times, to effectively prosecute war and defend the nation by conducting operations at sea, as outlined in Title 10 section 5062 of the United States Code. The Navy's mission is achieved in part by conducting training and testing within the Study Area in accordance with established military readiness requirements. Training requirements have been developed through many years of iteration and adaptation and are designed to ensure that Sailors achieve the levels of readiness needed to properly respond to the multitude of contingencies they may face during military missions and combat operations. Activities are planned and scheduled in accordance with the Optimized Fleet Response Plan, which details instructions on manning distribution, range scheduling, operational requirements, maintenance and modernization plans, quality of work and life for personnel, achieving training capabilities, and meeting strategic readiness objectives.

To achieve the highest skill proficiency and most accurate testing results possible, the Navy conducts activities in a variety of realistic tactical oceanographic and environmental conditions. Such conditions include variations in bathymetry, topography, surface fronts, and sea surface temperatures. Training activities must be as realistic as possible to provide the experiences and stressors necessary to successfully execute all required military missions and combat operations. Degraded training would result in units being unqualified to conduct the range of military operations required by operational Commanders. The inability of such Commanders to meet national security objectives would result in not only the increased risk to life, but also the degradation of national security. Testing activities must be as realistic as possible for the Navy to conduct accurate acoustic research to validate acoustic models; conduct accurate engineering tests of acoustic sources, signal processing algorithms, and acoustic interactions; and to effectively test systems and platforms (and components of these systems and platforms) to validate whether they perform as expected and determine whether they are operationally effective, suitable, survivable, and safe for their intended use by the fleet. Testing must be completed before full-scale production or delivery to the fleet to ensure functionality and accuracy in military mission and combat conditions.

As described in Chapter 2 (Description of Proposed Action and Alternatives), the Navy requires access to FDM, sea space, and airspace throughout the Study Area within pierside locations, nearshore areas, and large-scale open ocean areas of the high seas. Each area plays a critical role in the Navy's ability to plan, schedule, and effectively execute military readiness activities. The locations where training and testing occur must be situated in a way that allows the Navy to complete its activities without physical or logistical obstructions. The Navy requires extensive sea space so that individual training and testing activities can occur at sufficient distances so they do not interfere with one another. Some training and testing activities require continuous access to large and unobstructed areas, consisting potentially of tens or thousands of square miles. This provides personnel the ability to develop competence and confidence in their capabilities across multiple types of weapons and sensors, and the ability to train to communicate and operate in a coordinated fashion as required during military missions and combat operations. For example, major exercises using integrated warfare components may require large areas of the littorals, open ocean, and nearshore areas for realistic and safe anti-submarine warfare training. The Navy also requires large areas of sea space because it trains in a manner to avoid observation by potential adversaries. Modern sensing technologies make training on a large scale without observation more difficult. A foreign military's continual observation of U.S. Navy training in predictable geographic areas and timeframes would enable foreign nations to gather intelligence and subsequently develop techniques, tactics, and procedures to potentially and effectively counter U.S. naval operations. Other activities may be conducted on a smaller and more localized scale, with training or testing at discrete locations (e.g., on FDM) that are critical to certain aspects of military readiness.

The locations for training and testing activities are selected to maximize efficiency while supporting specific mission and safety requirements, deconflict sea space and airspace, and minimize the time personnel must spend away from home. Training and testing locations are typically selected based on their proximity to homeports, home bases, associated training ranges, testing facilities, air squadrons, and existing infrastructure (e.g., land ranges) to reduce travel time and associated costs. Activities involving the use of rotary-wing aircraft typically occur in proximity to shore or refueling stations due to fuel restrictions and safety requirements. Testing events are typically located near systems command support facilities, which provide critical infrastructure support and technical expertise necessary to conduct testing. Logistical support of range testing can only efficiently and effectively occur when the support is co-located with the testing activities. These same principles also apply to pierside and at-sea testing that must occur in proximity to naval harbors. Testing event site locations and associated field activities were originally established to support specific Navy mission testing needs using a selection process that included testing requirements, cost of living, availability of personnel, and low level of crowding from industry and development.

During its assessment to determine how and to what degree the implementation of mitigation would be compatible with meeting the purpose and need of the Proposed Action, the Navy considered mitigation measures to be practical to implement if they met all criteria discussed below:

- **Implementing the mitigation is safe:** Mitigation measures must not increase safety risks to Navy personnel and equipment, or to the public. When assessing whether implementing a mitigation measure would be safe, the Navy factored in the potential for increased pilot fatigue; accelerated fatigue-life of aircraft; typical fuel restrictions of participating aircraft; locations of refueling stations; proximity to aircraft emergency landing fields, critical medical facilities, and search and rescue capabilities; space restrictions of the observation platforms; the ability to de-conflict platforms and activities to ensure that training and testing activities do not impact each other; and the ability to avoid interaction with non-Navy sea space and airspace uses, such as established commercial air traffic routes, commercial vessel shipping lanes, and areas used for energy exploration or alternative energy development. Other safety considerations included identifying if mitigation measures would reasonably allow Lookouts to safely and effectively maintain situational awareness while observing the mitigation zones during typical activity conditions, or if the mitigation would increase the safety risk for personnel. For example, the safety risk would increase if Lookouts were required to direct their attention away from essential mission requirements.

- **Implementing the mitigation is sustainable:** One of the primary factors that the Navy incorporates into the planning and scheduling of its training and testing activities is the amount and type of available resources, such as funding, personnel, and equipment. Mitigation measures must be sustainable over the life of the Proposed Action, meaning that they will not require the use of resources in excess of what is available. When assessing whether implementing a mitigation measure would be sustainable, the Navy considered if the measure would require excessive time on station or time away from homeport for Navy personnel, require the use of additional personnel (i.e., manpower) or equipment (e.g., adding a small boat to serve as an additional observation platform), or result in additional operational costs (e.g., increased fuel consumption, equipment maintenance, or acquisition of new equipment).
- **Implementing the mitigation allows the Navy to continue meeting its mission requirements:** The Navy considered if each individual measure and the iterative and cumulative impact of all potential measures would be within the Navy's legal authority to implement. The Navy also considered if mitigation would modify training or testing activities in a way that would prevent individual activities from meeting their mission objectives and if mitigation would prevent the Navy from meeting its national security requirements or statutorily mandated Title 10 requirements, such as by:
    - Impacting training and testing realism or preventing ready access to ranges, operating areas, facilities, or range support structures (which would reduce realism and present sea space and airspace conflicts).
    - Impacting the ability for Sailors to train and become proficient in using sensors and weapon systems as would be required in areas analogous to where the military operates or causing an erosion of capabilities or reduction in perishable skills (which would result in a significant risk to personnel or equipment safety during military missions and combat operations).
    - Impacting the ability for units to meet their individual training and certification requirements (which would impact the ability to deploy with the required level of readiness necessary to accomplish any tasking by Combatant Commanders).
    - Impacting the ability to certify forces to deploy to meet national security tasking (which would limit the flexibility of Combatant Commanders and warfighters to project power, engage in multi-national operations, and conduct the full range of naval warfighting capabilities in support of national security interests).
    - Impacting the ability of researchers, program managers, and weapons system acquisition programs to conduct accurate acoustic research to meet research objectives, effectively test systems and platforms (and components of these systems and platforms) before full-scale production or delivery to the fleet, or complete shipboard maintenance, repairs, or pierside testing prior to at-sea operations (which would not allow the Navy to ensure safety, functionality, and accuracy in military mission and combat conditions per required acquisition milestones or on an as-needed basis to meet operational requirements).
    - Requiring the Navy to provide advance notification of specific times and locations of Navy platforms, such as platforms using active sonar (which would present national security concerns).

- Reducing the Navy's ability to be ready, maintain deployment schedules, or respond to national emergencies or emerging national security challenges (which would present national security concerns).

#### 5.2.4.2 Factors Affecting Practicality

Two of the factors that influenced whether procedural mitigation measures met the practicality criteria were the number of times mitigation measures would likely be implemented and the duration over which the activity would likely be ceased due to mitigation implementation. The number of times mitigation would likely be implemented is largely dependent on the size of the mitigation zone. As a mitigation zone size increases, the area of observation increases by an order of magnitude. This is because mitigation zones are measured as the radius (r) from a stressor but apply to circular area (A) around that stressor ($A = \pi * r^2$, where $\pi$ is a constant that is approximately equal to 3.14). For example, a 100-yard (yd.) mitigation zone is equivalent to an area of 31,416 square yd. A 200 yd. mitigation zone is equivalent to an area of 125,664 square yd. Therefore, increasing a mitigation zone from 100 yd. to 200 yd. (i.e., doubling the mitigation zone radius) would quadruple the mitigation zone area (the area over which mitigation must be implemented). Similarly, increasing a mitigation zone from 1,000 yd. to 4,000 yd. (i.e., quadrupling the mitigation zone radius) would increase the mitigation zone area by a factor of 16. Increasing the area over which mitigation must be implemented consequently increases the number of times mitigation would likely be implemented during that activity.

The duration over which mitigation is implemented can differ considerably depending on the mitigation zone size, number of animal sightings, behavioral state of animals sighted (e.g., travelling at a fast pace on course to exit the mitigation zone, milling slowly in the center of the mitigation zone), and which pre-activity commencement or during-activity recommencement condition is met before the activity can commence or resume after each sighting. The duration of mitigation implementation typically equates to the amount of time the training or testing activity will be extended. The impact that extending the length of an activity has on safety, sustainability, and the Navy's ability to accomplish the activity's intended objectives varies by activity. This is one reason why the Navy tailors its mitigation zone sizes and mitigation requirements by activity category or stressor and the platforms involved.

As described in Section 5.2.1 (At-Sea Procedural Mitigation Development), the Navy will mitigate for each applicable sighting and will continue mitigating until one of five conditions has been met. In some instances, such as if an animal dives underwater after a sighting, it may not be possible for a Lookout to visually verify if the animal has exited the mitigation zone. The Navy cannot delay or cease activities indefinitely for the purpose of mitigation due to impacts on safety, sustainability, and the Navy's ability to continue meeting its mission requirements. To account for this, one of the pre-activity commencement and during-activity recommencement conditions is an established post-sighting wait period of 30 minutes or 10 minutes, based on the platforms involved. Wait periods are designed to allow animals the maximum amount of time practical to resurface (i.e., become available to be observed by a Lookout) before activities resume. When developing the length of its wait periods, the Navy factored in the assumption that mitigation may need to be implemented more than once. For example, an activity may need to be delayed or ceased for more than one 30-minute or 10-minute period.

The Navy assigns a 30-minute wait period to activities conducted from vessels and that involve aircraft that are not typically fuel constrained (e.g., maritime patrol aircraft). A 30-minute period covers the average dive times of most marine mammals and a portion of the dive times of sea turtles and deep-diving marine mammals (i.e., sperm whales, dwarf and pygmy sperm whales [Kogia whales], and beaked whales) (U.S. Department of the Navy, 2017c). The Navy determined that a 30-minute wait period is the maximum wait time that is practical to implement during activities involving vessels and aircraft that are not typically fuel constrained to allow the activities to continue meeting their intended objectives. For example, the typical duration of Maritime Security Operations – Anti-Swimmer Grenades (which involve the use of small boats) is one hour. These activities are scheduled to occur at specific locations within specific timeframes based on range scheduling and for sea space deconfliction. Implementing one wait period would result in the activity being extended by half of the typical activity duration. The Navy determined that, given the benefit of this mitigation, a 30-minute wait period would be practical to implement for this activity; however, implementing a longer wait period (such as extending the wait period to 45 or 60 minutes to cover the average dive times of sea turtles and additional marine mammal species) would be impractical. Increasing the wait period, and consequently, the amount of time the activity would need to be delayed or extended in order to accomplish its intended objective, would impact activity realism or cause sea space conflicts in a way that could impact the Navy's ability to continue meeting its mission requirements. For example, delaying an activity for multiple wait periods could result in personnel not being able to detonate an explosive before the participating platforms are required to depart the range due to range scheduling; therefore, the activity would not accomplish its intended objectives.

The Navy assigns a 10-minute wait period to activities involving aircraft that are typically fuel constrained (e.g., rotary-wing aircraft, fighter aircraft). A 10-minute period covers a portion, but not the average, dive times of marine mammals and sea turtles (U.S. Department of the Navy, 2017c). The Navy determined that a 10-minute wait period is the maximum wait time that is practical to implement during activities involving aircraft that are typically fuel constrained. Increasing the wait period, and consequently the amount of time the training or testing activity would need to be extended in order to accomplish its intended objective, would require aircraft to depart the activity area to refuel in order to safely complete the event. If the wait period was implemented multiple times, the aircraft would be required to depart the activity area to refuel multiple times. Refueling events would vary in duration, depending on the activity location and proximity to the nearest refueling station. Multiple refueling events would generally be expected to extend the length of the activity by two to five times or more. This would impact activity realism, could cause air space or sea space conflicts in a way that could impact the Navy's ability to continue meeting its mission requirements, would decrease the ability for Lookouts to safely and effectively maintain situational awareness of the activity area, and would increase safety risks due to increased pilot fatigue and accelerated fatigue-life of aircraft. For example, delaying a Torpedo Exercise – Helicopter activity for multiple wait periods could result in personnel not being able to effectively search for, detect, classify, localize, and track a simulated threat submarine before the rotary-wing aircraft is required to depart the range due to range scheduling; therefore, the activity would not accomplish its intended objectives.

Factors that influenced whether a mitigation area measure met the practicality criteria included the historical use and projected future use of geographic locations for training and testing activities under the Proposed Action, and the relative importance of each location. The frequency that an area is used for training or testing does not necessarily equate to that area's level of importance for meeting an individual activity objective, or collectively, the Navy's mission requirements. While frequently used areas can be essential to one or more types of military readiness activities, some infrequently used areas are critical for a particular training exercise, testing mission, or research project.

## 5.3 At-Sea Procedural Mitigation to be Implemented

The first at-sea procedural mitigation measure (Section 5.3.1, Environmental Awareness and Education) is designed to aid Lookouts and other personnel with observation, environmental compliance, and reporting responsibilities. The remaining procedural mitigation measures are organized by stressor type and training or testing activity category.

### 5.3.1 Environmental Awareness and Education

The Navy will continue to implement procedural mitigation to provide environmental awareness and education to the appropriate personnel to aid visual observation, environmental compliance, and reporting responsibilities, as outlined in Table 5.3-1.

**Table 5.3-1: Environmental Awareness and Education**

| ***Procedural Mitigation Description*** |
|---|
| **Stressor or Activity**<br>• All training and testing activities, as applicable |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles |
| **Mitigation Requirements**<br>• Appropriate personnel (including civilian personnel) involved in mitigation and training or testing activity reporting under the Proposed Action will complete one or more modules of the U.S. Navy Afloat Environmental Compliance Training Series, as identified in their career path training plan. Modules include:<br>– **Introduction to the U.S. Navy Afloat Environmental Compliance Training Series.** The introductory module provides information on environmental laws (e.g., ESA, MMPA) and the corresponding responsibilities that are relevant to Navy training and testing activities. The material explains why environmental compliance is important in supporting the Navy's commitment to environmental stewardship.<br>– **Marine Species Awareness Training.** All bridge watch personnel, Commanding Officers, Executive Officers, maritime patrol aircraft aircrews, anti-submarine warfare and mine warfare rotary-wing aircrews, Lookouts, and equivalent civilian personnel must successfully complete the Marine Species Awareness Training prior to standing watch or serving as a Lookout. The Marine Species Awareness Training provides information on sighting cues, visual observation tools and techniques, and sighting notification procedures. Navy biologists developed Marine Species Awareness Training to improve the effectiveness of visual observations for biological resources, focusing on marine mammals and sea turtles, and including jellyfish aggregations and flocks of seabirds.<br>– **U.S. Navy Protective Measures Assessment Protocol.** This module provides the necessary instruction for accessing mitigation requirements during the event planning phase using the Protective Measures Assessment Protocol software tool.<br>– **U.S. Navy Sonar Positional Reporting System and Marine Mammal Incident Reporting.** This module provides instruction on the procedures and activity reporting requirements for the Sonar Positional Reporting System and marine mammal incident reporting. |

The Navy requires Lookouts and other personnel to complete their assigned environmental compliance responsibilities (e.g., mitigation, reporting requirements) before, during, and after training and testing activities. Marine Species Awareness Training was first developed in 2007 and has since undergone numerous updates to ensure that the content remains current, with the most recent product approved by NMFS and released by the Navy in 2014. In 2014, the Navy developed a series of educational training modules, known as the Afloat Environmental Compliance Training program, to ensure Navywide compliance with environmental requirements. The Afloat Environmental Compliance Training program, including the updated Marine Species Awareness Training, helps Navy personnel from the most junior Sailors to Commanding Officers gain a better understanding of their personal environmental compliance roles and responsibilities. Additional information on the Protective Measures Assessment Protocol is provided in Section 5.1.2.1 (Protective Measures Assessment Protocol), and additional information on training and testing activity and incident reports is provided in Section 5.1.2.2 (Monitoring, Research, and Reporting Initiatives).

From an operational perspective, the interactive web-based format of the U.S. Navy Afloat Environmental Compliance Training Series is ideal for providing engaging and educational content that is cost effective and convenient to access by personnel who oftentimes face rotating job assignments. The U.S. Navy Afloat Environmental Compliance Training Series has resulted in an improvement in the quality and accuracy of training and testing activity reports, incident reports, and Sonar Positional Reporting System reports submitted by Navy operators. Improved reporting quality indicates that the U.S. Navy Afloat Environmental Compliance Training Series is helping to facilitate Navywide environmental compliance as intended.

Lookouts and members of the operational community have demonstrated enhanced knowledge and understanding of the Navy's environmental compliance responsibilities since the development of the U.S. Navy Afloat Environmental Compliance Training Series. To date, the Navy has had zero vessel strikes of marine mammals in the Study Area. Outside of the Study Area, there has been a decrease in Navy vessel strikes of marine mammals since implementation of the Marine Species Awareness Training in 2007. It is likely that the implementation of the Marine Species Awareness Training starting in 2007, and the additional U.S. Navy Afloat Environmental Compliance Training Series modules starting in 2014, has contributed to the lack of vessel strikes of marine mammals in the Study Area and decrease in vessel strikes of marine mammals outside of the Study Area. This indicates that the environmental awareness and education program is helping to improve the effectiveness of mitigation implementation. A more detailed analysis of vessel strikes is presented in Section 3.4.2.4 (Physical Disturbance and Strike Stressors) of this Draft SEIS/OEIS.

### 5.3.2 Acoustic Stressors

The Navy will implement procedural mitigation to avoid or reduce potential impacts on biological resources at sea from the acoustic stressors or activities discussed in the sections below.

#### 5.3.2.1 Active Sonar

The Navy will continue to implement procedural mitigation to avoid or reduce potential impacts on marine mammals and sea turtles from active sonar, as outlined in Table 5.3-2. In the 2015 MITT Final EIS/OEIS, the Navy's active sonar mitigation zones were based on associated average ranges to PTS. When developing the mitigation for this Draft SEIS/OEIS, the Navy analyzed the potential for increasing the sizes of these mitigation zones. The Navy determined that the current mitigation zones for active sonar are the largest areas within which it is practical to implement mitigation; therefore, it will continue implementing these same mitigation zones under the Proposed Action. The Navy is clarifying in the table that the mitigation zone for low-frequency active sonar sources at or above 200 dB will be the same as the mitigation implemented for hull-mounted mid-frequency active sonar; whereas low-frequency active sonar sources below 200 dB will implement the same mitigation zone as high-frequency active sonar and mid-frequency active sonar sources that are not hull-mounted. The Navy is also clarifying that it will require observation of the mitigation zone prior to the initial start of the activity to ensure the area is clear of applicable biological resources. The Navy has always verified that the mitigation zone is visually clear prior to conducting active sonar activities and is more clearly capturing this current practice in the mitigation measures for this activity.

### Table 5.3-2: Procedural Mitigation for Active Sonar

| *Procedural Mitigation Description* |
|---|
| **Stressor or Activity**<br>• Low-frequency active sonar, mid-frequency active sonar, high-frequency active sonar<br>– For vessel-based active sonar activities, mitigation applies only to sources that are positively controlled and deployed from manned surface vessels (e.g., sonar sources towed from manned surface platforms).<br>– For aircraft-based active sonar activities, mitigation applies only to sources that are positively controlled and deployed from manned aircraft that do not operate at high altitudes (e.g., rotary-wing aircraft). Mitigation does not apply to active sonar sources deployed from unmanned aerial systems or aircraft operating at high altitudes (e.g., maritime patrol aircraft). |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles (only for sources <2 kilohertz [kHz]) |
| **Number of Lookouts and Observation Platform**<br>• Hull-mounted sources:<br>– 1 Lookout: Platforms with space or manning restrictions while underway (at the forward part of a small boat or ship) and platforms using active sonar while moored or at anchor (including pierside)<br>– 2 Lookouts: Platforms without space or manning restrictions while underway (at the forward part of the ship)<br>• Sources that are not hull-mounted:<br>– 1 Lookout on the ship or aircraft conducting the activity |
| **Mitigation Requirements**<br>• Mitigation zones:<br>– 1,000 yd. power down, 500 yd. power down, and 200 yd. shut down for low-frequency active sonar ≥200 decibels (dB) and hull-mounted mid-frequency active sonar<br>– 200 yd. shut down for low-frequency active sonar <200 dB, mid-frequency active sonar sources that are not hull-mounted, and high-frequency active sonar<br>• Prior to the initial start of the activity (e.g., when maneuvering on station):<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, relocate or delay the start of active sonar transmission.<br>• During the activity:<br>– Low-frequency active sonar ≥200 decibels (dB) and hull-mounted mid-frequency active sonar: Observe the mitigation zone for marine mammals and sea turtles (for sources <2 kHz); power down active sonar transmission by 6 dB if observed within 1,000 yd. of the sonar source; power down an additional 4 dB (10 dB total) within 500 yd.; cease transmission within 200 yd.<br>– Low-frequency active sonar <200 dB, mid-frequency active sonar sources that are not hull-mounted, and high-frequency active sonar: Observe the mitigation zone for marine mammals and sea turtles (for sources <2 kHz); cease active sonar transmission if observed within 200 yd. of the sonar source.<br>• Commencement/recommencement conditions after a marine mammal or sea turtle sighting before or during the activity:<br>– The Navy will allow a sighted marine mammal or sea turtle to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing or powering up active sonar transmission) until one of the following conditions has been 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, speed, and movement relative to the sonar source; (3) the mitigation zone has been clear from any additional sightings for 10 minutes for aircraft-deployed sonar sources or 30 minutes for vessel-deployed sonar sources; (4) for mobile activities, the active sonar source has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting; or (5) for activities using hull-mounted sonar, the ship concludes that dolphins are deliberately closing in on the ship to ride the ship's bow wave, and are therefore out of the main transmission axis of the sonar (and there are no other marine mammal sightings within the mitigation zone). |

The Navy will follow the incident reporting procedures outlined in Section 5.1.2.2.3 (Incident Reports) if an incident is detected at any time during the event. The mitigation zone sizes and proximity to the observation platforms will result in a high likelihood that Lookouts will be able to detect marine mammals and sea turtles throughout the mitigation zones.

Section 3.4.2.1.2 (Impacts from Sonar and Other Transducer Stressors) of this SEIS/OEIS provides a full analysis of the potential impacts of sonar on marine mammals and includes the impact ranges for various source bins. For low-frequency active sonar at 200 dB or more and hull-mounted mid-frequency active sonar, bin MF1 has the longest predicted ranges to PTS. For low-frequency active sonar below

200 dB, mid-frequency active sonar sources that are not hull-mounted, and high-frequency active sonar, bin HF4 has the longest predicted ranges to PTS. For the highest source levels in bin MF1 and HF4, the mitigation zones extend beyond the respective average ranges to PTS for marine mammals. The mitigation zones for active sonar will help avoid or reduce the potential for exposure to PTS for marine mammals.

The active sonar mitigation zones also extend into a portion of the average ranges to TTS for marine mammals; therefore, mitigation will help avoid or reduce the potential for some exposure to higher levels of TTS. Active sonar sources that fall within lower source bins or are used at lower source levels have shorter impact ranges than those discussed above; therefore, the mitigation zones will extend further beyond or into the average ranges to PTS and TTS for these sources. The analysis in Section 3.4.2.1.2 (Impacts from Sonar and Other Transducers) of this SEIS/OEIS indicates that pygmy and dwarf sperm whales (Kogia whales) are the only deep-diving marine mammal species that could potentially experience PTS impacts from active sonar in the Study Area. The 30-minute wait period for vessel-deployed sources will cover the average dive times of marine mammal species that could experience PTS from sonar in the mitigation zone, except for Kogia whales. The 10-minute wait period for aircraft-deployed sources will cover a portion, but not the average, dive times of marine mammals.

Section 3.5.2.1.2 (Impacts from Sonar and Other Transducers) provides a full analysis of the potential impacts of sonar on sea turtles. Due to sea turtle hearing capabilities, the mitigation only applies to sea turtles during the use of sources below 2 kilohertz. The range to auditory effects for most active sonar sources in sea turtle hearing range (e.g., LF4) is zero meters. Impact ranges are longer (i.e., up to tens of meters) for active sonars with higher source levels. The mitigation zones for active sonar extend beyond the ranges to PTS and TTS for sea turtles; therefore, mitigation will help avoid or reduce the potential for exposure to these effects for sea turtles.

As described previously, the mitigation zones developed for this SEIS/OEIS are based on the largest areas within which it is practical for the Navy to implement mitigation during training and testing within the Study Area. Training and testing with active sonar is essential to national security. Active sonar is the only reliable technology for detecting and tracking potential enemy diesel-electric submarines. For example, small diesel-electric submarines operate quietly and may hide in shallow coastal and littoral waters. The ability to effectively operate active sonar is a highly perishable skill that must be repeatedly practiced during realistic training. Naval forces must train in the same mode and manner in which they conduct military missions and combat operations. Anti-submarine warfare training typically involves the periodic use of active sonar 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). This can take from several hours to multiple days and typically occurs over vast areas with varying physical and oceanographic conditions (e.g., bathymetry, topography, surface fronts, and variations in sea surface temperature). Sonar operators train to avoid or reduce interference and sound-reducing clutter from varying ocean floor topographies and environmental conditions, practice coordinating their efforts with other sonar operators in a strike group, develop skill proficiency in detecting and tracking submarines and other threats, and practice the focused endurance vital to effectively working as a team in shifts around the clock until the conclusion of the event.

Increasing the mitigation zone sizes would result in a larger area over which active sonar would need to be powered down or shut down in response to a sighting, and therefore would likely increase the number of times that these mitigation measures would be implemented. This would extend the length of the activity, significantly diminish event realism, and prevent activities from meeting their intended objectives. It would also create fundamental differences between how active sonar would be used in training and how active sonar should be used during military missions and combat operations. For example, additional active sonar power downs or shut downs would prevent sonar operators from developing and maintaining awareness of the tactical picture during training events. Without realistic training in conditions analogous to military missions and combat operations, sonar operators cannot become proficient in effectively operating active sonar. Sonar operators, vessel crews, and aircrews would be expected to operate active sonar during military missions and combat operations in a manner inconsistent with how they were trained.

During integrated training, multiple vessels and aircraft may participate in an exercise using different warfare components simultaneously. Degrading the value of one training element results in a degradation of the training value of the other training elements. Degrading the value of training would cause a reduction in perishable skills and diminished operational capability, which would significantly impact military readiness. Each of these factors would ultimately impact the ability for units to meet their individual training and certification requirements and the Navy's ability to certify forces to safely deploy to meet national security tasking. Diminishing proficiency or eroding active sonar capabilities would present a significant risk to personnel safety during military missions and combat operations and would impact the ability to deploy with the required level of readiness necessary to accomplish any tasking by Combatant Commanders.

Increasing the number of times that the Navy must power down or shut down active sonar transmissions during testing activities would result in similar consequences to activity realism. For example, at-sea sonar testing activities are required in order to calibrate or document the functionality of sonar and torpedo systems while a ship or submarine is in an open ocean environment. Additional powering down or shutting down active sonar transmissions would prevent this activity from meeting its intended objective, such as verifying if the ship meets design acoustic specifications. These types of impacts would impede the ability of researchers, program managers, and weapons system acquisition programs to meet research objectives and testing requirements per required acquisition milestones or on an as-needed basis to meet operational requirements, and would impede shipboard maintenance, repairs, or pierside testing prior to at-sea operations.

For activities that involve aircraft (e.g., activities involving rotary-wing aircraft that use dipping sonar or sonobuoys to locate submarines or submarine targets), extending the length of the activity would require aircraft to depart the area to refuel. If multiple refueling events were required, the length of the activity would be extended by two to five times or more, which would decrease the ability for Lookouts to safely and effectively maintain situational awareness of the activity area and increase safety risks due to increased pilot fatigue and accelerated fatigue-life of aircraft. Extending the length of the activity would also result in additional operational costs due to increased fuel consumption. Increasing the mitigation zone sizes would not result in a substantial reduction of injurious impacts because, as described above, the mitigation zones extend beyond the average ranges to PTS for sea turtles and marine mammals.

In summary, the operational community determined that implementing procedural mitigation for active sonar beyond what is detailed in Table 5.3-2 would be incompatible with the practicality assessment criteria for safety, sustainability, and mission requirements.

#### 5.3.2.2 Weapons Firing Noise

The Navy will continue to implement procedural mitigation to avoid or reduce potential impacts on marine mammals and sea turtles from weapons firing noise, as outlined in Table 5.3-3.

**Table 5.3-3: Procedural Mitigation for Weapons Firing Noise**

| ***Procedural Mitigation Description*** |
|---|
| **<u>Stressor or Activity</u>**<br>• Weapons firing noise associated with large-caliber gunnery activities |
| **<u>Resource Protection Focus</u>**<br>• Marine mammals<br>• Sea turtles |
| **<u>Number of Lookouts and Observation Platform</u>**<br>• 1 Lookout positioned on the ship conducting the firing<br>– Depending on the activity, the Lookout could be the same one described in Section 5.3.3.3 (Explosive Medium-Caliber and Large-Caliber Projectiles) or Section 5.3.4.3 (Small-, Medium-, and Large-Caliber Non-Explosive Practice Munitions). |
| **<u>Mitigation Requirements</u>**<br>• Mitigation zone:<br>– 30° on either side of the firing line out to 70 yd. from the muzzle of the weapon being fired<br>• Prior to the initial start of the activity:<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, relocate or delay the start of weapons firing.<br>• During the activity:<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, cease weapons firing.<br>• Commencement/recommencement conditions after a marine mammal or sea turtle sighting before or during the activity:<br>– The Navy will allow a sighted marine mammal or sea turtle to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing weapons firing) until one of the following conditions has been 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, speed, and movement relative to the firing ship; (3) the mitigation zone has been clear from any additional sightings for 30 minutes; or (4) for mobile activities, the firing ship has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting. |

In the 2015 MITT Final EIS/OEIS, the weapons firing noise mitigation zone was based on the associated average ranges to PTS. When developing the mitigation for this SEIS/OEIS, the Navy analyzed the potential for increasing the size of the mitigation zone. The Navy determined that the current mitigation zone is the largest area within which it is practical to implement mitigation for this activity; therefore, it will continue implementing the same mitigation zone size under the Proposed Action. The Navy is clarifying in the table that it will require observation of the mitigation zone prior to the initial start of the activity to ensure the area is clear of applicable biological resources. The Navy has always verified that the mitigation zone is visually clear prior to conducting weapons firing activities and is more clearly capturing this current practice in the mitigation measures for this activity. The Navy will follow the incident reporting procedures outlined in Section 5.1.2.2.3 (Incident Reports) if an incident is detected at any time during the event.

Section 3.4.4.2.5 (Impacts from Weapons Firing, Launch, and Impact Noise) and Section 3.5.3.1.8 (Impacts from Weapons Firing, Launch, and Impact Noise) of the 2015 MITT Final EIS/OEIS provide a full analysis of the potential impacts of weapons noise on marine mammals and sea turtles, respectively. As described in Section 3.0.5.2.1.4 (Weapons Firing, Launch, and Impact Noise) of the 2015 MITT Final EIS/OEIS, underwater sounds from large-caliber weapons firing activities would be strongest just below the surface and directly under the firing point. Any sound that enters the water only does so within a narrow cone below the firing point or path of the projectile. The mitigation zone extends beyond the distance to which marine mammals and sea turtles would likely experience PTS or TTS from weapons firing noise; therefore, mitigation will help avoid or reduce the potential for exposure to these impacts. The small mitigation zone size and proximity to the observation platform will result in a high likelihood that Lookouts will be able to detect marine mammals and sea turtles throughout the mitigation zone.

As described previously, the mitigation zone developed for this SEIS/OEIS is based on the largest area within which it is practical for the Navy to implement mitigation for this activity. Increasing the mitigation zone would result in a larger area over which weapons firing would need to be ceased in response to a sighting, and therefore would likely increase the number of times weapons firing would be ceased. However, increasing the mitigation zone size would not result in a substantial reduction of injurious impacts because the mitigation zone extends beyond the average ranges to PTS for sea turtles and marine mammals.

Large-caliber gunnery training activities may involve a single ship firing or may be conducted as part of a larger exercise involving multiple ships. Surface ship crews learn to track targets (e.g., with radar), engage targets, practice defensive marksmanship, and coordinate their efforts within the context of larger activities. Increasing the number of times that the Navy must cease weapons firing during training would decrease realism and impact the ability for Navy Sailors to train and become proficient in using large-caliber guns as required during military missions and combat operations. For example, additional ceasing of the activity would reduce the crew's ability to react to changes in the tactical situation or respond to an incoming threat, which could result in a delay to the ship's training schedule. When training is undertaken in the context of a coordinated exercise involving multiple ships, degrading the value of one of the training element results in a degradation of the training value of the other training elements. These factors would ultimately impact the ability for units to meet their individual training and certification requirements, and the Navy's ability to certify forces to deploy to meet national security tasking.

In summary, the operational community determined that implementing procedural mitigation for weapons firing noise beyond what is detailed in Table 5.3-3 would be incompatible with the practicality assessment criteria for safety and mission requirements.

## 5.3.3 Explosive Stressors

The Navy will implement procedural mitigation to avoid or reduce potential impacts on biological resources at sea from the explosives discussed in the sections below. Section 3.4.2.2 (Explosive Stressors) and Section 3.5.2.2 (Explosive Stressors) provide a full analysis of potential impacts of explosives on marine mammals and sea turtles, respectively, including predicted impact ranges.

### 5.3.3.1 Explosive Sonobuoys

The Navy will continue to implement procedural mitigation to avoid or reduce potential impacts on marine mammals and sea turtles from explosive sonobuoys, as outlined in Table 5.3-4. In the 2015 MITT Final EIS/OEIS, explosive sonobuoys had two mitigation zone sizes based on net explosive weight and the associated average ranges to PTS. When developing mitigation for this Draft SEIS/OEIS, the Navy analyzed the potential for increasing the size of these mitigation zones. The Navy identified an opportunity to increase the mitigation zone size by 250 yd. for sonobuoys using up to 2.5-pound (lb.) net explosive weight so that explosive sonobuoys will implement a 600 yd. mitigation zone, regardless of net explosive weight, to enhance protections to the maximum extent practicable. This increase is reflected in Table 5.3-4. The mitigation zone for explosive sonobuoys is now based on the largest area within which it is practical to implement mitigation.

### Table 5.3-4: Procedural Mitigation for Explosive Sonobuoys

| *Procedural Mitigation Description* |
|---|
| **Stressor or Activity**<br>• Explosive sonobuoys |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles |
| **Number of Lookouts and Observation Platform**<br>• 1 Lookout positioned in an aircraft or on a small boat<br>• If additional platforms are participating in the activity, personnel positioned in those assets (e.g., safety observers, evaluators) will support observing the mitigation zone for applicable biological resources while performing their regular duties. |
| **Mitigation Requirements**<br>• Mitigation zone:<br>– 600 yd. around an explosive sonobuoy<br>• Prior to the initial start of the activity (e.g., during deployment of a sonobuoy pattern, which typically lasts 20–30 minutes):<br>– Conduct passive acoustic monitoring for marine mammals; use information from detections to assist visual observations.<br>– Visually observe the mitigation zone for marine mammals and sea turtles; if observed, relocate or delay the start of sonobuoy or source/receiver pair detonations.<br>• During the activity:<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, cease sonobuoy or source/receiver pair detonations.<br>• Commencement/recommencement conditions after a marine mammal or sea turtle sighting before or during the activity:<br>– The Navy will allow a sighted marine mammal or sea turtle to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing detonations) until one of the following conditions has been 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, speed, and movement relative to the sonobuoy; or (3) the mitigation zone has been clear from any additional sightings for 10 minutes when the activity involves aircraft that have fuel constraints, or 30 minutes when the activity involves aircraft that are not typically fuel constrained.<br>• After completion of the activity (e.g., prior to maneuvering off station):<br>– When practical (e.g., when platforms are not constrained by fuel restrictions or mission-essential follow-on commitments), observe the vicinity of where detonations occurred; if any injured or dead marine mammals or ESA-listed species are observed, follow established incident reporting procedures.<br>– If additional platforms are supporting this activity (e.g., providing range clearance), these assets will assist in the visual observation of the area where detonations occurred. |

The Navy is clarifying in the table that it will require observation of the mitigation zone prior to the initial start of the activity to ensure the area is clear of applicable biological resources. The Navy has always verified that the mitigation zone is visually clear prior to conducting explosive activities and is more clearly capturing this current practice in the mitigation measures for this activity. The Navy developed a new mitigation measure requiring the Lookout to observe the mitigation zone after completion of the activity. In accordance with the 2015 MITT Final EIS/OEIS consultation requirements, the Navy currently conducts post-activity observations for some, but not all explosive activities. When developing mitigation for this Draft SEIS/OEIS, the Navy determined that it could expand this requirement to other explosive activities for enhanced consistency and to help determine if any resources were injured during explosive events, when practical. The Navy is adding a requirement that additional platforms already participating in the activity will support observing the mitigation zone before, during, and after the activity while performing their regular duties. There are typically multiple platforms in the vicinity of activities that use explosive sonobuoys (e.g., safety aircraft). When available, having additional personnel support observations of the mitigation zone will help increase the likelihood of detecting biological resources. The Navy will follow the incident reporting procedures outlined in Section 5.1.2.2.3 (Incident Reports) if an incident is detected at any time during the event, including during the post-activity observations.

Some activities that use explosive sonobuoys involve detonations of a single sonobuoy or sonobuoy pair, while other activities involve deployment of multiple sonobuoys that may be dispersed in a pattern over a large distance. Lookouts will have a better likelihood of detecting marine mammals and sea turtles when observing the mitigation zone around a single sonobuoy or sonobuoy pair than when observing multiple sonobuoys dispersed over a large distance. When observing large distances, Lookouts will be more likely to detect large visual cues (e.g., whale blows or large pods of dolphins) than individual marine mammals, cryptic marine mammal species, and sea turtles.

Bin E3 has the longest predicted impact ranges for explosive sonobuoys used in the Study Area (e.g., MK-61 SUS sonobuoys). For the largest explosive in bin E3, the mitigation zone extends beyond the ranges to 50 percent non-auditory injury and 50 percent mortality for sea turtles and marine mammals. The mitigation zone extends beyond the average ranges to PTS for sea turtles and mid-frequency cetaceans, and into a portion of the average ranges to PTS for high-frequency cetaceans and low-frequency cetaceans. The mitigation zone also extends beyond or into a portion of the average ranges to TTS for sea turtles and marine mammals. Therefore, depending on the species, mitigation will help avoid or reduce all or a portion of the potential for exposure to mortality, non-auditory injury, PTS, and higher levels of TTS for the largest explosives in bin E3. Smaller explosives in bin E3 and explosives in smaller source bins (E1) have shorter predicted impact ranges; therefore, the mitigation zone will extend further beyond or cover a greater portion of the impact ranges for these explosives.

As described previously, the mitigation zone developed for this SEIS/OEIS is based on the largest area within which it is practical for the Navy to implement mitigation. It is not practical to increase the mitigation zone because observations within the margin of increase would be ineffective unless the Navy allocated additional platforms to observe for biological resources. This is particularly true when observations occur from a small boat or during observations over a large distance. The use of additional personnel and equipment (aircraft or small boats) would be unsustainable due to increased operational costs and an exceedance of the available manpower and resources for this activity. Adding aircraft to observe the mitigation zone could result in airspace conflicts with the event participants. This would either require the aircraft conducting the activity to modify their flights plans (which would reduce activity realism) or force the observing aircraft to position itself a safe distance away from the activity area (which would decrease observation effectiveness). Adding vessels to observe the mitigation zone would increase safety risks due to the presence of observation vessels within the vicinity of an explosive sonobuoy or pattern of explosive sonobuoys.

Increasing the mitigation zone size would result in a larger area over which detonations would need to be ceased in response to a sighting, and therefore would likely increase the number of times detonations would be ceased and would extend the length of the activity. These impacts would significantly diminish event realism in a way that would prevent the activity from meeting its intended objectives. For example, during Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft events, additional ceasing of the activity would not allow the Navy to effectively test sensors and systems that are used to detect and track submarines and ensure that systems perform to specifications and meet operational requirements. Such testing is required to ensure functionality and accuracy in military mission and combat conditions. Extending the length of the activity would require aircraft to depart the area to refuel. If multiple refueling events were required, the activity length would extend by two to five times or more, which would decrease the ability for Lookouts to safely and effectively maintain situational awareness of the activity area and increase safety risks due to increased pilot fatigue and accelerated fatigue-life of aircraft. Extending the length of the activity would also result in additional operational costs due to increased fuel consumption.

In summary, the operational community determined that implementing procedural mitigation for explosive sonobuoys beyond what is detailed in Table 5.3-4 would be incompatible with the practicality assessment criteria for safety, sustainability, and mission requirements.

#### 5.3.3.2 Explosive Torpedoes

The Navy will continue to implement procedural mitigation to avoid or reduce potential impacts on marine mammals and sea turtles from explosive torpedoes, as outlined in Table 5.3-5. In the 2015 MITT Final EIS/OEIS, the explosive torpedo mitigation zone was based on net explosive weight and the associated average ranges to PTS. When developing the mitigation for this SEIS/OEIS, the Navy analyzed the potential for increasing the size of this mitigation zone. The Navy determined that the current mitigation zone is the largest area within which it is practical to implement mitigation for this activity; therefore, it will continue implementing this same mitigation zone under the Proposed Action.

**Table 5.3-5: Procedural Mitigation for Explosive Torpedoes**

| *Procedural Mitigation Description* |
|---|
| **Stressor or Activity**<br>• Explosive torpedoes |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles |
| **Number of Lookouts and Observation Platform**<br>• 1 Lookout positioned in an aircraft<br>• If additional platforms are participating in the activity, personnel positioned in those assets (e.g., safety observers, evaluators) will support observing the mitigation zone for applicable biological resources while performing their regular duties. |
| **Mitigation Requirements**<br>• Mitigation zone:<br>– 2,100 yd. around the intended impact location<br>• Prior to the initial start of the activity (e.g., during deployment of the target):<br>– Conduct passive acoustic monitoring for marine mammals; use information from detections to assist visual observations.<br>– Visually observe the mitigation zone for marine mammals, sea turtles, and jellyfish aggregations; if observed, relocate or delay the start of firing.<br>• During the activity:<br>– Observe the mitigation zone for marine mammals, sea turtles, and jellyfish aggregations; if observed, cease firing.<br>• Commencement/recommencement conditions after a marine mammal or sea turtle sighting before or during the activity:<br>– The Navy will allow a sighted marine mammal or sea turtle to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing firing) until one of the following conditions has been 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, speed, and movement relative to the intended impact location; or (3) the mitigation zone has been clear from any additional sightings for 10 minutes when the activity involves aircraft that have fuel constraints, or 30 minutes when the activity involves aircraft that are not typically fuel constrained.<br>• After completion of the activity (e.g., prior to maneuvering off station):<br>– When practical (e.g., when platforms are not constrained by fuel restrictions or mission-essential follow-on commitments), observe the vicinity of where detonations occurred; if any injured or dead marine mammals or ESA-listed species are observed, follow established incident reporting procedures.<br>– If additional platforms are supporting this activity (e.g., providing range clearance), these assets will assist in the visual observation of the area where detonations occurred. |

The post-activity observations for explosive torpedoes are a continuation from the 2015 MITT Final EIS/OEIS and will help the Navy determine if any resources were injured during the activity. The Navy will follow the incident reporting procedures outlined in Section 5.1.2.2.3 (Incident Reports) if an incident is detected at any time during the event, including during the post-activity observations. The Navy is clarifying in the table that it will require observation of the mitigation zone prior to the initial start of the activity to ensure the area is clear of applicable biological resources. The Navy has always verified that the mitigation zone is visually clear prior to conducting explosive activities and is more clearly capturing this current practice in the mitigation measures for this activity. The Navy is adding a requirement that additional platforms already participating in the activity will support observing the mitigation zone before, during, and after the activity while performing their regular duties. Typically, when aircraft are firing explosive torpedoes, there are additional observation aircraft, support vessels (e.g., range craft for torpedo retrieval), or other safety aircraft in the vicinity. When available, having additional personnel support observations of the mitigation zone will help increase the likelihood of detecting biological resources.

Explosive torpedo activities involve detonations at a target located down range of the firing platform. Due to the distance between the mitigation zone and the observation platform, Lookouts will have a better likelihood of detecting large visual cues (e.g., whale blows or large pods of dolphins) than individual marine mammals, cryptic marine mammal species, and sea turtles. Some species of sea turtles forage on jellyfish, and some of the locations where explosive torpedo activities could occur support high densities of jellyfish throughout parts of the year. Observing for jellyfish aggregations will further help avoid or reduce potential impacts on sea turtles within the mitigation zone. The post-activity observations for marine mammals and sea turtles will help the Navy determine if any resources were injured during the activity.

Bin E11 has the longest predicted impact ranges for explosive torpedoes used in the Study Area. For the largest explosive in bin E11, the mitigation zone extends beyond the ranges to 50 percent non-auditory injury and 50 percent mortality for sea turtles and marine mammals. The mitigation zone extends beyond the average ranges to PTS for sea turtles, low-frequency cetaceans, and mid-frequency cetaceans, and into a portion of the average ranges to PTS for high-frequency cetaceans. The mitigation zone extends beyond the average range to TTS for sea turtles and mid-frequency cetaceans, and into a portion of the average ranges to TTS for low-frequency cetaceans and high-frequency cetaceans. Therefore, depending on the species, mitigation will help avoid or reduce all or a portion of the potential for exposure to mortality, non-auditory injury, PTS, and higher levels of TTS for the largest explosives in bin E11. Explosive torpedoes in smaller source bins (e.g., E8) have shorter predicted impact ranges; therefore, the mitigation zone will extend further beyond or cover a greater portion of the impact ranges for these explosives.

As described previously, the mitigation zone developed for this Draft SEIS/OEIS is based on the largest area within which it is practical for the Navy to implement mitigation. It is not practical to increase this mitigation zone because observations within the margin of increase would be ineffective unless the Navy allocated additional platforms to observe for biological resources. The use of additional personnel and observation platforms would be unsustainable due to increased operational costs and an exceedance of the available manpower and resources for this activity. Adding aircraft to observe the mitigation zone could result in airspace conflicts with the event participants. This would either require the aircraft participating in the activity to modify their flights plans (which would reduce activity realism) or force the observing aircraft to position itself a safe distance away from the activity area (which would decrease observation effectiveness). Adding vessels to observe the mitigation zone would increase safety risks due to the presence of observation vessels within the vicinity of explosive torpedoes.

Increasing the mitigation zone size would result in a larger area over which detonations would need to be ceased in response to a sighting, and therefore would likely increase the number of times detonations would be ceased and would extend the length of the activity. These impacts would significantly diminish event realism in a way that would prevent the activity from meeting its intended objectives. For example, the Navy conducts Torpedo (Explosive) Testing events to test the functionality of torpedoes and torpedo launch systems. These events often involve aircrews locating, approaching, and firing a torpedo on an artificial target. They require focused situational awareness of the activity area and continuous coordination between the participating platforms as required during military missions and combat operations. Extending the length of the activity would require aircraft to depart the area to refuel. If the firing aircraft departed the activity location to refuel, the aircrew would lose the ability to maintain situational awareness and effectively coordinate with other participating platforms. If multiple refueling events were required, the activity length would extend by two to five times or more, which would increase safety risks due to increased pilot fatigue and accelerated fatigue-life of aircraft. Therefore, an increase in mitigation would impede the Navy's ability to meet testing requirements per required acquisition milestones or on an as-needed basis to meet operational requirements. Extending the length of the activity would also result in additional operational costs due to increased fuel consumption.

In summary, the operational community determined that implementing procedural mitigation for explosive torpedoes beyond what is detailed in Table 5.3-5 would be incompatible with the practicality assessment criteria for safety, sustainability, and mission requirements.

#### 5.3.3.3 Explosive Medium-Caliber and Large-Caliber Projectiles

The Navy will continue to implement procedural mitigation to avoid or reduce potential impacts on marine mammals and sea turtles from explosive gunnery activities, as outlined in Table 5.3-6.

In the 2015 MITT Final EIS/OEIS, explosive gunnery activity mitigation zones were based on net explosive weight and the associated average ranges to PTS. When developing mitigation for this Draft SEIS/OEIS, the Navy analyzed the potential for increasing the size of these mitigation zones. The Navy identified an opportunity to increase the mitigation zone size by 400 yd. for surface-to-surface activities to enhance protections to the maximum extent practicable. This increase is reflected in Table 5.3-6. The mitigation zones for explosive medium-caliber and large-caliber projectiles are now based on the largest areas within which it is practical to implement mitigation.

The Navy is clarifying in the table that it will require observation of the mitigation zone prior to the initial start of the activity to ensure the area is clear of applicable biological resources. The Navy has always verified that the mitigation zone is visually clear prior to conducting explosive activities and is more clearly capturing this current practice in the mitigation measures for this activity. The Navy developed a new mitigation measure requiring the Lookout to observe the mitigation zone after completion of the activity. In accordance with the 2015 MITT Final EIS/OEIS consultation requirements, the Navy currently conducts post-activity observations for some, but not all explosive activities. When developing the mitigation for this SEIS/OEIS, the Navy determined that it could expand this requirement to other explosive activities for enhanced consistency and to help determine if any resources were injured during explosive events, when practical.

### Table 5.3-6: Procedural Mitigation for Explosive Medium-Caliber and Large-Caliber Projectiles

| *Procedural Mitigation Description* |
|---|
| **Stressor or Activity**<br>• Gunnery activities using explosive medium-caliber and large-caliber projectiles<br>– Mitigation applies to activities using a surface target |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles |
| **Number of Lookouts and Observation Platform**<br>• 1 Lookout on the vessel or aircraft conducting the activity<br>– For activities using explosive large-caliber projectiles, depending on the activity, the Lookout could be the same as the one described in Section 5.3.2.2 (Weapons Firing Noise)<br>• If additional platforms are participating in the activity, personnel positioned in those assets (e.g., safety observers, evaluators) will support observing the mitigation zone for applicable biological resources while performing their regular duties. |
| **Mitigation Requirements**<br>• Mitigation zones:<br>– 200 yd. around the intended impact location for air-to-surface activities using explosive medium-caliber projectiles<br>– 600 yd. around the intended impact location for surface-to-surface activities using explosive medium-caliber projectiles<br>– 1,000 yd. around the intended impact location for surface-to-surface activities using explosive large-caliber projectiles<br>• Prior to the initial start of the activity (e.g., when maneuvering on station):<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, relocate or delay the start of firing.<br>• During the activity:<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, cease firing.<br>• Commencement/recommencement conditions after a marine mammal or sea turtle sighting before or during the activity:<br>– The Navy will allow a sighted marine mammal or sea turtle to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing firing) until one of the following conditions has been 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, speed, and movement relative to the intended impact location; (3) the mitigation zone has been clear from any additional sightings for 10 minutes for aircraft-based firing or 30 minutes for vessel-based firing; or (4) for activities using mobile targets, the intended impact location has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.<br>• After completion of the activity (e.g., prior to maneuvering off station):<br>– When practical (e.g., when platforms are not constrained by fuel restrictions or mission-essential follow-on commitments), observe the vicinity of where detonations occurred; if any injured or dead marine mammals or ESA-listed species are observed, follow established incident reporting procedures.<br>– If additional platforms are supporting this activity (e.g., providing range clearance), these assets will assist in the visual observation of the area where detonations occurred. |

The Navy is adding a requirement that additional platforms already participating in the activity will support observing the mitigation zone before, during, and after the activity while performing their regular duties. Typically, when aircraft are firing explosive munitions there are additional observation aircraft, multiple aircraft firing munitions, or other safety aircraft in the vicinity. When available, having additional personnel support observations of the mitigation zone will help increase the likelihood of detecting biological resources. The Navy will follow the incident reporting procedures outlined in Section 5.1.2.2.3 (Incident Reports) if an incident is detected at any time during the event, including during the post-activity observations.

Large-caliber gunnery activities involve vessels firing projectiles at targets located up to 6 nautical miles (NM) down range. Medium-caliber gunnery activities involve vessels or aircraft firing projectiles at targets located up to 4,000 yd. down range, although typically much closer. As described in Section 5.2.1 (At-Sea Procedural Mitigation Development), certain platforms, such as the small boats and aircraft used during explosive medium-caliber gunnery exercises, have manning or space restrictions; therefore, the Lookout for these activities is typically an existing member of the aircraft or boat crew who is responsible for other essential tasks (e.g., navigation). Due to their relatively lower vantage point, Lookouts on vessels (during medium-caliber or large-caliber gunnery exercises) will be more likely to detect large visual cues (e.g., whale blows or large pods of dolphins) than individual marine mammals, cryptic marine mammal species, and sea turtles when observing around targets located at the furthest firing distances. The Navy will implement larger mitigation zones for large-caliber gunnery activities than for medium-caliber gunnery activities due to the nature of how the activities are conducted. For example, large-caliber gunnery activities are conducted from surface combatants, so Lookouts can observe a larger mitigation zone because they typically have access to high-powered binoculars mounted on the ship deck. This will enable observation of the distant mitigation zone in combination with hand-held binoculars and naked-eye scanning. Lookouts in aircraft (during medium-caliber gunnery exercises), have a relatively higher vantage point for observing the mitigation zones but will still be more likely to detect individual marine mammals and sea turtles when observing mitigation zones located close to the firing platform than at the furthest firing distances.

The mitigation applies only to activities using surface targets. Most airborne targets are recoverable aerial drones that are not intended to be hit by ordnance. Given the speed of the projectiles and mobile target, and the long ranges that projectiles typically travel, it is not possible to definitively predict or to effectively observe where the projectile fragments will fall. For gunnery activities using explosive medium-caliber and large-caliber projectiles, the potential military expended material fall zone can only be predicted within thousands of yards, which can be up to 6 NM from the firing location. These areas are too large to be effectively observed for marine mammals and sea turtles with the number of personnel and platforms available for this activity. The potential risk to marine mammals and sea turtles during events using airborne targets is limited to the animal being directly struck by falling military expended materials. There is no potential for direct impact from the explosives because the detonations occur in air. Based on the extremely low potential for projectile fragments to co-occur in space and time with a marine mammal or sea turtle at or near the surface of the water, the potential for a direct strike is negligible; therefore, mitigation for gunnery activities using airborne targets would not be effective at avoiding or reducing potential impacts.

Bin E5 (e.g., 5-inch projectiles) has the longest predicted impact ranges for explosive projectiles that apply to the 1,000 yd. mitigation zone. Bin E2 (e.g., 40-millimeter projectiles) has the longest predicted impact ranges for explosive projectiles that apply to the 600 yd. and 200 yd. mitigation zones. The 1,000 yd., 600 yd., and 200 yd. mitigation zones extend beyond the respective ranges to 50 percent non-auditory injury and 50 percent mortality for sea turtles and marine mammals. The 1,000 yd., 600 yd., and 200 yd. mitigation zones extend beyond the respective average ranges to PTS for sea turtles, mid-frequency cetaceans, and low-frequency cetaceans, and into a portion of the average ranges to PTS for high-frequency cetaceans. The mitigation zones also extend beyond or into a portion of the average ranges to TTS for sea turtles and marine mammals. Therefore, depending on the species, mitigation will help avoid or reduce all or a portion of the potential for exposure to mortality, non-auditory injury, PTS, and higher levels of TTS for the largest explosives in bin E5 and bin E2. Explosives in smaller source bins (e.g., E1) have shorter predicted impact ranges; therefore, the mitigation zones will extend further beyond or cover a greater portion of the impact ranges for these explosives.

As described previously, the mitigation zones developed for this SEIS/OEIS are based on the largest areas within which it is practical for the Navy to implement mitigation. It is not practical to increase these mitigation zones because observations within the margin of increase would be unsafe and ineffective. One of the mission-essential safety protocols for explosive gunnery activities is a requirement for event participants (including the Lookout) to maintain focus on the activity area to ensure safety of Navy personnel and equipment, and the public. For example, when air-to-surface medium-caliber gunnery exercises involve fighter aircraft descending on a target, or rotary-wing aircraft flying a racetrack pattern and descending on a target using a forward-tilted firing angle, maintaining attention on the activity area is paramount to aircraft safety. The typical activity areas for medium-caliber and large-caliber gunnery activities coincide with the applicable mitigation zones; therefore, the Lookout can safely and effectively observe the mitigation zones for biological resources while simultaneously maintaining focus on the activity area. However, if the mitigation zone sizes increased, the Lookout would need to redirect attention to observe beyond the activity area. This would not meet the safety criteria since personnel would be required to direct attention away from mission requirements. Alternatively, the Navy would need to add personnel to serve as additional Lookouts on the existing observation platforms or allocate additional platforms to the activity to observe for biological resources. These actions would not be safe or sustainable due to an exceedance of manpower, resource, and space restrictions for these activities. Similarly, positioning platforms closer to the intended impact location would increase safety risks related to proximity to the detonation location and path of the explosive projectile.

Increasing the mitigation zone sizes would result in larger areas over which detonations would need to be ceased in response to a sighting, and therefore would likely increase the number of times firing would be ceased and would extend the length of the activity. These impacts would significantly diminish event realism in a way that would prevent activities from meeting their intended objectives. For example, the Navy must train its gun crews to coordinate with other participating platforms (e.g., small boats launching a target, other firing platforms), locate and engage surface targets (e.g., high speed maneuverable surface targets), and practice precise defensive marksmanship to disable threats.

Depending on the type of target being used, additional stopping of the activity could result in the target needing to be recovered and relaunched, which would cause a significant loss of training time. For activities that involve aircraft, extending the length of the activity would require aircraft to depart the area to refuel. If multiple refueling events were required, the length of the activity would be extended by two to five times or more, which would decrease the ability for Lookouts to safely and effectively maintain situational awareness of the activity area and increase safety risks due to increased pilot fatigue and accelerated fatigue-life of aircraft. These types of impacts would reduce the number of opportunities that gun crews have to fire on the target and cause significant delays to the training schedule. Therefore, an increase in mitigation would impede the ability for gun crews to train and become proficient in using their weapons as required during military missions and combat operations and would prevent units from meeting their individual training and certification requirements (which would prevent them from deploying with the required level of readiness necessary to accomplish their missions). Extending the length of the activity would also result in additional operational costs due to increased fuel consumption.

In summary, the operational community determined that implementing procedural mitigation for explosive medium-caliber and large-caliber projectiles beyond what is detailed in Table 5.3-6 would be incompatible with the practicality assessment criteria for safety, sustainability, and mission requirements.

#### 5.3.3.4 Explosive Missiles and Rockets

The Navy will continue to implement procedural mitigation to avoid or reduce potential impacts on marine mammals and sea turtles from explosive missiles and rockets, as outlined in Table 5.3-7.

### Table 5.3-7: Procedural Mitigation for Explosive Missiles and Rockets

| ***Procedural Mitigation Description*** |
|---|
| **Stressor or Activity**<br>• Aircraft-deployed explosive missiles and rockets<br>  – Mitigation applies to activities using a surface target |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles |
| **Number of Lookouts and Observation Platform**<br>• 1 Lookout positioned in an aircraft<br>• If additional platforms are participating in the activity, personnel positioned in those assets (e.g., safety observers, evaluators) will support observing the mitigation zone for applicable biological resources while performing their regular duties. |
| **Mitigation Requirements**<br>• Mitigation zones:<br>  – 900 yd. around the intended impact location for missiles or rockets with 0.6–20 lb. net explosive weight<br>  – 2,000 yd. around the intended impact location for missiles with 21–500 lb. net explosive weight<br>• Prior to the initial start of the activity (e.g., during a fly-over of the mitigation zone):<br>  – Observe the mitigation zone for marine mammals and sea turtles; if observed, relocate or delay the start of firing.<br>• During the activity:<br>  – Observe the mitigation zone for marine mammals and sea turtles; if observed, cease firing.<br>• Commencement/recommencement conditions after a marine mammal or sea turtle sighting before or during the activity:<br>  – The Navy will allow a sighted marine mammal or sea turtle to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing firing) until one of the following conditions has been 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, speed, and movement relative to the intended impact location; or (3) the mitigation zone has been clear from any additional sightings for 10 minutes when the activity involves aircraft that have fuel constraints, or 30 minutes when the activity involves aircraft that are not typically fuel constrained.<br>• After completion of the activity (e.g., prior to maneuvering off station):<br>  – When practical (e.g., when platforms are not constrained by fuel restrictions or mission-essential follow-on commitments), observe the vicinity of where detonations occurred; if any injured or dead marine mammals or ESA-listed species are observed, follow established incident reporting procedures.<br>  – If additional platforms are supporting this activity (e.g., providing range clearance), these assets will assist in the visual observation of the area where detonations occurred. |

In the 2015 MITT Final EIS/OEIS, explosive missile and rocket mitigation zones were based on net explosive weight and the associated average ranges to PTS. When developing the mitigation for this SEIS/OEIS, the Navy analyzed the potential for increasing the mitigation zone sizes. The Navy identified an opportunity to increase the mitigation zone by 1,100 yd. for missiles and rockets using 21–250 lb. net explosive weight to enhance protections to the maximum extent practicable. This increase is reflected in Table 5.3-7. The mitigation zones are now based on the largest areas within which it is practical to implement mitigation.

The Navy is clarifying in the table that it will require observation of the mitigation zone prior to the initial start of the activity to ensure the area is clear of applicable biological resources. The Navy has always verified that the mitigation zone is visually clear prior to conducting explosive activities and is more clearly capturing this current practice in the mitigation measures for this activity. The Navy developed a new mitigation measure requiring the Lookout to observe the mitigation zone after completion of the activity. In accordance with the 2015 MITT Final EIS/OEIS consultation requirements, the Navy currently conducts post-activity observations for some, but not all explosive activities. When developing the mitigation for this SEIS/OEIS, the Navy determined that it could expand this requirement to other explosive activities for enhanced consistency and to help determine if any resources were injured during explosive events, when practical. The Navy is adding a requirement that additional platforms already participating in the activity will support observing the mitigation zone before, during, and after the activity while performing their regular duties. Typically, when aircraft are firing explosive munitions there are additional observation aircraft, multiple aircraft firing munitions, or other safety aircraft in the vicinity. For example, during typical explosive missile exercises, two aircraft circle the activity location. One aircraft clears the intended impact location while the other fires, and vice versa. A third aircraft is typically present for safety or proficiency inspections. When available, having additional personnel support observations of the mitigation zone will help increase the likelihood of detecting biological resources. The Navy will follow the incident reporting procedures outlined in Section 5.1.2.2.3 (Incident Reports) if an incident is detected at any time during the event, including during the post-activity observations.

Missile and rocket exercises involve firing munitions at a target typically located up to 15 NM down range, and infrequently up to 75 NM down range. Due to the distance between the mitigation zone and the observation platform, the Lookout will have a better likelihood of detecting marine mammals and sea turtles during close-range observations and are less likely to detect these resources once positioned at the firing location, particularly individual marine mammals, cryptic marine mammal species, and sea turtles. There is a chance that animals could enter the mitigation zone after the aircraft conducts its close-range mitigation zone observations and before firing begins (once the aircraft has transited to its firing position). The Navy will implement larger mitigation zones for missiles using 21–500 lb. net explosive weight than for missiles and rockets using 0.6–20 lb. net explosive weight due to the nature of how these activities are conducted. During activities using missiles in the larger net explosive weight category, firing aircraft (e.g., maritime patrol aircraft) have the capability of mitigating a larger area due to their larger fuel capacity. During activities using missiles or rockets in the smaller net explosive weight category, firing aircraft (e.g., rotary-wing aircraft) are typically constrained by their fuel capacity.

The mitigation applies to aircraft-deployed missiles and rockets because aircraft can fly over the intended impact area prior to commencing firing. Mitigation would be ineffective for vessel-deployed missiles and rockets because of the inability for a Lookout to detect marine mammals or sea turtles from a vessel from the distant firing position. It would not be effective or practical to have a vessel conduct close-range observations of the mitigation zone prior to firing due to the length of time it would take to complete observations and transit back to the firing position, and the costs associated with increased fuel consumption.

The mitigation applies to activities using surface targets. Most airborne targets are recoverable aerial drones that are not intended to be hit by ordnance. For example, telemetry-configured anti-air missiles used in training are designed to detonate or simulate a detonation near a target, but not as a result of a direct strike on a target. Given the speed of missiles and mobile targets, the high altitudes involved, and the long ranges that missiles typically travel, 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 75 NM from the firing location; and thousands of yards for short range events, which can occur 15 NM from the firing location. These areas are too large to be effectively observed for marine mammals and sea turtles with the number of personnel and platforms available for this activity. The potential risk to marine mammals and sea turtles during events using airborne targets is limited to the animal being directly struck by falling military expended materials. There is no potential for direct impact from explosives because the detonations occur in air. Based on the extremely low potential for military expended materials to co-occur in space and time with a marine mammal or sea turtle at or near the surface of the water, the potential for a direct strike is negligible; therefore, mitigation would not be effective at avoiding or reducing impacts.

Bin E10 (e.g., Harpoon missiles) has the longest predicted impact ranges for explosive missiles that apply to the 2,000 yd. mitigation zone. Bin E6 (e.g., Hellfire missiles) has the longest predicted impact ranges for explosive missiles and rockets that apply to the 900 yd. mitigation zone. The 2,000 yd. and 900 yd. mitigation zones extend beyond the respective ranges to 50 percent non-auditory injury and 50 percent mortality for sea turtles and marine mammals. The mitigation zones extend beyond the respective average ranges to PTS for sea turtles, mid-frequency cetaceans, and low-frequency cetaceans, and into a portion of the respective average ranges to PTS for high-frequency cetaceans. The mitigation zones also extend beyond or into a portion of the average ranges to TTS for sea turtles and marine mammals. Therefore, depending on the species, mitigation will help avoid or reduce all or a portion of the potential for exposure to mortality, non-auditory injury, PTS, and higher levels of TTS for the largest explosives in bin E10 and bin E6. Explosives in smaller source bins (e.g., missiles in bin E8, rockets in bin E3) have shorter predicted impact ranges; therefore, the mitigation zones will cover a greater portion of the impact ranges for these explosives.

As described previously, the mitigation zones developed for this SEIS/OEIS are based on the largest areas within which it is practical for the Navy to implement mitigation. It is not practical to increase these mitigation zones because observations within the margin of increase would be unsafe and ineffective unless the Navy allocated additional platforms to the activity to observe for biological resources. The use of additional personnel and equipment (e.g., aircraft) would be unsustainable due to increased operational costs and an exceedance of the available manpower and resources for this activity. Adding aircraft to observe the mitigation zone could result in airspace conflicts with the event participants. This would either require the aircraft conducting the activity to modify their flights plans (which would reduce activity realism) or force the observing aircraft to position itself a safe distance away from the activity area (which would decrease observation effectiveness). Similarly, positioning platforms closer to the intended impact location (as would be required if mitigation applied to vessel-deployed missiles and rockets) would increase safety risks related to proximity to the detonation location and path of the explosive missile or rocket.

Increasing the mitigation zone sizes would result in larger areas over which firing would need to be ceased in response to a sighting, and therefore would likely increase the number of times detonations would be ceased and would extend the length of the activity. These impacts would significantly diminish event realism in a way that would prevent the activity from meeting its intended objectives. Explosive missile and rocket events require focused situational awareness of the activity area and continuous coordination between the participating platforms as required during military missions and combat operations. For activities using missiles in the larger net explosive weight category, the flyover distance between the mitigation zone and the firing location can extend upwards of 75 NM; therefore, even aircraft with larger fuel capacities would need to depart the activity area to refuel if the length of the activity was extended. If the firing aircraft departed the activity location to refuel, the aircrew would lose the ability to maintain situational awareness of the activity area and effectively coordinate with other participating platforms. If multiple refueling events were required, the activity length would extend by two to five times or more, which would increase safety risks due to increased pilot fatigue and accelerated fatigue-life of aircraft. These types of impacts would cause a significant loss of training or testing time, reduce the number of opportunities that aircrews have to fire on the target, and cause a significant delay to the training or testing schedule. Therefore, an increase in mitigation would impede the ability for aircrews to train and become proficient in using their weapons as required during military missions and combat operations, would prevent units from meeting their individual training and certification requirements (which would prevent them from deploying with the required level of readiness necessary to accomplish their missions), and would impede the ability of program managers and weapons system acquisition programs to meet testing requirements per required acquisition milestones or on an as-needed basis to meet operational requirements. Extending the length of the activity would also result in additional operational costs due to increased fuel consumption.

In summary, the operational community determined that implementing procedural mitigation for explosive missiles and rockets beyond what is detailed in Table 5.3-7 would be incompatible with the practicality assessment criteria for safety, sustainability, and mission requirements.

#### 5.3.3.5 Explosive Bombs

The Navy will continue to implement procedural mitigation to avoid or reduce potential impacts on marine mammals and sea turtles from explosive bombs, as outlined in Table 5.3-8.

### Table 5.3-8: Procedural Mitigation for Explosive Bombs

| *Procedural Mitigation Description* |
|---|
| **Stressor or Activity**<br>• Explosive bombs |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles |
| **Number of Lookouts and Observation Platform**<br>• 1 Lookout positioned in the aircraft conducting the activity<br>• If additional platforms are participating in the activity, personnel positioned in those assets (e.g., safety observers, evaluators) will support observing the mitigation zone for applicable biological resources while performing their regular duties. |
| **Mitigation Requirements**<br>• Mitigation zone:<br>– 2,500 yd. around the intended target<br>• Prior to the initial start of the activity (e.g., when arriving on station):<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, relocate or delay the start of bomb deployment.<br>• During the activity (e.g., during target approach):<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, cease bomb deployment.<br>• Commencement/recommencement conditions after a marine mammal or sea turtle sighting before or during the activity:<br>– The Navy will allow a sighted marine mammal or sea turtle to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing bomb deployment) until one of the following conditions has been 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, speed, and movement relative to the intended target; (3) the mitigation zone has been clear from any additional sightings for 10 minutes; or (4) for activities using mobile targets, the intended target has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.<br>• After completion of the activity (e.g., prior to maneuvering off station):<br>– When practical (e.g., when platforms are not constrained by fuel restrictions or mission-essential follow-on commitments), observe the vicinity of where detonations occurred; if any injured or dead marine mammals or ESA-listed species are observed, follow established incident reporting procedures.<br>– If additional platforms are supporting this activity (e.g., providing range clearance), these assets will assist in the visual observation of the area where detonations occurred. |

In the 2015 MITT Final EIS/OEIS, the explosive bombing mitigation zone was based on net explosive weight and the associated average ranges to PTS. When developing the mitigation for this SEIS/OEIS, the Navy analyzed the potential for increasing the size of this mitigation zone. The Navy determined that the current mitigation zone for explosive bombs is the largest area within which it is practical to implement mitigation for this activity; therefore, it will continue implementing this same mitigation zone under the Proposed Action.

The Navy is clarifying in the table that it will require observation of the mitigation zone prior to the initial start of the activity to ensure the area is clear of applicable biological resources. The Navy has always verified that the mitigation zone is visually clear prior to conducting explosive activities and is more clearly capturing this current practice in the mitigation measures for this activity. The Navy developed a new mitigation measure requiring the Lookout to observe the mitigation zone after completion of this activity. In accordance with the 2015 MITT Final EIS/OEIS consultation requirements, the Navy currently conducts post-activity observations for some, but not all explosive activities. When developing mitigation for this SEIS/OEIS, the Navy determined that it could expand this requirement to other explosive activities for enhanced consistency and to help determine if any resources were injured during explosive events, when practical. The Navy is adding a requirement that additional platforms already participating in the activity will support observing the mitigation zone before, during, and after the activity while performing their regular duties. Typically, when aircraft are firing explosive munitions there are additional observation aircraft, multiple aircraft firing munitions, or other safety aircraft in the vicinity. When available, having additional personnel support observations of the mitigation zone will help increase the likelihood of detecting biological resources. The Navy will follow the incident reporting procedures outlined in Section 5.1.2.2.3 (Incident Reports) if an incident is detected at any time during the event, including during the post-activity observations.

Bombing exercises involve an aircraft deploying munitions at a surface target located beneath the firing platform. During target approach, aircraft maintain a relatively steady altitude of approximately 1,500 ft. Lookouts, by necessity for safety and mission success, primarily focus their attention on the water surface surrounding the intended detonation location (i.e., the mitigation zone). Being positioned in an aircraft gives the Lookout a good vantage point for observing marine mammals and sea turtles throughout the mitigation zone.

Bin E12 (e.g., 2,000 lb. bombs) has the longest predicted impact ranges for explosive bombs used in the Study Area. The 2,500 yd. mitigation zone extends beyond the ranges to 50 percent non-auditory injury and 50 percent mortality for sea turtles and marine mammals. The mitigation zone extends beyond the average ranges to PTS for sea turtles, mid-frequency cetaceans, and low-frequency cetaceans, and into a portion of the average range to PTS for high-frequency cetaceans. The mitigation zone also extends beyond or into a portion of the average ranges to TTS for sea turtles and marine mammals. Therefore, depending on the species, mitigation will help avoid or reduce all or a portion of the potential for exposure to mortality, non-auditory injury, PTS, and higher levels of TTS for the largest bombs in bin E12. Smaller bombs (e.g., 250 lb. bombs, 500 lb. bombs) have shorter predicted impact ranges; therefore, the mitigation zone will extend further beyond or cover a greater portion of the impact ranges for these explosives.

As described previously, the mitigation zone developed for this SEIS/OEIS is based on the largest area within which it is practical for the Navy to implement mitigation. It is not practical to increase this mitigation zone because observations within the margin of increase would be unsafe and ineffective unless the Navy allocated additional platforms to the activity to observe for biological resources. The use of additional personnel and aircraft would be unsustainable due to increased operational costs and an exceedance of the available manpower and resources for this activity. Adding aircraft to observe the mitigation zone could result in airspace conflicts with the event participants. This would either require the aircraft participating in the activity to modify their flights plans (which would reduce activity realism) or force the observing aircraft to position itself a safe distance away from the activity area (which would decrease observation effectiveness). Adding vessels to observe the mitigation zone would increase safety risks due to the presence of observation vessels within the vicinity of the intended explosive bomb detonation location.

Increasing the mitigation zone would result in a larger area over which explosive bomb deployment would need to be ceased in response to a sighting, and therefore would likely increase the number of times explosive bombing activities would be ceased and would extend the length of the activity. These impacts would significantly diminish event realism in a way that would prevent the activity from meeting its intended objectives. For example, critical components of a Bombing Exercise Air-to-Surface training activity are the assembly, loading, delivery, and assessment of an explosive bomb. The activity requires focused situational awareness of the activity area and continuous coordination between multiple training components. The training exercise starts with ground personnel, who must practice the building and loading of explosive munitions. Training includes the safe handling of explosive material, configuring munitions to precise specifications, and loading munitions onto aircraft. Aircrew must then identify a target and safely deliver fused munitions, discern if the bomb was assembled correctly, and determine bomb damage assessments based on how and where the explosive detonated. Extending the length of the activity would require aircraft to depart the area to refuel. If the firing aircraft departed the activity area to refuel, aircrew would lose the ability to maintain situational awareness of the activity area, effectively coordinate with other participating platforms, and complete all training components as required during military missions and combat operations. If multiple refueling events were required, the activity length would be extended by two to five times or more, which would cause a significant loss of training time and would increase safety risks due to increased pilot fatigue and accelerated fatigue-life of aircraft. This would reduce the number of opportunities that aircrews have to approach targets and deploy bombs, which would cause a significant delay to the training schedule. Therefore, an increase in mitigation would impede the ability for aircrews to train and become proficient in using their weapons. This would prevent units from meeting their individual training and certification requirements and deploying with the required level of readiness necessary to accomplish their missions. Extending the length of the activity would also result in additional operational costs due to increased fuel consumption.

In summary, the operational community determined that implementing procedural mitigation for explosive bombs beyond what is detailed in Table 5.3-8 would be incompatible with the practicality assessment criteria for safety, sustainability, and mission requirements.

#### 5.3.3.6 Sinking Exercises

The Navy will continue to implement procedural mitigation to avoid or reduce potential impacts on marine mammals and sea turtles from sinking exercises, as outlined in Table 5.3-9.

### Table 5.3-9: Procedural Mitigation for Sinking Exercises

| *Procedural Mitigation Description* |
|---|
| **Stressor or Activity**<br>• Sinking exercises |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles |
| **Number of Lookouts and Observation Platform**<br>• 2 Lookouts (one positioned in an aircraft and one on a vessel)<br>• If additional platforms are participating in the activity, personnel positioned in those assets (e.g., safety observers, evaluators) will support observing the mitigation zone for applicable biological resources while performing their regular duties. |
| **Mitigation Requirements**<br>• Mitigation zone:<br>– 2.5 NM around the target ship hulk<br>• Prior to the initial start of the activity (90 minutes prior to the first firing):<br>– Conduct aerial observations of the mitigation zone for marine mammals, sea turtles, and jellyfish aggregations; if observed, delay the start of firing.<br>• During the activity:<br>– Conduct passive acoustic monitoring for marine mammals; use information from detections to assist visual observations.<br>– Visually observe the mitigation zone for marine mammals and sea turtles from the vessel; if observed, cease firing.<br>– Immediately after any planned or unplanned breaks in weapons firing of longer than 2 hours, observe the mitigation zone for marine mammals and sea turtles from the aircraft and vessel; if observed, delay recommencement of firing.<br>• Commencement/recommencement conditions after a marine mammal or sea turtle sighting before or during the activity:<br>– The Navy will allow a sighted marine mammal or sea turtle to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing firing) until one of the following conditions has been 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, speed, and movement relative to the target ship hulk; or (3) the mitigation zone has been clear from any additional sightings for 30 minutes.<br>• After completion of the activity (for 2 hours after sinking the vessel or until sunset, whichever comes first):<br>– Observe the vicinity of where detonations occurred; if any injured or dead marine mammals or ESA-listed species are observed, follow established incident reporting procedures.<br>– If additional platforms are supporting this activity (e.g., providing range clearance), these assets will assist in the visual observation of the area where detonations occurred. |

In the 2015 MITT Final EIS/OEIS, the mitigation zone was based on net explosive weight and the associated average ranges to PTS. When developing the mitigation for this Draft SEIS/OEIS, the Navy analyzed the potential for increasing the size of the mitigation zone. The Navy determined that the current mitigation zone for sinking exercises is the largest area within which it is practical to implement mitigation; therefore, it will continue implementing this same mitigation zone under the Proposed Action. The Navy is clarifying in the table that it will require observation of the mitigation zone prior to the initial start of the activity to ensure the area is clear of applicable biological resources. The Navy has always verified that the mitigation zone is visually clear prior to conducting explosive activities and is more clearly capturing this current practice in the mitigation measures for this activity. The Navy is adding a requirement that additional platforms already participating in the activity will support observing the mitigation zone before, during, and after the activity while performing their regular duties. Sinking exercises typically involved multiple participating platforms. When available, having additional personnel support observations of the mitigation zone will help increase the likelihood of detecting biological resources. The two-hour post-activity observations for sinking exercises are a continuation from the 2015 MITT Final EIS/OEIS and will help the Navy determine if any resources were injured during the activity. Sinking exercises are scheduled to ensure they are conducted only in daylight hours. The Navy will be able to complete the full two hours of post-activity observation during typical activity conditions and it is unlikely that observations will be shortened due to nightfall. The Navy will follow the incident reporting procedures outlined in Section 5.1.2.2.3 (Incident Reports) if an incident is detected at any time during the event, including during the post-activity observations.

There is a chance that animals could enter the mitigation zone after the aircraft conducts its close-range mitigation zone observations and before firing begins (once the aircraft has transited to its distant firing position). The Lookout positioned on the vessel will have a higher likelihood of detecting individual marine mammals and sea turtles that are in the central portion of the mitigation zone near the target ship hulk. Near the perimeter of the mitigation zone, the Lookout will be more likely to detect large visual cues (e.g., whale blows or large pods of dolphins) than individual marine mammals, cryptic marine mammal species, and sea turtles. The Lookout positioned in the aircraft will be able to assist the vessel-based Lookout by observing the entire mitigation zone, including near the perimeter, because the aircraft will be able to transit a larger area more quickly (e.g., during range clearance), and will offer a better vantage point. Some species of sea turtles forage on jellyfish in the region where this activity occurs. Observing for jellyfish aggregations will further help avoid or reduce potential impacts on sea turtles within the mitigation zone.

Bin E12 has the longest predicted impact ranges for the types of explosives used during sinking exercises in the Study Area. For the largest explosive in bin E12, the mitigation zone extends beyond the ranges to 50 percent non-auditory injury and 50 percent mortality for sea turtles and marine mammals. The mitigation zone extends beyond the average ranges to PTS for sea turtles and marine mammals. The mitigation zone also extends beyond or into a portion of the average ranges to TTS for sea turtles and marine mammals. Therefore, depending on the species, mitigation will help avoid or reduce all or a portion of the potential for exposure to mortality, non-auditory injury, PTS, and higher levels of TTS for the largest explosives in bin E12. Smaller explosives in bin E12 and explosives in smaller source bins (e.g., E10, E5) have shorter predicted impact ranges; therefore, the mitigation zone will extend further beyond or cover a greater portion of the impact ranges for these explosives.

As described previously, the mitigation zone developed for this SEIS/OEIS is based on the largest area within which it is practical for the Navy to implement mitigation. It is not practical to increase this mitigation zone because observations within the margin of increase would be ineffective unless the Navy allocated additional platforms to the activity to observe for biological resources. The use of additional personnel, aircraft, or vessels would be unsustainable due to increased operational costs and an exceedance of available manpower and resources for this activity. Adding aircraft to observe the mitigation zone could result in airspace conflicts with the event participants. This would either require the aircraft participating in the activity to modify their flights plans (which would reduce activity realism) or force the observing aircraft to position itself a safe distance away from the activity area (which would decrease observation effectiveness). Adding additional platforms to observe the mitigation zone would increase safety risks due to the presence of additional vessels or aircraft within the vicinity of the intended impact location or in the path of explosive projectiles.

Increasing the mitigation zone size would result in a larger area over which firing would need to be ceased in response to a sighting, and therefore would likely increase the number of times that the sinking exercise would be ceased and would extend the length of the activity. These impacts would significantly diminish event realism in a way that would prevent the activity from meeting its intended objectives. Sinking exercises require focused situational awareness of the activity area and continuous coordination of tactics between ship, submarine, and aircraft crews using multiple weapon systems to deliver explosive ordnance to deliberately sink a deactivated vessel. Extending the length of the activity would require aircraft to depart the area to refuel, which would disrupt the ability for platforms to maintain continuous coordination of tactics. If multiple refueling events were required, the length of the activity would be extended by two to five times or more, which would decrease the ability for Lookouts to safely and effectively maintain situational awareness of the activity area and increase safety risks due to increased pilot fatigue and accelerated fatigue-life of aircraft. These types of impacts would reduce the frequency at which participants would be able to fire on the deactivated vessel. Because the activity ends when the ship sinks, firing at a decreased frequency would ultimately extend the amount of time it takes for the deactivated vessel to sink. Sinking exercises only take place during daylight hours; therefore, the training exercise would likely be delayed into the next day or next several days, which would significantly impact the schedules of the multiple participants. An increase in mitigation would impede the ability for the participants to become proficient in using their weapons as required during military missions and combat operations and would prevent units from meeting their individual training and certification requirements (which would prevent them from deploying with the required level of readiness necessary to accomplish their missions). Extending the length of the activity would also result in additional operational costs due to increased fuel consumption.

In summary, the operational community determined that implementing procedural mitigation for sinking exercises beyond what is detailed in Table 5.3-9 would be incompatible with the practicality assessment criteria for safety, sustainability, and mission requirements.

#### 5.3.3.7 Explosive Mine Countermeasure and Neutralization Activities

The Navy will continue to implement procedural mitigation to avoid or reduce potential impacts on marine mammals and sea turtles from explosive mine countermeasure and neutralization activities, as outlined in Table 5.3-10. The mitigation applies to all explosive mine countermeasure and neutralization activities except those that involve the use of Navy divers, which are discussed in Section 5.3.3.8 (Explosive Mine Neutralization Activities Involving Navy Divers).

The types of charges used in these activities are positively controlled, which means the detonation is controlled by the personnel conducting the activity and is not authorized until the mitigation zone is clear at the time of detonation. In the 2015 MITT Final EIS/OEIS, explosive mine countermeasure and neutralization activity mitigation zones were based on net explosive weight and the associated average ranges to PTS. When developing the mitigation for this SEIS/OEIS, the Navy analyzed the potential for increasing the size of the mitigation zone. The Navy determined that the current mitigation zone is the largest area within which it is practical to implement mitigation based on the net explosive weights that will be used for this activity under the Proposed Action; therefore, it will continue implementing this same mitigation zone. The post-activity observations are a continuation from the 2015 MITT Final EIS/OEIS and will help the Navy determine if any resources were injured during the activity. The Navy will follow the incident reporting procedures outlined in Section 5.1.2.2.3 (Incident Reports) if an incident is detected at any time during the event, including during the post-activity observations.

## Table 5.3-10: Procedural Mitigation for Explosive Mine Countermeasure and Neutralization Activities

| *Procedural Mitigation Description* |
|---|
| **Stressor or Activity**<br>• Explosive mine countermeasure and neutralization activities |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles |
| **Number of Lookouts and Observation Platform**<br>• 1 Lookout positioned on a vessel or in an aircraft<br>• If additional platforms are participating in the activity, personnel positioned in those assets (e.g., safety observers, evaluators) will support observing the mitigation zone for applicable biological resources while performing their regular duties. |
| **Mitigation Requirements**<br>• Mitigation zone:<br>– 600 yd. around the detonation site<br>• Prior to the initial start of the activity (e.g., when maneuvering on station; typically, 10 minutes when the activity involves aircraft that have fuel constraints, or 30 minutes when the activity involves aircraft that are not typically fuel constrained):<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, relocate or delay the start of detonations.<br>• During the activity:<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, cease detonations.<br>• Commencement/recommencement conditions after a marine mammal or sea turtle sighting before or during the activity:<br>– The Navy will allow a sighted marine mammal or sea turtle to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing detonations) until one of the following conditions has been 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, speed, and movement relative to detonation site; or (3) the mitigation zone has been clear from any additional sightings for 10 minutes when the activity involves aircraft that have fuel constraints, or 30 minutes when the activity involves aircraft that are not typically fuel constrained.<br>• After completion of the activity (typically 10 minutes when the activity involves aircraft that have fuel constraints, or 30 minutes when the activity involves aircraft that are not typically fuel constrained):<br>– Observe the vicinity of where detonations occurred; if any injured or dead marine mammals or ESA-listed species are observed, follow established incident reporting procedures.<br>– If additional platforms are supporting this activity (e.g., providing range clearance), these assets will assist in the visual observation of the area where detonations occurred. |

The Navy is clarifying in the table that it will require observation of the mitigation zone prior to the initial start of the activity to ensure the area is clear of applicable biological resources. The Navy has always verified that the mitigation zone is visually clear prior to conducting explosive activities and is more clearly capturing this current practice in the mitigation measures for this activity. The Navy is adding a requirement that additional platforms already participating in the activity will support observing the mitigation zone before, during, and after the activity while performing their regular duties. When available, having additional personnel support observations of the mitigation zone will help increase the likelihood of detecting biological resources. The small observation area and proximity to the observation platform will result in a high likelihood that the Lookout will be able to detect marine mammals and sea turtles throughout the mitigation zone (regardless of the type of observation platform used).

Bin E4 (e.g., 5 lb. net explosive weight charges) has the longest predicted impact ranges for explosives used in the Study Area during mine countermeasures and neutralization activities. The 600 yd. mitigation zone extends beyond the respective ranges to 50 percent non-auditory injury and 50 percent mortality for sea turtles and marine mammals. The mitigation zone extends beyond the respective average ranges to PTS for sea turtles, mid-frequency cetaceans, and low-frequency cetaceans, and into a portion of the average ranges to PTS for high-frequency cetaceans. The mitigation zones also extend beyond or into a portion of the average ranges to TTS for sea turtles and marine mammals. Therefore, depending on the species, mitigation will help avoid or reduce all or a portion of the potential for exposure to mortality, non-auditory injury, PTS, and higher levels of TTS for the largest explosives in bin E4. Smaller explosives within bin E4 have shorter predicted impact ranges; therefore, the mitigation zones will cover a greater portion of the impact ranges for these explosives.

As described previously, the mitigation zone for this activity is based on the largest area within which it is practical for the Navy to implement mitigation. It is not practical to increase the mitigation zone because observations within the margin of increase would be unsafe and ineffective unless the Navy allocated additional platforms to the activity to observe for biological resources. The use of additional personnel and equipment (e.g., small boats, aircraft) would be unsustainable due to increased operational costs and an exceedance of available manpower and resources for this activity. Adding aircraft to observe the mitigation zone could result in airspace conflicts with the event participants. This would either require the aircraft conducting the activity to modify their flights plans (which would reduce activity realism) or force the observing aircraft to position itself a safe distance away from the activity area (which would decrease observation effectiveness). Adding vessels to observe the mitigation zone would increase safety risks due to the presence observation vessels within the vicinity of detonations.

Increasing the mitigation zone size would result in a larger area over which firing would need to be ceased in response to a sighting, and therefore would likely increase the number of times detonations would be ceased and would extend the length of the activity. These impacts would significantly diminish realism in a way that would prevent the activity from meeting its intended objectives. For example, Mine Neutralization – Remotely Operated Vehicle Sonar training exercises require focused situational awareness of the activity area and continuous coordination of tactics between ship, small boat, and rotary-wing aircraft crews to locate and neutralize mines. During Mine Countermeasure and Neutralization Testing events, personnel evaluate the system's ability to detect and destroy mines from an airborne mine countermeasures-capable rotary-wing aircraft in advance of delivery to the fleet for operational use. Extending the length of these activities would require aircraft to depart the activity area to refuel. If multiple refueling events were required, the length of the activity would be extended by two to five times or more. This would decrease the ability for Lookouts to safely and effectively maintain situational awareness of the activity area and would increase safety risks due to increased pilot fatigue and accelerated fatigue-life of aircraft.

These types of impacts would result in a significant loss of training or testing time (which would reduce the number of opportunities that platforms have to locate and neutralize mines and reduce the Navy's ability to validate whether mine neutralization systems perform as expected) and cause a significant delay to the training or testing schedule. Therefore, an increase in mitigation would impede the ability for the Navy to train and become proficient in using mine neutralization systems as required during military missions and combat operations, would prevent units from meeting their individual training and certification requirements (which would prevent them from deploying with the required level of readiness necessary to accomplish their missions), and would impede the ability of program managers and weapons system acquisition programs to meet testing requirements per required acquisition milestones or on an as-needed basis to meet operational requirements. Extending the length of the activities would also result in additional operational costs due to increased fuel consumption.

In summary, the operational community determined that implementing procedural mitigation for explosive mine countermeasure and neutralization activities beyond what is detailed in Table 5.3-10 would be incompatible with the practicality assessment criteria for safety, sustainability, and mission requirements.

#### 5.3.3.8 Explosive Mine Neutralization Activities Involving Navy Divers

The Navy will continue to implement procedural mitigation to avoid or reduce potential impacts on marine mammals and sea turtles from explosive mine neutralization activities involving Navy divers as outlined in Table 5.3-11. Navy divers participating in these activities may be explosive ordnance disposal personnel.

In the 2015 MITT Final EIS/OEIS, the mitigation zones for explosive mine neutralization activities involving Navy divers were based on net explosive weight and the associated average ranges to PTS. When developing the mitigation for this SEIS/OEIS, the Navy analyzed the potential for increasing the size of the mitigation zones. The Navy identified an opportunity to increase the mitigation zone size for positive control charges in bin E4 or below to enhance protections to the maximum extent practicable and for consistency across activities. These increases are reflected in Table 5.3-11. The mitigation zones for explosive mine neutralization activities involving the use of Navy divers are now based on the largest areas within which it is practical to implement mitigation. The post-activity observations are a continuation from the 2015 MITT Final EIS/OEIS and will help the Navy determine if any resources were injured during the activity. The Navy will follow the incident reporting procedures outlined in Section 5.1.2.2.3 (Incident Reports) if an incident is detected at any time during the event, including during the post-activity observations.

The Navy is clarifying in the table that it will require observation of the mitigation zone prior to the initial start of the activity to ensure the area is clear of applicable biological resources. The Navy has always verified that the mitigation zone is visually clear prior to conducting explosive activities and is more clearly capturing this current practice in the mitigation measures for this activity. The Navy is adding a requirement that additional platforms already participating in the activity will support observing the mitigation zone before, during, and after the activity while performing their regular duties. When available, having additional personnel support observations of the mitigation zone will help increase the likelihood of detecting biological resources.

The charges used during explosive mine neutralization activities involving Navy divers are either positively controlled or initiated using a time-delay fuse. Positive control means the detonation is controlled by the personnel conducting the activity and is not authorized until the area is clear at the time of detonation. Time-delay means 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 but cannot be terminated once the fuse is initiated due to human safety concerns.

For activities using a time-delay fuse (which have a maximum charge size of 20 lb. net explosive weight), there is a remote chance that animals could swim into the mitigation zone after the fuse has been initiated. The Navy established a mitigation measure to set time-delay firing devices not to exceed 10 minutes to limit the potential time that animals have to swim into the mitigation zone after fuse initiation. During activities under positive control, the Navy can cease detonations at any time in response to a sighting of a marine mammal or sea turtle. For this reason, all activities using a time-delay fuse will implement the 1,000 yd. mitigation zone, while activities that are under positive control will implement the 500 yd. mitigation zone.

## Table 5.3-11: Procedural Mitigation for Explosive Mine Neutralization Activities Involving Navy Divers

| *Procedural Mitigation Description* |
|---|
| **Stressor or Activity**<br>• Explosive mine neutralization activities involving Navy divers |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles<br>• Fish (hammerhead sharks) |
| **Number of Lookouts and Observation Platform**<br>• 2 Lookouts (two small boats with one Lookout each, or one Lookout on a small boat and one in a rotary-wing aircraft) when implementing the smaller mitigation zone<br>• 4 Lookouts (two small boats with two Lookouts each), and a pilot or member of an aircrew will serve as an additional Lookout if aircraft are used during the activity, when implementing the larger mitigation zone<br>• All divers placing the charges on mines will support the Lookouts while performing their regular duties and will report applicable sightings to their supporting small boat or Range Safety Officer.<br>• If additional platforms are participating in the activity, personnel positioned in those assets (e.g., safety observers, evaluators) will support observing the mitigation zone for applicable biological resources while performing their regular duties. |
| **Mitigation Requirements**<br>• Mitigation zones:<br>– 500 yd. around the detonation site during activities under positive control<br>– 1,000 yd. around the detonation site during activities using time-delay fuses<br>• Prior to the initial start of the activity (e.g., when maneuvering on station for activities under positive control; 30 minutes for activities using time-delay firing devices):<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, relocate or delay the start of detonations or fuse initiation.<br>• During the activity:<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, cease detonations or fuse initiation.<br>– To avoid potential impacts on ESA-listed scalloped hammerhead sharks within the Mariana Islands Range Complex, divers will notify their supporting small boat or Range Safety Officer of hammerhead shark sightings (of any hammerhead species, due to the difficulty of differentiating species) at the detonation location. The Navy will delay fuse initiations or detonations until the shark is observed exiting the detonation location.<br>– To the maximum extent practicable depending on mission requirements, safety, and environmental conditions, boats will position themselves near the mid-point of the mitigation zone radius (but outside of the detonation plume and human safety zone), will position themselves on opposite sides of the detonation location (when two boats are used), and will travel in a circular pattern around the detonation location with one Lookout observing inward toward the detonation site and the other observing outward toward the perimeter of the mitigation zone.<br>– If used, aircraft will travel in a circular pattern around the detonation location to the maximum extent practicable.<br>– The Navy will not set time-delay firing devices to exceed 10 minutes.<br>• Commencement/recommencement conditions after a marine mammal or sea turtle sighting before or during the activity:<br>– The Navy will allow a sighted marine mammal or sea turtle to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing detonations) until one of the following conditions has been 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, speed, and movement relative to the detonation site; or (3) the mitigation zone has been clear from any additional sightings for 10 minutes during activities under positive control with aircraft that have fuel constraints, or 30 minutes during activities under positive control with aircraft that are not typically fuel constrained and during activities using time-delay firing devices.<br>• After completion of an activity (for 30 minutes):<br>– Observe the vicinity of where detonations occurred; if any injured or dead marine mammals or ESA-listed species are observed, follow established incident reporting procedures.<br>– If additional platforms are supporting this activity (e.g., providing range clearance), these assets will assist in the visual observation of the area where detonations occurred. |

For the 500 yd. mitigation zone, the small observation area and proximity to observation platforms will result in a high likelihood that Lookouts will be able to detect marine mammals and sea turtles throughout the mitigation zone. For the 1,000 yd. mitigation zone, the use of two additional Lookouts increases the likelihood that Lookouts will be able to detect marine mammals and sea turtles across the larger observation area. Due to their low vantage point on the water, Lookouts in small boats will be more likely to detect large visual cues (e.g., whale blows or large pods of dolphins) or the splashes of individual marine mammals than cryptic marine mammal species and sea turtles near the perimeter of the 1,000 yd. mitigation zone. When rotary-wing aircraft are used, Lookouts positioned in an aircraft will have a good vantage point for observing out to the perimeter of the 500 yd. and 1,000 yd. mitigation zones. The additional mitigation within the Mariana Islands Range Complex will help the Navy avoid or reduce potential impacts on ESA-listed scalloped hammerhead sharks.

Bin E6 (e.g., 20 lb. net explosive weight) has the longest predicted impact ranges for the time-delay explosives that apply to the 1,000 yd. mitigation zone. Bin E6 also has the longest predicted impact ranges for the positive control explosives that apply to the 500 yd. mitigation zone. The 1,000 yd. and 500 yd. mitigation zones extend beyond the respective ranges to 50 percent non-auditory injury and 50 percent mortality for sea turtles and marine mammals. For time-delay charges, the 1,000 yd. mitigation zone extends beyond the average ranges to PTS for sea turtles, mid-frequency cetaceans, and low-frequency cetaceans, and into a portion of the average range to PTS for high-frequency cetaceans. For positive control charges, the 500 yd. mitigation zone extends beyond the average ranges to PTS for sea turtles and mid-frequency cetaceans, and into a portion of the average ranges to PTS for high-frequency cetaceans and low-frequency cetaceans. The mitigation zones also extend beyond or into a portion of the average ranges to TTS for sea turtles and marine mammals. Therefore, depending on the species, mitigation will help avoid or reduce all or a portion of the potential for exposure to mortality, non-auditory injury, PTS, and higher levels of TTS for the largest explosives in bin E6. Smaller explosives within bin E6 and explosives in smaller source bins (e.g., E5) have shorter predicted impact ranges; therefore, the mitigation zones will cover a greater portion of the impact ranges for these explosives.

As described previously, the mitigation zones developed for this SEIS/OEIS are based on the largest areas within which it is practical for the Navy to implement mitigation. It is not practical to increase these mitigation zones because observations within the margin of increase would be unsafe and ineffective unless the Navy allocated additional platforms to the activity to observe for biological resources. Because mine neutralization activities involve training Navy divers in the safe handling of explosive charges, one of the mission-essential safety protocols required of all event participants, including Lookouts, is to maintain focus on the activity area to ensure safety of personnel and equipment. The typical mine neutralization activity areas coincide with the mitigation zone sizes developed for this SEIS/OEIS; therefore, Lookouts can safely and effectively observe the mitigation zones for biological resources while simultaneously maintaining focus on the activity areas. However, if the mitigation zone sizes increased, Lookouts would need to redirect their attention beyond the activity areas. This would not meet the safety criteria since personnel would be required to direct their attention away from mission requirements. Alternatively, the Navy would need to add personnel to serve as additional Lookouts on the existing observation platforms or allocate additional platforms to the activity to observe for biological resources. These actions would not be safe or sustainable due to an exceedance of manpower, resource, and space restrictions for these activities.

Increasing the mitigation zone sizes would result in larger areas over which detonations would need to be ceased in response to a sighting, and therefore would likely increase the number of times detonations would be ceased. This would extend the length of the activities and cause significant safety risks for Navy divers and loss of training time. Ceasing an activity (e.g., fuse initiation) with divers in the water would have safety implications for diver air consumption and bottom time. It would also impede the ability for Navy divers to complete the training exercise with the focused endurance as required during military missions and combat operations. These impacts would significantly diminish event realism in a way that would prevent activities from meeting their intended objectives. For example, the number of opportunities that divers would have to locate and neutralize mines would be reduced. Divers would then not be able to gain skill proficiency in precise identification and evaluation of a threat mine, safe handling of explosive material during charge placement, and effective charge detonation or fuse initiation. Mine neutralization activities involving the use of Navy divers only take place during daylight hours for safety reasons; therefore, extending the length of the activity could delay the activity into the next day or next several days, which would significantly impact training schedules for all participating platforms. Therefore, an increase in mitigation would impede the ability for Navy divers to train and become proficient in mine neutralization and would prevent units from meeting their individual training and certification requirements (which would prevent them from deploying with the required level of readiness necessary to accomplish their missions).

For activities that involve aircraft, extending the length of the activity would require aircraft to depart the area to refuel. If multiple refueling events were required, the length of the activity would be extended by two to five times or more, which would decrease the ability for Lookouts to safely and effectively maintain situational awareness of the activity area and increase safety risks due to increased pilot fatigue and accelerated fatigue-life of aircraft. Extending the length of the activity would also result in additional operational costs due to increased fuel consumption.

In summary, the operational community determined that implementing procedural mitigation for explosive mine neutralization activities involving Navy divers beyond what is detailed in Table 5.3-11 would be incompatible with the practicality assessment criteria for safety, sustainability, and mission requirements.

#### 5.3.3.9 Maritime Security Operations – Anti-Swimmer Grenades

The Navy will continue to implement procedural mitigation to avoid or reduce potential impacts on marine mammals and sea turtles from anti-swimmer grenades during Maritime Security Operations, as outlined in Table 5.3-12.

In the 2015 MITT Final EIS/OEIS, the Maritime Security Operations – Anti-Swimmer Grenade mitigation zone was based on net explosive weight and the associated average ranges to PTS. When developing the mitigation for this SEIS/OEIS, the Navy analyzed the potential for increasing the size of the mitigation zone. The Navy determined that the current mitigation zone is the largest area within which it is practical to implement mitigation for this activity; therefore, it will continue implementing this same mitigation zone under the Proposed Action. The Navy is clarifying in the table that it will require observation of the mitigation zone prior to the initial start of the activity to ensure the area is clear of applicable biological resources. The Navy has always verified that the mitigation zone is visually clear prior to conducting explosive activities and is more clearly capturing this current practice in the mitigation measures for this activity.

### Table 5.3-12: Procedural Mitigation for Maritime Security Operations – Anti-Swimmer Grenades

| *Procedural Mitigation Description* |
|---|
| **Stressor or Activity**<br>• Maritime Security Operations – Anti-Swimmer Grenades |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles |
| **Number of Lookouts and Observation Platform**<br>• 1 Lookout positioned on the small boat conducting the activity<br>• If additional platforms are participating in the activity, personnel positioned in those assets (e.g., safety observers, evaluators) will support observing the mitigation zone for applicable biological resources while performing their regular duties. |
| **Mitigation Requirements**<br>• Mitigation zone:<br>  – 200 yd. around the intended detonation location<br>• Prior to the initial start of the activity (e.g., when maneuvering on station):<br>  – Observe the mitigation zone for marine mammals and sea turtles; if observed, relocate or delay the start of detonations.<br>• During the activity:<br>  – Observe the mitigation zone for marine mammals and sea turtles; if observed, cease detonations.<br>• Commencement/recommencement conditions after a marine mammal or sea turtle sighting before or during the activity:<br>  – The Navy will allow a sighted marine mammal or sea turtle to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing detonations) until one of the following conditions has been 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, speed, and movement relative to the intended detonation location; (3) the mitigation zone has been clear from any additional sightings for 30 minutes; or (4) the intended detonation location has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.<br>• After completion of the activity (e.g., prior to maneuvering off station):<br>  – When practical (e.g., when platforms are not constrained by fuel restrictions or mission-essential follow-on commitments), observe the vicinity of where detonations occurred; if any injured or dead marine mammals or ESA-listed species are observed, follow established incident reporting procedures.<br>  – If additional platforms are supporting this activity (e.g., providing range clearance), these assets will assist in the visual observation of the area where detonations occurred. |

The Navy developed a new mitigation measure requiring the Lookout to observe the mitigation zone after completion of the activity. In accordance with the 2015 MITT Final EIS/OEIS consultation requirements, the Navy currently conducts post-activity observations for some, but not all explosive activities. In developing mitigation for this SEIS/OEIS, the Navy determined that it could expand this requirement to other explosive activities for enhanced consistency and to help determine if any resources were injured during explosive events, when practical. The Navy is adding a requirement that additional platforms already participating in the activity will support observing the mitigation zone before, during, and after the activity while performing their regular duties. When available, having additional personnel support observations of the mitigation zone will help increase the likelihood of detecting biological resources. The Navy will follow the incident reporting procedures outlined in Section 5.1.2.2.3 (Incident Reports) if an incident is detected at any time during the event, including during the post-activity observations. The small mitigation zone size and proximity to the observation platform result in a high likelihood that Lookouts will be able to detect marine mammals and sea turtles throughout the mitigation zone.

Explosives used during Maritime Security Operations – Anti-Swimmer Grenades exercises are in bin E2 (e.g., 0.5 lb. net explosive weight). The mitigation zone extends beyond the ranges to 50 percent non-auditory injury and 50 percent mortality for sea turtles and marine mammals. The mitigation zone extends beyond the average ranges to PTS for sea turtles, mid-frequency cetaceans, and low-frequency cetaceans, and into a portion of the average range to PTS for high-frequency cetaceans. The mitigation zone also extends beyond or into a portion of the average ranges to TTS for sea turtles and marine mammals. Therefore, mitigation will help avoid or reduce all or a portion of the potential for exposure to mortality, non-auditory injury, PTS, and higher levels of TTS for the largest explosives in bin E2.

As described previously, the mitigation zone developed for this SEIS/OEIS is based on the largest area within which it is practical for the Navy to implement mitigation. It is not practical to increase the mitigation zone because observations within the margin of increase would be unsafe and ineffective. Because this activity involves training crews in the safe handling of explosive hand grenades, one of the mission-essential safety protocols required of all event participants, including the Lookout, is to maintain focus on the activity area to ensure safety of personnel and equipment. The typical activity area coincides with the mitigation zone; therefore, the Lookout can safely and effectively observe the mitigation zone for biological resources while simultaneously maintaining focus on the activity area. However, if the mitigation zone size increased, the Lookout would need to redirect attention to observe beyond the activity area. This would not meet the safety criteria since personnel would be required to direct their attention away from mission requirements. Alternatively, the Navy would need to either add personnel to serve as additional Lookouts on the existing observation platform or allocate additional platforms to the activity to observe for biological resources. These actions would not be safe or sustainable due an exceedance of manpower, resource, and space restrictions for this activity).

In summary, the operational community determined that implementing procedural mitigation for Maritime Security Operations – Anti-Swimmer Grenades beyond what is detailed in Table 5.3-12 would be incompatible with the practicality assessment criteria for safety and sustainability.

### 5.3.4 Physical Disturbance and Strike Stressors

The Navy will implement procedural mitigation to avoid or reduce potential impacts on biological resources from the physical disturbance and strike stressors or activities discussed in the sections below. Section 3.4.2.4 (Physical Disturbance and Strike Stressors) and Section 3.5.2.4 (Physical Disturbance and Strike Stressors) provide a full analysis of the potential impacts of physical disturbance and strikes on marine mammals and sea turtles, respectively.

#### 5.3.4.1 Vessel Movement

The Navy will continue to implement procedural mitigation to avoid or reduce the potential for vessel strikes of marine mammals and sea turtles, as outlined in Table 5.3-13. The procedural mitigation measures for vessel movement are a continuation from the 2015 MITT Final EIS/OEIS based on the largest areas within which it is practical for the Navy to implement mitigation and guidance from NMFS for vessel strike avoidance. Although the Navy is unable to position Lookouts on unmanned vessels, as a standard operating procedure, some vessels that operate autonomously have embedded sensors that aid in avoidance of large objects. The embedded sensors may help those unmanned vessels avoid vessel strikes of marine mammals.

### Table 5.3-13: Procedural Mitigation for Vessel Movement

| ***Procedural Mitigation Description*** |
|---|
| **Stressor or Activity**<br>• Vessel movement<br>– The mitigation will not be applied if: (1) the vessel's safety is threatened, (2) the vessel is restricted in its ability to maneuver (e.g., during launching and recovery of aircraft or landing craft, during towing activities, when mooring, etc.), (3) the vessel is operated autonomously, or (4) when impractical based on mission requirements (e.g., during Amphibious Assault and Amphibious Raid exercises). |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles |
| **Number of Lookouts and Observation Platform**<br>• 1 Lookout on the vessel that is underway |
| **Mitigation Requirements**<br>• Mitigation zones:<br>– 500 yd. around whales<br>– 200 yd. around other marine mammals (except bow-riding dolphins)<br>– Within the vicinity of sea turtles<br>• During the activity:<br>– When underway, observe the mitigation zone for marine mammals and sea turtles; if observed, maneuver to maintain distance.<br>• Additional requirements:<br>– Within the designated vessel traffic lane during Amphibious Assault and Amphibious Raid exercises, while underway, observe for sea turtles; if observed, cease beach approach. To allow a sighted sea turtle to leave the designated vessel traffic lanes, the Navy will not recommence the beach approach until one of the recommencement conditions has been met: (1) the animal is observed exiting the designated vessel traffic lane; (2) the animal is thought to have exited the designated vessel traffic lane based on a determination of its course, speed, and movement relative to the intended impact location; or (3) the designated vessel traffic lane has been clear from any additional sightings for 30 minutes.<br>– If a marine mammal or sea turtle vessel strike occurs, the Navy will follow the established incident reporting procedures. |

As discussed in Section 5.3.1 (Environmental Awareness and Education), it is likely that the implementation of the Marine Species Awareness Training starting in 2007, and the additional U.S. Navy Afloat Environmental Compliance Training Series modules starting in 2014, has contributed to the lack of vessel strikes of marine mammals in the Study Area. The Navy is able to detect if a whale is struck due to the diligence of standard watch personnel and Lookouts stationed specifically to observe for marine mammals while a vessel is underway. In the unlikely event that a vessel strike of a marine mammal occurs, the Navy will notify the appropriate regulatory agency immediately or as soon as operational security considerations allow per the established incident reporting procedures described in Section 5.1.2.2.3 (Incident Reports). The Navy's incident reports include relevant information pertaining to the incident, including but not limited to vessel speed.

The small mitigation zone sizes and close proximity to the observation platform will result in a high likelihood that Lookouts will be able to detect marine mammals throughout the mitigation zones while vessels are underway. A mitigation zone size is not specified for sea turtles to allow flexibility based on vessel type and mission requirements (e.g., small boats operating in a narrow harbor). Observation for sea turtles in the designated vessel traffic lanes during Amphibious Assault and Amphibious Raid exercises will help the Navy avoid striking sea turtles in these nearshore environments.

As described in Section 5.1.1 (Vessel Safety) of the 2015 MITT Final EIS/OEIS, Navy vessels are required to operate in accordance with applicable navigation rules. Applicable rules include the Inland Navigation Rules (33 Code of Federal Regulations 83) and International Regulations for Preventing Collisions at Sea (72 COLREGS), which were formalized in the Convention on the International Regulations for Preventing

Collisions at Sea, 1972. These rules require that vessels proceed at a safe speed so proper and effective action can be taken to avoid collision and so vessels can be stopped within a distance appropriate to the prevailing circumstances and conditions. In addition to complying with navigation requirements, Navy ships transit at speeds that are optimal for fuel conservation, to maintain ship schedules, and to meet mission requirements. Vessel captains use the totality of the circumstances to ensure the vessel is traveling at appropriate speeds in accordance with navigation rules. Depending on the circumstances, this may involve adjusting speeds during periods of reduced visibility or in certain locations.

As discussed in Section 3.0.5.2.3.2 (Vessels) of the 2015 MITT Final EIS/OEIS, large Navy ships typically operate at average speeds of between 10 and 15 knots, which for reference is slower than large commercial vessels, such as container ships that steam at approximately 24 knots during normal operations (Maloni et al., 2013). Operating vessels at speeds that are not optimal for fuel conservation or mission requirements would be unsustainable due to increased time on station and increased fuel consumption. Each ship has a limited amount of time that it can be underway based on target service requirements and ship schedules. Ship schedules are driven largely by training cycles, scheduled maintenance periods, certification schedules, and deployment requirements. Because of the complex logistical considerations involved with maintaining ship schedules, the Navy does not have the flexibility to extend the amount of time that ships are underway, which would result from vessel speed restriction mitigation.

Navy vessel operators need to train to proficiently operate vessels as they would during military missions and combat operations, including being able to react to changing tactical situations and evaluate system capabilities. For example, during training activities involving flight operations from an aircraft carrier, the vessel must maintain a certain wind speed over the deck to launch or recover aircraft. Depending on wind conditions, the aircraft carrier itself must travel at a certain speed to generate the wind required to launch or recover aircraft. Implementing vessel speed restrictions would increase safety risks for Navy personnel and equipment and the public during the training event and would reduce skill proficiency in a way that would increase safety risks during military missions and combat operations. Furthermore, vessel speed restrictions would not allow the Navy to continue meeting its training requirements due to diminished realism of training exercises.

The Navy needs to test the full range of its vessel and system capabilities to ensure safety and functionality in conditions analogous to military missions and combat operations. For example, during non-explosive torpedo testing activities, the Navy must operate its vessels using speeds typical of military missions and combat operations to accurately test the functionality of its acoustic countermeasures and torpedo systems during firing. Vessel speed restrictions would not allow the Navy to continue meeting its testing program requirements due to diminished realism of testing events. Researchers, program managers, and weapons system acquisition programs would be unable to conduct accurate acoustic research to meet research objectives and effectively test vessels and vessel-deployed systems and platforms before full-scale production or delivery to the fleet. Such testing is required to ensure functionality and accuracy in military mission and combat conditions per required acquisition milestones or on an as-needed basis to meet operational requirements.

In summary, the operational community determined that implementing procedural mitigation for vessel movements beyond what is detailed in Table 5.3-13 would be incompatible with the practicality assessment criteria for safety, sustainability, and mission requirements.

#### 5.3.4.2 Towed In-Water Devices

The Navy will continue to implement procedural mitigation to avoid or reduce the potential for strike of marine mammals and sea turtles from towed in-water devices, as outlined in Table 5.3-14. Vessels involved in towing in-water devices will implement the mitigation described in Section 5.3.4.1 (Vessel Movement), in addition to the mitigation outlined in Table 5.3-14.

**Table 5.3-14: Procedural Mitigation for Towed In-Water Devices**

| ***Procedural Mitigation Description*** |
|---|
| **Stressor or Activity**<br>• Towed in-water devices<br>– Mitigation applies to devices that are towed from a manned surface platform or manned aircraft<br>– The mitigation will not be applied if the safety of the towing platform or in-water device is threatened |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles |
| **Number of Lookouts and Observation Platform**<br>• 1 Lookout positioned on the manned towing platform |
| **Mitigation Requirements**<br>• Mitigation zones:<br>– 250 yd. around marine mammals<br>– Within the vicinity of sea turtles<br>• During the activity (i.e., when towing an in-water device):<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, maneuver to maintain distance. |

The mitigation zones for towed in-water devices are a continuation from the 2015 MITT Final EIS/OEIS based on the largest area within which it is practical for the Navy to implement mitigation. The small mitigation zone size and proximity to the observation platform will result in a high likelihood that Lookouts will be able to detect marine mammals throughout the mitigation zone when manned vessels or manned aircraft are towing in-water devices. A mitigation zone size is not specified for sea turtles to allow flexibility based on towing platform type and mission requirements (e.g., small boats operating in a narrow harbor).

Mission and safety requirements determine the operational parameters (e.g., course) for in-water device towing platforms. Towed in-water devices must be towed at certain speeds and water depths for stability, which are controlled in part by the towing platform's speed and directional movements. Because these devices are towed and not self-propelled, they generally have limited maneuverability and are not able to make immediate course corrections. For example, during a Mine Countermeasure – Towed Mine Neutralization activity using rotary-wing aircraft, towed devices are used to trigger mines and perform various other functions, such as detaching floating moored mines. A high degree of pilot skill is required in deploying devices, safely towing them at relatively low speeds and altitudes, and then recovering devices. The aircraft can safely alter course to shift the route of the towed device in response to a sighted marine mammal or sea turtle up to a certain extent (i.e., up to the size of the mitigation zone) while still maintaining the parameters needed for stable towing. However, the aircraft would be unable to further alter its course to more drastically course-correct the towed device without decreasing towing stability, which would have implications for safety of personnel and equipment.

In summary, the operational community determined that implementing procedural mitigation for towed in-water devices beyond what is detailed in Table 5.3-14 would be incompatible with the practicality assessment criteria for safety.

#### 5.3.4.3 Small-, Medium-, and Large-Caliber Non-Explosive Practice Munitions

The Navy will continue to implement procedural mitigation to avoid or reduce the potential for strike of marine mammals and sea turtles from small-, medium-, and large-caliber non-explosive practice munitions, as outlined in Table 5.3-15.

**Table 5.3-15: Procedural Mitigation for Small-, Medium-, and Large-Caliber Non-Explosive Practice Munitions**

| *Procedural Mitigation Description* |
|---|
| **Stressor or Activity**<br>• Gunnery activities using small-, medium-, and large-caliber non-explosive practice munitions<br>– Mitigation applies to activities using a surface target |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles |
| **Number of Lookouts and Observation Platform**<br>• 1 Lookout positioned on the platform conducting the activity<br>– Depending on the activity, the Lookout could be the same as the one described in Section 5.3.2.2 (Weapons Firing Noise) |
| **Mitigation Requirements**<br>• Mitigation zone:<br>– 200 yd. around the intended impact location<br>• Prior to the initial start of the activity (e.g., when maneuvering on station):<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, relocate or delay the start of firing.<br>• During the activity:<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, cease firing.<br>• Commencement/recommencement conditions after a marine mammal or sea turtle sighting before or during the activity:<br>– The Navy will allow a sighted marine mammal or sea turtle to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing firing) until one of the following conditions has been 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, speed, and movement relative to the intended impact location; (3) the mitigation zone has been clear from any additional sightings for 10 minutes for aircraft-based firing or 30 minutes for vessel-based firing; or (4) for activities using a mobile target, the intended impact location has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting. |

The mitigation zone is conservatively designed to be several times larger than the impact footprint for large-caliber non-explosive practice munitions, which are the largest projectiles used for these activities. Small-caliber and medium-caliber non-explosive practice munitions have smaller impact footprints than large-caliber non-explosive practice munitions; therefore, the mitigation zone will extend even further beyond the impact footprints for these smaller projectiles.

Large-caliber gunnery activities involve vessels firing projectiles at a target located up to 6 NM down range. Small- and medium-caliber gunnery activities involve vessels or aircraft firing projectiles at targets located up to 4,000 yd. down range, although typically much closer. Lookouts will have a better likelihood of detecting marine mammals and sea turtles when observing mitigation zones around targets located close to the firing platform. When observing activities that use a target located far from the firing platform, Lookouts will be more likely to detect large visual cues (e.g., whale blows or large pods of dolphins) than individual marine mammals, cryptic marine mammal species, and sea turtles. Positioning additional observers closer to the targets would increase safety risks because these platforms would be located in the vicinity of an intended impact location or in the path of a projectile.

#### 5.3.4.4 Non-Explosive Missiles and Rockets

The Navy will continue to implement procedural mitigation to avoid or reduce the potential for strike of marine mammals and sea turtles from non-explosive missiles and rockets, as outlined in Table 5.3-16.

### Table 5.3-16: Procedural Mitigation for Non-Explosive Missiles and Rockets

| *Procedural Mitigation Description* |
|---|
| **Stressor or Activity**<br>• Aircraft-deployed non-explosive missiles and rockets<br>— Mitigation applies to activities using a surface target |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles |
| **Number of Lookouts and Observation Platform**<br>• 1 Lookout positioned in an aircraft |
| **Mitigation Requirements**<br>• Mitigation zone:<br>— 900 yd. around the intended impact location<br>• Prior to the initial start of the activity (e.g., during a fly-over of the mitigation zone):<br>— Observe the mitigation zone for marine mammals and sea turtles; if observed, relocate or delay the start of firing.<br>• During the activity:<br>— Observe the mitigation zone for marine mammals and sea turtles; if observed, cease firing.<br>• Commencement/recommencement conditions after a marine mammal or sea turtle sighting prior to or during the activity:<br>— The Navy will allow a sighted marine mammal or sea turtle to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing firing) until one of the following conditions has been 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, speed, and movement relative to the intended impact location; or (3) the mitigation zone has been clear from any additional sightings for 10 minutes when the activity involves aircraft that have fuel constraints, or 30 minutes when the activity involves aircraft that are not typically fuel constrained. |

The mitigation zone for non-explosive missiles and rockets is conservatively designed to be several times larger than the impact footprint for the largest non-explosive missile used for these activities. Smaller non-explosive missiles and non-explosive rockets have smaller impact footprints than the largest non-explosive missile used for these activities; therefore, the mitigation zone will extend even further beyond the impact footprints for these smaller projectiles.

Mitigation applies to activities using non-explosive missiles or rockets fired from aircraft at targets that are typically located up to 15 NM down range, and infrequently up to 75 NM down range. There is a chance that animals could enter the mitigation zone after the aircraft conducts its close-range mitigation zone observations and before firing begins (once the aircraft has transited to its firing position). Due to the distance between the mitigation zone and the observation platform, Lookouts will have a better likelihood of detecting marine mammals and sea turtles during the close-range observations and are less likely to detect these resources once positioned at the firing location, particularly individual marine mammals, cryptic marine mammal species, and sea turtles. The mitigation only applies to aircraft-deployed missiles and rockets for the reasons discussed in Section 5.3.3.4 (Explosive Missiles and Rockets). Positioning additional observers closer to the targets would increase safety risks because these platforms would be located in the vicinity of an intended impact location or in the path of a projectile.

#### 5.3.4.5 Non-Explosive Bombs and Mine Shapes

The Navy will continue to implement procedural mitigation to avoid or reduce the potential for strike of marine mammals and sea turtles from non-explosive bombs and mine shapes, as outlined in Table 5.3-17.

### Table 5.3-17: Procedural Mitigation for Non-Explosive Bombs and Mine Shapes

| *Procedural Mitigation Description* |
|---|
| **Stressor or Activity**<br>• Non-explosive bombs<br>• Non-explosive mine shapes during mine laying activities |
| **Resource Protection Focus**<br>• Marine mammals<br>• Sea turtles |
| **Number of Lookouts and Observation Platform**<br>• 1 Lookout positioned in an aircraft |
| **Mitigation Requirements**<br>• Mitigation zone:<br>– 1,000 yd. around the intended target<br>• Prior to the initial start of the activity (e.g., when arriving on station):<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, relocate or delay start of bomb deployment or mine laying.<br>• During the activity (e.g., during approach of the target or intended minefield location):<br>– Observe the mitigation zone for marine mammals and sea turtles; if observed, cease bomb deployment or mine laying.<br>• Commencement/recommencement conditions after a marine mammal or sea turtle sighting prior to or during the activity:<br>– The Navy will allow a sighted marine mammal or sea turtle to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing bomb deployment or mine laying) until one of the following conditions has been 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, speed, and movement relative to the intended target or minefield location; (3) the mitigation zone has been clear from any additional sightings for 10 minutes; or (4) for activities using mobile targets, the intended target has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting. |

The mitigation zone for non-explosive bombs and mine shapes is conservatively designed to be several times larger than the impact footprint for the largest non-explosive bomb used for these activities. Smaller non-explosive bombs and mine shapes have smaller impact footprints than the largest non-explosive bomb used for these activities; therefore, the mitigation zone will extend even further beyond the impact footprints for these smaller military expended materials.

Activities involving non-explosive bombing and mine laying involve aircraft deploying munitions or mine shapes from a relatively steady altitude of approximately 1,500 ft. at a surface target or in an intended minefield located beneath the aircraft. Due to the mitigation zone size, proximity to the observation platform, and the good vantage point from an aircraft, Lookouts will be able to observe the entire mitigation zone during approach of the target or intended minefield location.

## 5.4 At-Sea Mitigation Areas to be Implemented

The section below describes mitigation areas that are designed to avoid or reduce potential impacts on seafloor resources in the Study Area. A draft biological assessment and operational analysis of mitigation areas that the Navy considered for marine mammals and sea turtles is provided in Appendix I (Geographic Mitigation Assessment). The Navy will finalize development of its mitigation areas during the consultation and permitting processes and will summarize any approved measures in this section of the Final SEIS/OEIS.

### 5.4.1 Mitigation Areas for Seafloor Resources

As outlined in Table 5.4-1 and shown in Figure 5.4-1 and Figure 5.4-2, the Navy will continue to implement mitigation to avoid or reduce potential impacts on biological or cultural resources that are not observable by Lookouts from the water's surface (i.e., resources for which procedural mitigation cannot be implemented).

### Table 5.4-1: Mitigation Areas for Seafloor Resources

| *Mitigation Area Description* |
|---|
| **Stressor or Activity**<br>• Explosives<br>• Physical disturbance and strikes |
| **Resource Protection Focus**<br>• Shallow-water coral reefs<br>• Live hard bottom<br>• Artificial reefs<br>• Shipwrecks |
| **Mitigation Area Requirements**<br>• **Within the anchor swing circle of shallow-water coral reefs, live hard bottom, artificial reefs, and shipwrecks:**<br>– The Navy will not conduct precision anchoring (except at designated anchorages and nearshore training areas around Guam and within Apra Harbor, where these resources will be avoided to the maximum extent practicable).<br>• **Within a 350 yd. radius of live hard bottom, artificial reefs, and shipwrecks:**<br>– The Navy will not conduct explosive mine countermeasure and neutralization activities or explosive mine neutralization activities involving Navy divers (except at designated nearshore training areas, where these resources will be avoided to the maximum extent practicable).<br>– The Navy will not place mine shapes, anchors, or mooring devices on the seafloor (except in designated locations, where these resources will be avoided to the maximum extent practicable).<br>• **Within a 350 yd. radius of shallow-water coral reefs:**<br>– The Navy will not conduct explosive or non-explosive small-, medium-, and large-caliber gunnery activities using a surface target; explosive or non-explosive missile and rocket activities using a surface target; explosive or non-explosive bombing and mine-laying activities; explosive or non-explosive mine countermeasure and neutralization activities; and explosive or non-explosive mine neutralization activities involving Navy divers (except at designated nearshore training areas, where these resources will be avoided to the maximum extent practicable).<br>– The Navy will not place mine shapes, anchors, or mooring devices on the seafloor (except in designated locations, where these resources will be avoided to the maximum extent practicable). |

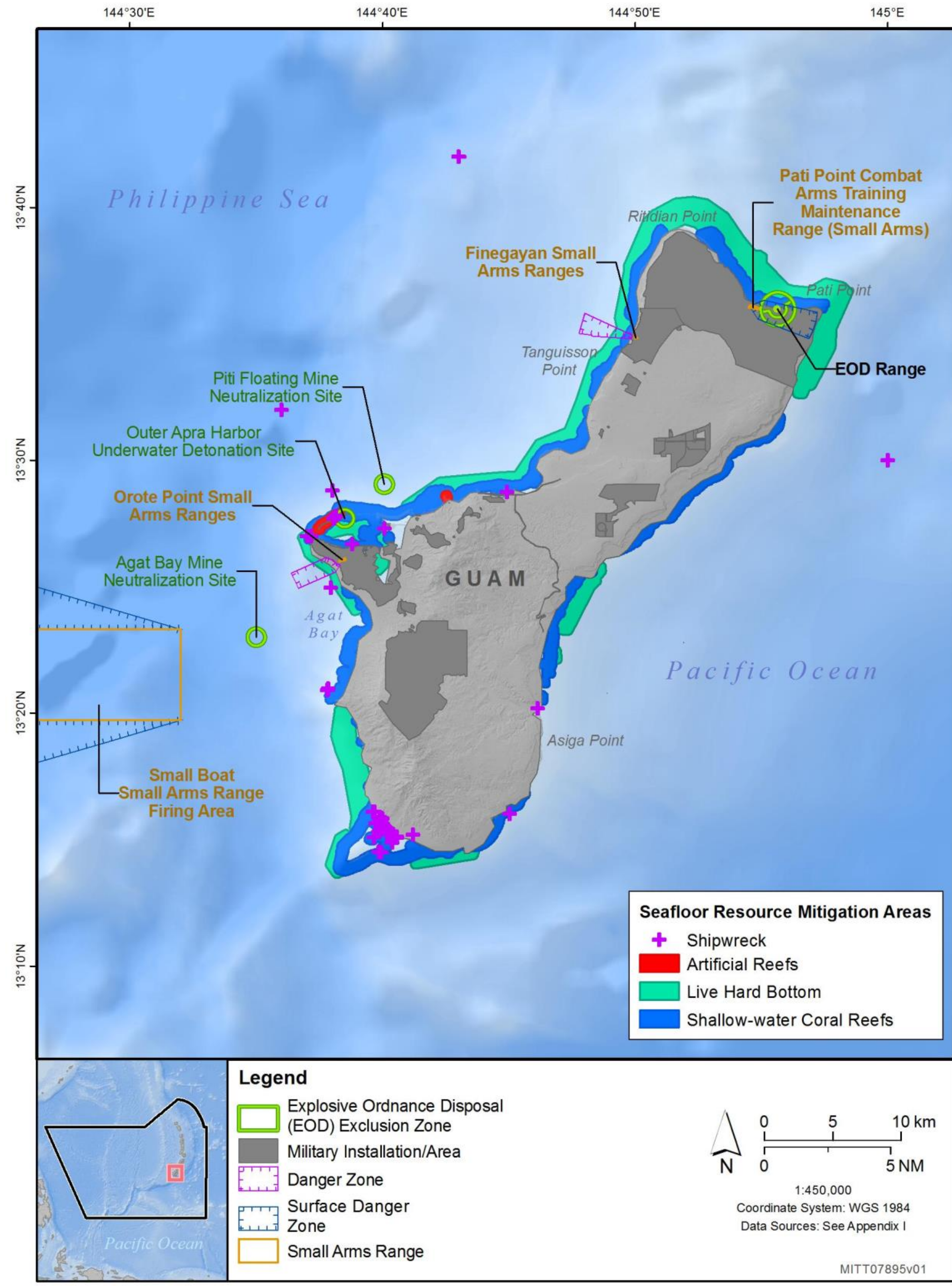


**Figure 5.4-1: Seafloor Resource Mitigation Areas off Guam**

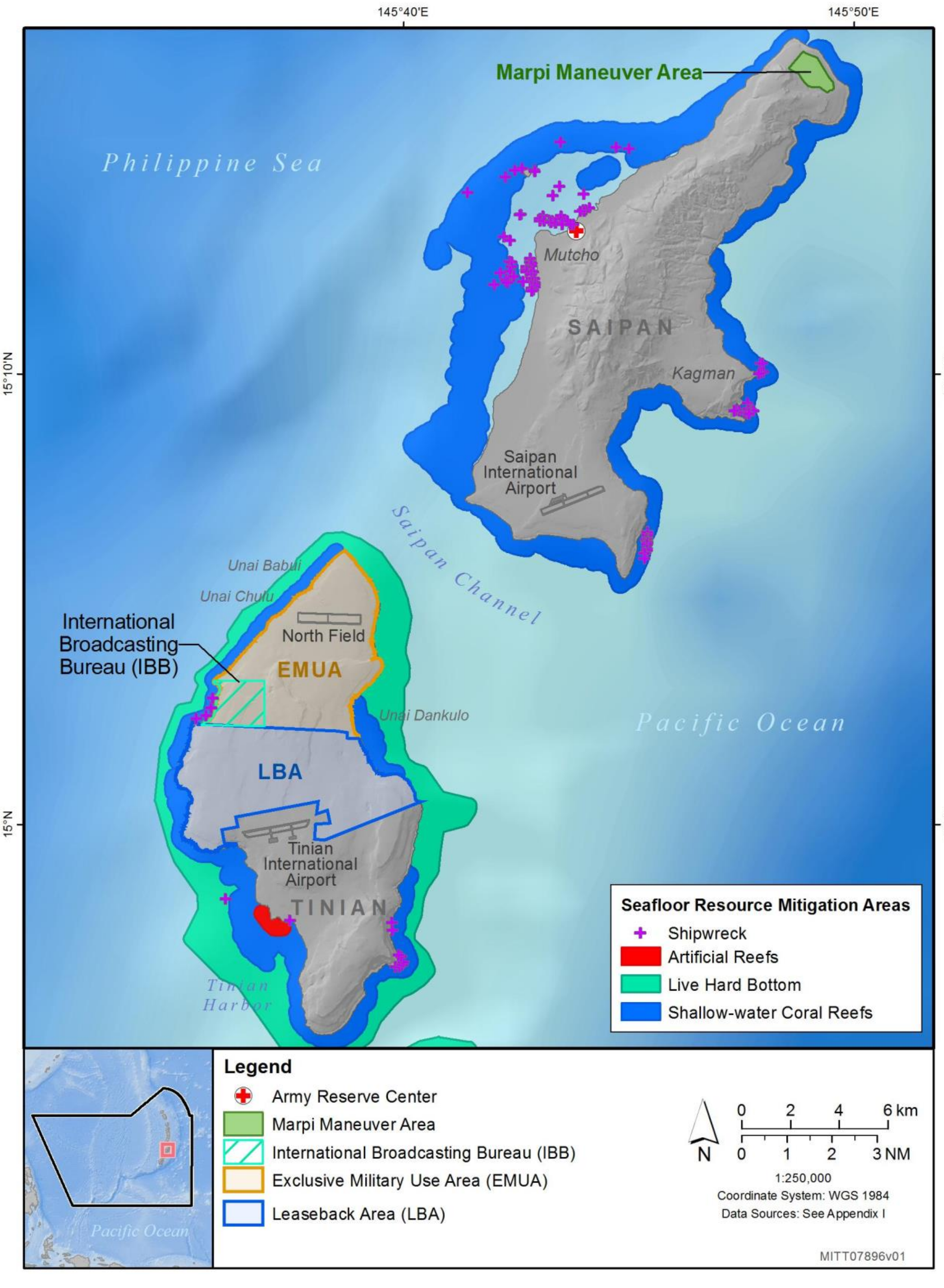


**Figure 5.4-2: Seafloor Resource Mitigation Areas off Tinian and Saipan**

#### 5.4.1.1 Resource Description

Seafloor resources fulfill important ecosystem functions. Live hard bottom habitats and artificial structures (e.g., artificial reefs, shipwrecks) provide attachment substrate for aquatic vegetation and invertebrates, such as corals, seaweed, seagrass, macroalgae, and sponges. These habitats in turn support a community of organisms, such as fish, shrimp, crabs, barnacles, worms, and sea cucumbers. Shallow-water coral reefs provide substrate, shelter, and food for hundreds of invertebrate species, sea turtles, fishes, and other biological resources. They are one of the most productive and diverse assemblages on Earth.

Dive sites occur throughout nearshore areas of the Study Area where there are shipwrecks, artificial reefs, and shallow-water coral reefs, making these resources highly valuable from a socioeconomic standpoint. Historic shipwrecks are classified as archaeological resources and are an important part of maritime history. For additional information on the biological, cultural, and socioeconomic importance of seafloor resources and their associated ecosystem components, refer to Section 3.3 (Marine Habitats), Section 3.4 (Marine Mammals), Section 3.5 (Sea Turtles), Section 3.6 (Birds), Section 3.7 (Marine Vegetation), Section3.8 (Marine Invertebrates), Section 3.9 (Fish), Section 3.11 (Cultural Resources), and Section 3.12 (Socioeconomic Resources).

#### 5.4.1.2 Mitigation Area Assessment

Without mitigation, explosives and physical disturbance and strike stressors could potentially impact shallow-water coral reefs, live hard bottom, artificial reefs, shipwrecks, and their associated ecosystem components during certain training and testing activities in the Study Area. Figure 5.4-1 and Figure 5.4-2 show the relevant seafloor resources and the Navy training or testing locations that overlap them. The Navy developed mitigation areas as either the anchor swing circle diameter or a 350 yd. radius around a seafloor resource, as indicated by the best available georeferenced data. Mitigating within the anchor swing circle will protect seafloor resources during precision anchoring activities when factoring in environmental conditions that could affect anchoring position and swing circle size, such as winds, currents, and water depth. For other activities applicable to the mitigation, a 350 yd. radius around a seafloor resource is a conservatively sized mitigation area that will provide protection well beyond the maximum expected impact footprint (e.g., crater and expelled material radius) of the explosives and non-explosive practice munitions used in the Study Area. The mitigation zone size extends beyond the military expended material with the largest footprint for all Study Areas where this mitigation measure is implemented. For example, the military expended material with the largest footprint (which is not used in the MITT Study Area) is an explosive mine with a 650 lb. net explosive weight, which has an estimated impact footprint of approximately 14,800 square ft. and an associated radius of 22.7 yd. The largest military expended material applicable to this mitigation in the MITT Study Area has a charge size of 500 lb. net explosive weight. The 350 yd. mitigation zone is well beyond the maximum expected direct impact footprint for the activities listed in Table 5.4-1, and further mitigates some level of indirect impact from explosive disturbances.

The seafloor resource mitigation areas will help the Navy avoid or reduce potential impacts from explosives and physical disturbance and strike stressors on sensitive seafloor resources and to any biological or cultural resources that inhabit, shelter, rest, feed, or occur in the mitigation areas. As described in Section 3.3 (Marine Habitats), other habitats, such as soft bottom, are expected to recover relatively quickly from potential disturbances; therefore, there would be a limited benefit of mitigation for other habitat types.

To facilitate mitigation implementation, the Navy will include maps of the best available georeferenced data for shallow-water coral reefs, artificial reefs, live hard bottom, and shipwrecks in its Protective Measures Assessment Protocol. The Navy will include data that most accurately represent the natural boundaries of seafloor resources, as described in *Building and Maintaining a Comprehensive Database and Prioritization Scheme for Overlapping Habitat Data* (U.S. Department of the Navy, 2016). Data presented in Section 3.3 (Marine Habitats), Section 3.8 (Marine Invertebrates), and Section 3.11 (Cultural Resources) will serve as the baseline of best available georeferenced data for seafloor resource mitigation areas. The Navy will also include additional seafloor resource data (such as data that the Navy has acquired access to but that is not publicly available), if applicable. Mitigation areas apply to georeferenced resources because the Navy requires accurate resource identification and mapping for the mitigation to be effective and practical to implement.

The mitigation for seafloor resources is a continuation from the 2015 MITT Final EIS/OEIS. Input from the operational community indicates that the mitigation detailed in Table 5.4-1 is practical to implement. Implementing additional mitigation for other activities or types of seafloor resources would not allow the Navy to continue meeting its mission requirements to successfully accomplish military readiness objectives. Expanding the mitigation to protect additional seafloor features where marine species are known to occur (e.g., soft bottom, which provides habitat for resources such as seagrass, worms, and clams) would essentially result in the Navy not conducting training and testing activities throughout a significant portion of the Study Area. This would prohibit the Navy from accessing a majority of its mission-essential activity locations. This would also push training and testing activities farther offshore, which would have implications for safety and sustainability. Moving activities farther offshore would increase the distance from aircraft emergency landing fields, critical medical facilities, and search and rescue capabilities; would require excessive time on station or time away from homeport for Navy personnel; and would result in significant increases to operational costs.

In summary, the operational community determined that implementing mitigation for seafloor resources beyond what is detailed in Table 5.4-1 would be incompatible with the practicality assessment criteria for safety, sustainability, and mission requirements.

## 5.5 Terrestrial Mitigation Measures to be Implemented

The Navy will implement mitigation measures for military readiness activities conducted on FDM, which is the only terrestrial portion of the Study Area. Mitigation measures for FDM are described in the section below.

### 5.5.1 Farallon De Medinilla

As outlined in Table 5.5-1, the Navy will continue to implement mitigation to avoid or reduce potential impacts on birds, bats, and sea turtles that occur on land on FDM.

### Table 5.5-1: Farallon de Medinilla Mitigation Measures

| *Mitigation Area Description* |
| --- |
| **Stressor or Activity**<br>• Explosives<br>• Physical disturbance and strikes |
| **Resource Protection Focus**<br>• Birds<br>• Bats<br>• Sea turtles |
| **Mitigation Area Requirements**<br>• The Navy will not use explosive cluster weapons, scatterable munitions, fuel air explosives, incendiary munitions, depleted uranium rounds, and bombs greater than 2,000 lb.<br>• The Navy will not target the northern Special Use Area and the narrow land bridge with explosive or non-explosive ordnance.<br>• The Navy will not use explosive ordnance in Impact Area 1.<br>• The Navy will only target Impact Areas 1, 2, and 3 during air-to-ground bombing, missile, and gunnery exercises.<br>• The Navy will only fire from the west during ship-based bombardment.<br>• Navy personnel will not be authorized on FDM without approval from Joint Region Marianas Operations.<br>• During training activities involving aircraft dropping explosive or non-explosive ordnance on a surface target, mitigation will include visual observation immediately before and during the exercise. Firing will cease if a sea turtle is observed (on shore) in the vicinity of the intended impact location. Firing will recommence if the sea turtle is observed exiting the vicinity of the intended impact location, or if the intended impact location has been repositioned to a new location (i.e., to where the sea turtle is no longer within the vicinity of the intended impact location). |

As described in Section 3.10 (Terrestrial Species and Habitats) of the 2015 MITT Final EIS/OEIS, FDM is recognized by regional ornithologists (bird specialists) as an important bird area for many species of marine birds, migrant shorebirds, and a limited number of terrestrial bird species, including the Mariana swiftlet, Mariana crow, Mariana common moorhen, Guam Micronesian kingfisher, ESA-listed Micronesian megapode, Guam rail Nightingale reed-warbler, and Rota bridled white-eye. Habitat for the Micronesian megapode on FDM primarily consists of trees, shrubs, and grasslands. The most recent survey for megapodes on FDM was completed in 2013, when Navy biologists detected 11 megapodes while surveying a limited transect within Impact Areas 1 and 2 (U.S. Department of the Navy, 2013b). FDM may also serve as Mariana fruit bat habitat for a small number of year-round residents and a stopover location for bats transiting between islands. The northern portion of the island may provide habitat for Mariana fruit bat foraging and roosting (U.S. Department of the Navy 2013a). Although the beaches on FDM are unsuitable for sea turtle nesting, green sea turtles have occasionally been observed on shore on FDM.

The Navy will continue to implement mitigation on FDM to help avoid or reduce potential impacts on ESA-listed species. Restricting the locations and type of ordnance used in the northern areas of FDM (including the Special Use Area and Impact Area 1) will help the Navy avoid or reduce potential impacts on ESA-listed Micronesian megapodes and Mariana fruit bats in the areas where they are most likely to occur for roosting and foraging. Only firing from the west during ship-based bombardment will help avoid potential impacts on rookery locations on the eastern cliff of FDM. The mitigation will also help the Navy avoid or reduce potential impacts on Micronesian megapodes and Mariana fruit bats, as well as other bird species that could be migrating or resting on FDM.

The mitigation measures on FDM are a continuation from the 2015 MITT Final EIS/OEIS based on the highest level of mitigation that is practical for the Navy to implement within this land portion of the Study Area. The Navy conducts training on FDM to ensure safety of personnel and skill proficiency in an area analogous to military mission and combat conditions. FDM is the only land training area considered in this SEIS/OEIS, and therefore represents the only location where certain activities, such as Naval

Surface Fire Support Exercise – Land-based Target, Bombing Exercise (Air-to-Ground), Gunnery Exercise (Air-to-Ground), and Direct Action (Tactical Air Control Party) can occur as part of the Proposed Action.

Because FDM is the only terrestrial area that the Navy plans to use under the Proposed Action, it provides a unique training environment within the Study Area essential to military readiness. Therefore, further mitigation measures with regard to the level, number, type, or timing (seasonal or time of day) of training activities on FDM would be impractical due to implications for safety, sustainability, and mission requirements. For example, during a Direct Action (Tactical Air Control Party) exercise, military personnel train for controlling of combat support aircraft, providing airspace deconfliction, and terminal control for Close Air Support in conjunction with an Air-to-Ground bombing or missile exercise. Personnel may also train to employ small arms, grenades, mortars, and crew served weapons in direct action against targets on the island. This activity provides critical training on coordination of tactics between fixed-wing aircraft, rotary-wing aircraft, and small boats in an environment that cannot be replicated elsewhere in the Study Area. Reducing the number of events or further restricting the type of ordnance used during training would impede the ability for the participants to become proficient in tactical air control and using their weapons as would be required during military missions and combat operations. This would prevent units from meeting their individual training and certification requirements and deploying with the required level of readiness necessary to accomplish their missions. Additional mitigation on FDM would also have significant impacts on personnel safety due to the reduced ability to safely and effectively train personnel for tactical air control and airspace deconfliction.

## 5.6 Measures Considered but Eliminated

As described in Section 5.2 (Mitigation Development Process), the Navy conducted a detailed review and assessment of each potential mitigation measure individually and then all potential mitigation measures collectively to determine if, as a whole, the mitigation will be effective at avoiding or reducing impacts and practical to implement. The assessment included consideration of mitigation recommendations received during scoping on this Proposed Action or through public comments and consultations on past environmental compliance documents applicable to the Study Area. The operational community determined that implementing procedural or terrestrial mitigation beyond what is detailed in Section 5.3 (At-Sea Procedural Mitigation to be Implemented) and Section 5.5 (Terrestrial Mitigation Measures to be Implemented) would be incompatible with the practicality assessment criteria for safety, sustainability, and mission requirements. Information about why implementing additional mitigation measures for active sonar, explosives, active and passive acoustic monitoring devices, thermal detection systems, third-party observers, foreign navy mitigation, and reporting requirements would be impractical is provided in the sections below. A draft biological assessment and operational analysis of mitigation areas that the Navy considered for marine mammals and sea turtles is provided in Appendix I (Geographic Mitigation Assessment) and will be summarized in Section 5.4 (Mitigation Areas to be Implemented) of the Final SEIS/OEIS.

When analyzing all potential mitigation measures collectively, the operational community determined that adopting certain mitigation measures, such as limiting active sonar to only be conducted in waters of great depth, would result in the Navy losing utilization of sea space and airspace required to support training and testing of naval forces in the Study Area. Certain measures would restrict or prohibit Navy training and testing throughout most of the Study Area except in very narrow circumstances. For example, blanket limitations or restrictions on the level, number, or timing (seasonal or time of day) of training and testing activities within discrete or broad-scale areas of water (e.g., embayments and large swaths of the littorals and open ocean), or other areas vital to mission requirements would prevent the

Navy from accessing its ranges, operating areas, facilities, or range support structures necessary to meet the purpose and need of the Proposed Action. As described in Section 5.2.4 (Practicality of Implementation), the Navy requires extensive sea space so that individual training and testing activities can occur at sufficient distances such that these activities do not interfere with one another, and so that Navy units can train to communicate and operate in a coordinated fashion over tens or hundreds of square miles, as required during military missions and combat operations. The Navy also needs to maintain access to sea space with the unique, challenging, and diverse environmental and oceanographic features (e.g., bathymetry, topography, surface fronts, and variations in sea surface temperature) analogous to military mission and combat conditions to achieve the highest skill proficiency and most accurate testing results possible.

Threats to national security are constantly evolving. The Navy requires the ability to adapt training and testing to meet these emerging threats. Restricting access to broad-scale areas of water would impact the ability for Navy training and testing to evolve as threats evolve. Eliminating opportunities for the Navy to train and test in a myriad of at-sea conditions would put U.S. forces at a tactical disadvantage during military missions and combat operations. This would also present a risk to national security if potential adversaries were to be alerted to the environmental conditions within which the U.S. Navy is prohibited from training and testing. Restricting large areas of ocean or other smaller areas at sea that are critical to Navy training and testing would make training and concealment much more difficult and would adversely impact the Navy's ability to perform its statutory mission.

### 5.6.1 Active Sonar

When assessing and developing mitigation, the Navy considered reducing active sonar training and testing hours, modifying active sonar sound sources, implementing time-of-day restrictions and restrictions during surface ducting conditions, replacing active sonar training and testing with synthetic activities (e.g., computer simulated training), and implementing active sonar ramp-up procedures. The Navy determined that it would be practical to implement certain restrictions on the use of active sonar in the Study Area, as detailed in Section 5.3.2.1 (Active Sonar) and Appendix I (Geographic Mitigation Assessment). As discussed in Chapter 2 (Description of Proposed Action and Alternatives), Section 5.2.4 (Practicality of Implementation), Appendix A (Training and Testing Activities Descriptions), and Appendix I (Geographic Mitigation Assessment), training and testing activities are planned and scheduled based on numerous factors and data inputs, such as compliance with the Optimized Fleet Response Plan. Information on why training and testing with active sonar is essential to national security is presented in Section 5.3.2.1 (Active Sonar). The Navy uses active sonar during military readiness activities only when it is essential to training missions or testing program requirements since active sonar has the potential to alert opposing forces to the operating platform's presence. Passive sonar and other available sensors are used in concert with active sonar to the maximum extent practicable.

The Navy currently uses, and will continue to use, computer simulation to augment training and testing whenever possible. As discussed in Section 1.4.1 (Why the Navy Trains), simulators and synthetic training are critical elements that provide early skill repetition and enhance teamwork; however, they cannot duplicate the complexity faced by Sailors during military missions and combat operations for the types of active sonar used under the Proposed Action (e.g., hull-mounted mid-frequency active sonar). Just as a pilot would not be ready to fly solo after simulator training, operational Commanders cannot allow military personnel to engage in military missions and combat operations based merely on simulator training. Similarly, in testing a system that is being developed, simulation can be used during the initial stages of development, but ultimately the system must be tested under conditions analogous to those faced during military missions and combat operations. Systems that have undergone maintenance need to be tested, and not simulated, to ensure that the system is operating correctly.

Sonar operators must train to effectively handle bottom bounce and sound passing through changing currents, eddies, and across changes in ocean temperature, pressure, salinity, depth, and in surface ducting conditions. Sonar systems must be tested in these conditions to ensure functionality and accuracy in military mission and combat conditions. The Navy tests its active sonar systems in areas analogous to where the Navy trains and operates. This includes a nighttime testing requirement for some active sonar systems, and a requirement to test in a variety of locations and environmental conditions depending on the testing program objectives. Training and testing in both good visibility (e.g., daylight, favorable weather conditions) and low visibility (e.g., nighttime, inclement weather conditions) is vital because environmental differences between day and night and varying weather conditions affect sound propagation and 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. This affects sound propagation and could affect how sonar systems function and are operated.

Submarines may hide in the higher ambient noise levels of shallow coastal waters and surface ducts. Surface ducting occurs when water conditions, such as temperature layers and lack of wave action, result in little sound energy penetrating beyond a narrow layer near the surface of the water. Avoiding surface ducting conditions would be impractical 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. Submarines have long been known to take advantage of the phenomena associated with surface ducting to avoid being detected by sonar. When surface ducting occurs, active sonar becomes more useful near the surface but less useful at greater depths. As noted by the U.S. Supreme Court in *Winter v. Natural Resources Defense Council Inc.*, 555 U.S. 7 (2008), because surface ducting conditions occur relatively rarely and are unpredictable, it is especially important for the Navy to be able to train under these conditions when they occur. Training with active sonar in these conditions is a critical component of 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 under these conditions. Reducing power or shutting down active sonar based on environmental conditions as a mitigation would affect a Commander’s ability to develop the tactical picture. It would also prevent sonar operators from training in conditions analogous to those faced during military missions and combat operations, such as during periods of low visibility.

Active sonar signals are designed explicitly to provide optimum performance at detecting underwater objects (e.g., submarines) in a variety of acoustic environments. The Navy assessed the potential for implementing active sonar signal modification as mitigation. At this time, the science on the differences in potential impacts of up or down sweeps of the sonar signal (e.g., different behavioral reactions) is extremely limited and requires further development. If future studies indicate that modifying active sonar signals (i.e., up or down sweeps) could be an effective mitigation approach, then the Navy will investigate if and how the mitigation would affect the sonar's performance.

Active sonar equipment power levels are set consistent with mission requirements. Active sonar ramp-up procedures are used during seismic surveys and some foreign navy sonar activities. Ramping up involves slowly increasing sound levels over a certain length of time until the optimal source level is reached. The intent of ramping up a sound source is to alert marine mammals with a low sound level to deter them from the area and avoid higher levels of sound exposure. The best available science does not suggest that ramp-up would be an effective mitigation tool for U.S. Navy active sonar training and testing activities under the Proposed Action. Wensveen et al. (2017) found that active sonar ramp-up was not an effective method for reducing impacts on humpback whales because most whales did not display strong behavioral avoidance to the sonar signals. The study suggested that sonar ramp-up could potentially be more effective for other more behaviorally responsive species but would likely also depend on the context of exposure. For example, ramp-up would be less effective if animals have a strong motivation not to move away from their current location, such as when foraging. Dunlop et al. (2016) and von Benda-Beckmann et al. (2014) found that implementing ramp-up as a mitigation may be effective for some activities in some situations. Additionally, von Benda-Beckmann et al. (2014) found that the main factors limiting ramp-up effectiveness for a typical anti-submarine warfare activity are a high source level, a moving sonar source, and long silences between consecutive sonar transmissions. Based on the source levels, vessel speeds, and sonar transmission intervals that will be used during typical active sonar activities under the Proposed Action, the Navy has determined that ramp-up would be an ineffective mitigation measure for the active sonar activities analyzed in this SEIS/OEIS.

Implementing active sonar ramp-up procedures during training or testing under the Proposed Action would not be representative of military mission and combat conditions and would significantly impact training and testing realism. For example, during an anti-submarine warfare exercise using active sonar, ramp-ups have the potential to alert opponents (e.g., target submarines) to the transmitting vessel's presence. This would defeat the purpose of the training by allowing the target submarine to detect the searching unit and take evasive measures, thereby denying the sonar operator the opportunity to learn how to locate the submarine. Similarly, testing program requirements determine test parameters to accurately determine whether a system is meeting its operational and performance requirements; therefore, implementing ramp-up during testing activities would impede the Navy's ability to collect essential data for evaluation of a system's capabilities.

Reducing realism in training impedes the ability for Navy Sailors to train and become proficient in using active sonar, erodes capabilities, and reduces perishable skills. These impacts would result in a significant risk to personnel safety during military missions and combat operations and would prevent units from meeting their individual training and certification requirements. Therefore, implementing additional mitigation that would reduce training realism would ultimately prevent units from deploying with the required level of readiness necessary to accomplish their missions and impede the Navy's ability to certify forces to deploy to meet national security tasking. Reducing realism in testing would impact the ability of researchers, program managers, and weapons system acquisition programs to conduct accurate acoustic research and effectively test systems and platforms (and components of these systems and platforms) before full-scale production or delivery to the fleet. These tests are required to ensure functionality and accuracy in military mission and combat conditions per required acquisition milestones or on an as-needed basis to meet operational requirements.

### 5.6.2 Explosives

When assessing and developing mitigation, the Navy considered reducing the number and size of explosives and limiting the locations and time of day of explosive training and testing in the Study Area. The Navy determined that it would be practical to implement certain restrictions on the use of explosives in the Study Area, as detailed in Section 5.3.3 (Explosive Stressors) and Appendix I (Geographic Mitigation Assessment). As discussed in Chapter 2 (Description of Proposed Action and Alternatives), Section 5.2.4 (Practicality of Implementation), Appendix I (Geographic Mitigation Assessment), Appendix A (Training and Testing Activities Descriptions), and Appendix I (Geographic

Mitigation Assessment), the locations and timing of the training and testing activities that use explosives vary throughout the Study Area based on range scheduling, mission requirements, testing program requirements, and standard operating procedures for safety and mission success.

Activities that involve explosive ordnance are inherently different from those that involve non-explosive practice munitions. For example, critical components of an explosive Bombing Exercise Air-to-Surface include the assembly, loading, delivery, and assessment of the explosive bomb. The explosive bombing training exercise starts with ground personnel, who must practice the building and loading of explosive munitions. Training includes the safe handling of explosive material, configuring munitions to precise specifications, and the loading of munitions onto aircraft. Aircrew must then identify a target and safely deliver fused munitions, discern if the bomb was assembled correctly, and determine bomb damage assessments based on how and where the explosive detonated. An air-to-surface bombing exercise using non-explosive practice munitions can train aircrews on valuable skills to locate and accurately deliver munitions on a target; however, it cannot effectively replicate the critical components of an explosive activity in terms of assembly, loading, delivery, and assessment of an explosive bomb. Reducing the number and size of explosives or diminishing activity realism by implementing time of day or geographic restrictions for additional explosive training activities would impede the ability for Navy Sailors to train and become proficient in using explosive weapons systems (which would result in a significant risk to personnel safety during military missions and combat operations), and would ultimately prevent units from meeting their individual training and certification requirements (which would prevent them from deploying with the required level of readiness necessary to accomplish their missions) and impede the Navy's ability to certify forces to deploy to meet national security tasking.

Similar to training, the Navy is required to test its explosives to quantify the compatibility of weapons with the platform from which they will be launched or released in military missions and combat operations. Such testing requires the use of the actual explosive ordnance that will be used during training exercises, military missions, and combat operations. Reducing the number and size of explosives or diminishing activity realism by implementing time of day or geographic restrictions for additional explosive testing events would impact the ability of researchers, program managers, and weapons system acquisition programs to effectively test systems and platforms (and components of these systems and platforms). Such testing must be conducted before full-scale production or delivery to the fleet to ensure functionality and accuracy in military mission and combat conditions per required acquisition milestones or on an as-needed basis to meet operational requirements.

### 5.6.3 Active and Passive Acoustic Monitoring Devices

When assessing and developing mitigation, the Navy considered using active and passive acoustic monitoring devices as procedural mitigation. During Surveillance Towed Array Sensor System low-frequency active sonar (which is not part of the Proposed Action), the Navy uses a specially designed adjunct high-frequency marine mammal monitoring active sonar known as "HF/M3" to mitigate potential impacts. HF/M3 can only be towed at slow speeds and operates like a fish finder used by commercial and recreational fishermen. Installing the HF/M3 adjunct system on the tactical sonar ships used under the Proposed Action would have implications for safety and mission requirements due to impacts on speed and maneuverability. Furthermore, installing the system would significantly increase costs associated with designing, building, installing, maintaining, and manning the equipment. The Navy will not install the HF/M3 system or other adjunct marine mammal monitoring devices as mitigation under the Proposed Action. However, Navy assets with passive acoustic monitoring capabilities that are already participating in an activity will continue to monitor for marine mammals, as described in

Section 5.2.1 (At-Sea Procedural Mitigation Development) and Section 5.3 (At-Sea Procedural Mitigation to be Implemented). Significant manpower and logistical constraints make constructing and maintaining additional passive acoustic monitoring systems for each training and testing activity under the Proposed Action impractical. Diverting platforms with passive acoustic monitoring capabilities to monitor training and testing events would impact their ability to meet their mission requirements and would reduce the service life of those systems.

The Navy is continuing to improve its capabilities to use range instrumentation to aid in the passive acoustic detection of marine mammals. For example, at the Southern California Offshore Range, the Pacific Missile Range Facility off Kauai, Hawaii, and the Atlantic Undersea Test and Evaluation Center in the Bahamas, the Navy can monitor instrumented ranges in real-time or through data recorded by hydrophones. The Navy has sponsored numerous studies that have produced meaningful results on marine mammal occurrence, distribution, and behavior on these ranges through the U.S. Navy Marine Species Monitoring Program. For information on the U.S. Navy Marine Species Monitoring Program, see Section 5.1.2.2.1 (Marine Species Research and Monitoring Programs).

Although the Navy's instrumented ranges are helping to facilitate a better understanding of the species that are present in those areas, instrumented ranges were not developed for the purpose of mitigation, and therefore do not have the capabilities to be used effectively for mitigation. To develop an estimated position for an individual marine mammal, the animal's vocalizations must be detected on at least three hydrophones. The vocalizations must be loud enough to provide the required signal to noise ratio on those hydrophones. The hydrophones must have the required bandwidth and dynamic range to capture that signal. Detection capabilities are generally degraded under noisy conditions (such as high sea state) that affect signal to noise ratio. The ability to detect and develop an estimated position for marine mammals on the Navy's instrumented ranges depends of numerous factors, such as behavioral state (e.g., only vocalizing animals can be detected), species (e.g., species vocalize at varying rates, call types, and source levels), animal location relative to the passive acoustic receivers (hydrophones), and location on the range. The Navy's hydrophones cannot track the real-time locations of individual animals with dispersed and directional vocalizations with the level of precision needed for effective mitigation. Even marine mammals that have been vocalizing for extended periods of time have been known to stop vocalizing for hours at a time, which would prevent the Navy from obtaining or maintaining an accurate estimate of that animal's location. In addition, the Navy does not currently have the capability to perform data processing for large baleen whales in real-time. Determining if an animal is located within a mitigation zone within the timeframes required for mitigation would be prohibited by the amount of time it takes to process the data.

If a vocalizing animal is detected on only one or two hydrophones, estimating its location is not possible, and the location of the animal would be assigned generally within the detection radius around each hydrophone. The detection radius of a hydrophone is typically much larger than the mitigation zone for the activities conducted on instrumented ranges. The Navy does not have a way to verify if that vocalizing animal is located within the mitigation zone or at a location down range. Mitigating for passive acoustic detections based on unknown animal locations would essentially increase the mitigation zone sizes for each activity to that of the hydrophone detection radius. Increasing the mitigation zone sizes beyond what is described for each activity is impractical for the reasons described throughout Section 5.3 (At-Sea Procedural Mitigation to be Implemented).

In summary, although the Navy is continuing to improve its capabilities to use range instrumentation to aid in the passive acoustic detection of marine mammals, at this time it would not be effective or practical for the Navy to monitor instrumented ranges for real-time mitigation or to construct additional instrumented ranges as a tool to aid in the implementation of mitigation.

### 5.6.4 Thermal Detection Systems

Thermal detection technology is designed to allow observers to detect the difference in temperature between a surfaced marine mammal (i.e., the body or blow of a whale) and the environment (i.e., the water and air). Although thermal detection may be reliable in some applications and environments, current technologies are limited by their: (1) reduced performance in certain environmental conditions, (2) inability to detect certain animal characteristics and behaviors, (3) low sensor resolution and narrow fields of view, and (4) high cost and low lifecycle (Boebel, 2017; Zitterbart et al., 2013).

Thermal detection systems can be effective at detecting some types of marine mammals in a limited range of marine environmental conditions. Current thermal detection systems have proven more effective at detecting large whale blows than the bodies of small animals, particularly at a distance (Zitterbart et al., 2013). The effectiveness of current technologies has not been demonstrated for small marine mammals. Thermal detection systems exhibit varying degrees of false positive detections (i.e., incorrect notifications) due in part to their low sensor resolution and reduced performance in certain environmental conditions. False positive detections may incorrectly identify other features (e.g., birds, waves, boats) as marine mammals. In one study, Zitterbart et al. (2013) reported a false positive rate approaching one incorrect notification per four minutes of observation.

Thermal detection systems are generally thought to be most effective in cold environments, which have a large temperature differential between an animal's temperature and the environment. Two studies that examined the effectiveness of thermal detection systems for marine mammal observations are Zitterbart et al. (2013), which tested a thermal detection system and automatic algorithm in polar waters between 34 and 50 degrees Fahrenheit, and a Navy-funded study in subtropical and tropical waters. Zitterbart et al. (2013) found that current technologies have limitations regarding temperature and survey conditions (e.g., rain, fog, sea state, glare, ambient brightness), for which further effectiveness studies are required. The Office of Naval Research Marine Mammals and Biology program funded a project (2013-2018) to test the thermal limits of infrared-based automatic whale detection technology. That project focused on capturing whale spouts at two different locations featuring subtropical and tropical water temperatures, optimizing detector/classifier performance on the collected data, and testing system performance by comparing system detections with concurrent visual observations.

The Navy has also been investigating the use of thermal detection systems with automated marine mammal detection algorithms for future mitigation during training and testing, including on autonomous platforms. For example, the Defense Advanced Research Projects Agency funded six initial studies to test and evaluate infrared-based thermal detection technologies and algorithms to automatically detect marine mammals on an unmanned surface vehicle. Based on the outcome of these initial studies, follow-on efforts and testing are planned for 2018–2019.

Thermal detection systems are currently used by some specialized U.S. Air Force aircraft for marine mammal mitigation. These systems are specifically designed for and integrated into Air Force aircraft and cannot be added to Navy aircraft. Only certain Navy aircraft have specialized infrared capabilities, and these capabilities are only for fine-scale targeting within a narrow field of view. The only thermal imagery sensors aboard Navy surface ships are associated with specific weapons systems, and these sensors are not available on all vessels. These sensors are typically used only in select training events, have a limited lifespan before requiring expensive replacement, and are not optimized for marine mammal observations within the Navy's mitigation zones. For example, as described in Section 5.3.3.3 (Explosive Medium-Caliber and Large-Caliber Projectiles), Lookouts are required to observe a 1,000 yd. mitigation zone around the intended impact location during explosive large-caliber gunnery activities. In addition to observing for marine mammals, one of the activity's mission-essential requirements is for event participants, including Lookouts, to maintain focus on the mitigation zone to ensure the safety of Navy personnel and equipment and the public. Lookouts would not be able to observe the 1,000 yd. mitigation zone using the Navy's thermal imagery sensors due to their narrow fields of view and technological design specific to fine-scale targeting. Such observations would be ineffective for marine mammals and would prevent Lookouts from effectively maintaining focus on the activity area and implementing mission-essential safety protocols.

The effectiveness of even the most advanced commercially available thermal detection systems with technological designs specific to marine mammal observations is highly dependent on environmental conditions, animal characteristics, and animal behaviors (Zitterbart et al., 2013). Considering the range of environmental conditions and diversity of marine mammal species found throughout the Study Area, the use of thermal detection systems would be less effective than the traditional techniques currently employed by the Navy, such as naked-eye scanning, hand-held binoculars, and high-powered binoculars mounted on a ship deck. Furthermore, high false positive rates of thermal detection systems could result in the Navy implementing mitigation for features incorrectly identified as marine mammals. Increasing the instances of mitigation implementation based on incorrectly identified features would have significant impacts on the ability for training and testing activities to accomplish their intended objectives, without providing any mitigation benefit to the species. In addition, thermal detection systems are designed to detect marine mammals and do not have the capability to detect other resources for which the Navy is required to implement mitigation. Requiring Lookouts to use thermal detection systems would prevent them from detecting and mitigating for sea turtles and other biological resources (e.g., jellyfish aggregations).

As discussed in Section 5.3 (At-Sea Procedural Mitigation to be Implemented), the Navy's procedural mitigation measures include the maximum number of Lookouts the Navy can assign to each activity based on available manpower and resources. It would be impractical to add personnel to serve as additional Lookouts for the sole purpose of thermal detection system use. For example, the Navy does not have available manpower to add Lookouts to use thermal detection systems in tandem with existing Lookouts who are using traditional observation techniques.

In summary, thermal detection systems have not been sufficiently studied both in terms of their effectiveness within the environmental conditions found in the Study Area and their compatibility with Navy training and testing. The Navy plans to continue researching thermal detection systems to determine their effectiveness and compatibility with Navy applications. If the technology matures to the state where thermal detection is determined to be an effective mitigation tool during training and testing, the Navy will assess the practicality of using the technology during training and testing events and retrofitting its observation platforms with thermal detection devices. The assessment will include an evaluation of the budget and acquisition process (including costs associated with designing, building, installing, maintaining, and manning equipment that is expensive and has a relatively short lifecycle before key system components need replacing); logistical and physical considerations for device installment, repair, and replacement (e.g., conducting engineering studies to ensure there is no electronic or power interference with existing shipboard systems); manpower and resource considerations for training personnel to effectively operate the equipment; and considerations of potential security and classification issues. New system integration on Navy assets can entail up to 5–10 years of effort to account for acquisition, engineering studies, and development and execution of systems training. The Navy will provide information to NMFS about the status and findings of Navy-funded thermal detection studies and any associated practicality assessments at the annual adaptive management meetings. Information about the Navy's adaptive management program is included in Section 5.1.2.2.1.1 (Adaptive Management).

### 5.6.5 Third-Party Observers

When assessing and developing mitigation, the Navy considered using third-party observers during training and testing to aid in the implementation of procedural mitigation. The use of third-party observers to conduct pre- or post-activity biological resource observations would be an ineffective mitigation because marine mammals would likely move into or out of the activity area, and mitigation must be implemented at the time the activity is taking place.

There are significant manpower and logistical constraints that make using third-party observers for every training and testing activity under the Proposed Action impractical. Training and testing activities often occur simultaneously and in various regions throughout the Study Area, some of which last for days or weeks at a time. Having third-party observers embark on Navy vessels or aircraft would result in safety and security clearance issues. Training and testing event planning includes careful consideration of capacity limitations when placing personnel on participating aircraft and vessels. The Navy is unable to add third-party observers on a ship or substitute a Navy Lookout with a third-party observer without causing a berthing shortage or exceedance of other space limitations, or impacting the ability for Lookouts to complete their other mission-essential duties. The use of third-party observers also presents national security concerns due to the requirement to provide advance notification of specific times and locations of Navy platform movements and activities (e.g., vessels using active sonar).

Reliance on the availability of third-party personnel for mitigation would be impractical because training and testing activity timetables oftentimes cannot be precisely fixed and are instead based on the free-flow development of tactical situations. Waiting for third-party aircraft or vessels to complete surveys, refuel, or transit on station would extend the length of the activity in a way that would diminish realism and delay training and testing schedules. Hiring third-party civilian vessels or aircraft to observe Navy training and testing activities would also be unsustainable due to the significant associated costs. Because many training and testing activities take place offshore, the amount of time observers would spend on station would be limited due to aircraft fuel restrictions. Fuel restrictions and distance from shore would increase safety risks should mechanical problems arise. The presence of civilian aircraft or vessels in the vicinity of training and testing activities would present increased safety risks due to airspace conflicts and proximity to explosives.

### 5.6.6 Foreign Navy Mitigation

When assessing and developing mitigation, the Navy considered adopting the mitigation measures implemented by foreign navies. Mitigation measures are carefully developed for and assessed by each individual navy based on the potential impacts of their activities on the biological resources that live in their Study Areas, and the practicality of mitigation implementation based on their training mission and testing program requirements and the resources available for mitigation. The U.S. Navy's readiness considerations differ from those of foreign navies based on each navy's strategic reach, global mission, country-specific legal requirements, and geographic considerations. Most non-U.S. navies do not possess an integrated strike group and do not have integrated training requirements. The U.S. Navy's training is built around the integrated warfare concept and is based on the U.S. Navy's capabilities, the threats faced, the operating environment, and the overall mission. For this reason, not all measures developed for foreign navies would be effective at reducing impacts of U.S. Navy training or testing, or practical to implement by the U.S. Navy (and vice versa). For example, some navies implement active sonar ramp-up as mitigation for marine mammals; however, as described in Section 5.6.1 (Active Sonar), the U.S. Navy determined that active sonar ramp-up would be an ineffective mitigation measure for training and testing activities under the Proposed Action and would be impractical to implement because it would significantly impact training and testing realism.

The U.S. Navy will implement mitigation measures that have been determined to be effective at avoiding or reducing impacts from the Proposed Action and practical to implement by the U.S. Navy. Many of these measures are the same as, or comparable to, those implemented by foreign navies. For example, most navies implement some form of procedural mitigation to cease certain activities if a marine mammal is observed in a mitigation zone (Dolman et al., 2009). Some navies also implement geographic mitigation to restrict activities within particularly important marine mammal breeding, feeding, or migration habitats. The U.S. Navy will implement several mitigation measures and environmental compliance initiatives that are not implemented by foreign navies. For example, as discussed in Section 5.1.2.2 (Monitoring, Research, and Reporting Initiatives), the U.S. Navy will continue to sponsor scientific monitoring and research and comply with stringent reporting requirements.

### 5.6.7 Reporting Requirements

When assessing and developing mitigation, the Navy considered increasing its reporting requirements, such as additional reporting of vessel speeds and marine species observations. As discussed in Section 5.1.2.2 (Monitoring, Research, and Reporting Initiatives), the Navy developed its reporting requirements in conjunction with NMFS to be consistent with mission requirements and balance the usefulness of the information to be collected with the practicality of collecting it. The Navy's training and testing activity reports and incident reports are designed to verify implementation of mitigation; comply with current permits, authorizations, and consultation requirements; and improve future environmental analyses. The Navy reports to NMFS if mitigation was implemented during sinking exercises (e.g., number of times explosive detonations were delayed due to marine mammal sightings). For major training exercises, the Navy's annual training and testing activity reports include information on each individual marine mammal sighting related to mitigation implementation. In the unlikely event that a vessel strike of a marine mammal should occur, the Navy would provide NMFS with relevant information pertaining to the incident, including but not limited to vessel speed.

Additional reporting would be ineffective as mitigation because it would not result in modifications to training or testing activities or further avoidance or reductions of potential impacts. For example, additional reporting of vessel speed data would not result in modifications to vessel speeds (e.g., speed restrictions) or reduce the already low potential for vessel strikes of marine mammals for the reasons described in Section 5.3.4.1 (Vessel Movement). Lookouts are not trained to make species-specific identification and would not be able to provide detailed scientific data if more detailed marine species observation reports were to be required. Furthermore, the Navy does not currently maintain a record management system to collect, archive, analyze, and report marine species observation or vessel speed data for every training and testing activity and all vessel movements. For example, the speed of Navy vessels can fluctuate an unlimited number of times during training and testing events. Developing and implementing a record management system of this magnitude would be unduly cost prohibitive and place a significant administrative burden on vessel operators and activity participants. Burdening operational Commanders, vessel operators, and event participations with requirements to complete additional administrative reporting would distract them from preparing a ready force and focusing on mission-essential tasks. Additional reporting requirements would draw event participants' attention away from the complex tactical tasks they are primarily obligated to perform, such as driving a warship or engaging in a gunnery event, which would adversely impact Navy personnel safety, public safety, and the effectiveness of training or testing.

## 5.7 Mitigation Summary

Table 5.7-1, Table 5.7-2, and Table 5.7-3 summarize the mitigation measures the Navy will implement under Alternative 1 or Alternative 2 of the Proposed Action. For a summary of mitigation areas the Navy considered for marine mammals and sea turtles for this Draft SEIS/OEIS, see Appendix I (Geographic Mitigation Assessment). The final mitigation areas resulting from the MMPA and ESA consultation and permitting processes will be included in Table 5.7-2 of the Final SEIS/OEIS. For specific requirements, additional information, and clarifications to the table summaries, see Section 5.3 (At-Sea Procedural Mitigation to be Implemented), Section 5.4 (At-Sea Mitigation Areas to be Implemented), and Section 5.5 (Terrestrial Mitigation Measures to be Implemented).

### Table 5.7-1: Summary of At-Sea Procedural Mitigation

| *Stressor or Activity* | *Mitigation Zone Sizes and Other Requirements* | *Protection Focus* |
|---|---|---|
| Environmental Awareness and Education | • Afloat Environmental Compliance Training program for applicable personnel | Marine mammals, Sea turtles |
| Active Sonar | Depending on sonar source:<br>• 1,000 yd. power down, 500 yd. power down, and 200 yd. shut down<br>• 200 yd. shut down | Marine mammals, Sea turtles |
| Weapons Firing Noise | • 30° on either side of the firing line out to 70 yd. | Marine mammals, Sea turtles |
| Explosive Sonobuoys | • 600 yd. | Marine mammals, Sea turtles |
| Explosive Torpedoes | • 2,100 yd. | Marine mammals, Sea turtles |
| Explosive Medium-Caliber and Large-Caliber Projectiles | • 1,000 yd. (large-caliber projectiles)<br>• 600 yd. (medium-caliber projectiles during surface-to-surface activities)<br>• 200 yd. (medium-caliber projectiles during air-to-surface activities) | Marine mammals, Sea turtles |
| Explosive Missiles and Rockets | • 2,000 yd. (21–500 lb. net explosive weight)<br>• 900 yd. (0.6–20 lb. net explosive weight) | Marine mammals, Sea turtles |
| Explosive Bombs | • 2,500 yd. | Marine mammals, Sea turtles |
| Sinking Exercises | • 2.5 NM | Marine mammals, Sea turtles |
| Explosive Mine Countermeasure and Neutralization Activities | • 600 yd. | Marine mammals, Sea turtles |
| Explosive Mine Neutralization Activities Involving Navy Divers | • 1,000 yd. (charges using time-delay fuses)<br>• 500 yd. (positive control charges) | Marine mammals, Sea turtles, Fish (hammerhead sharks) |
| Maritime Security Operations – Anti-Swimmer Grenades | • 200 yd. | Marine mammals, Sea turtles |

## Table 5.7-1: Summary of At-Sea Procedural Mitigation (continued)

| *Stressor or Activity* | *Mitigation Zone Sizes and Other Requirements* | *Protection Focus* |
|---|---|---|
| Vessel Movement | • 500 yd. (whales)<br>• 200 yd. (other marine mammals)<br>• Vicinity (sea turtles)<br>• Cease beach approach during Amphibious Assault and Amphibious Raid exercises (sea turtles) | Marine mammals, Sea turtles |
| Towed In-Water Devices | • 250 yd. (marine mammals)<br>• Vicinity (sea turtles) | Marine mammals, Sea turtles |
| Small-, Medium-, and Large-Caliber Non-Explosive Practice Munitions | • 200 yd. | Marine mammals, Sea turtles |
| Non-Explosive Missiles and Rockets | • 900 yd. | Marine mammals, Sea turtles |
| Non-Explosive Bombs and Mine Shapes | • 1,000 yd. | Marine mammals, Sea turtles |

## Table 5.7-2: Summary of Mitigation Areas

| *Summary of Mitigation Requirements* |
|---|
| ***Mitigation Areas for Seafloor Resources*** |
| • **Shallow-water coral reefs:** The Navy will not conduct precision anchoring, explosive mine countermeasure and neutralization activities, explosive mine neutralization activities involving Navy divers, explosive or non-explosive small-, medium-, and large-caliber gunnery activities using a surface target, explosive or non-explosive missile and rocket activities using a surface target, or explosive or non-explosive bombing or mine laying activities. The Navy will not place mine shapes, anchors, or mooring devices on the seafloor. Mitigation applies throughout the Study Area except in designated locations, where these resources will be avoided to the maximum extent practicable.<br>• **Live hard bottom, artificial reefs, and shipwrecks:** The Navy will not conduct precision anchoring, explosive mine countermeasure and neutralization activities, or explosive mine neutralization activities involving Navy divers. The Navy will not place mine shapes, anchors, or mooring devices on the seafloor. Mitigation applies throughout the Study Area except in designated locations, where these resources will be avoided to the maximum extent practicable. |
| ***Mitigation Areas for Marine Mammals and Sea Turtles*** |
| • A summary of mitigation areas applicable to marine mammals and sea turtles is presented in Appendix I (Geographic Mitigation Assessment) of this Draft SEIS/OEIS. |

## Table 5.7-3: Summary of Terrestrial Mitigation

| *Summary of Mitigation Requirements* |
|---|
| ***Terrestrial Mitigation Measures on Farallon de Medinilla for Birds, Bats, and Sea Turtles*** |
| • The Navy will not use explosive cluster weapons, scatterable munitions, fuel air explosives, incendiary munitions, depleted uranium rounds, and bombs greater than 2,000 lb.<br>• The Navy will not target the northern Special Use Area and the narrow land bridge with explosive or non-explosive ordnance.<br>• The Navy will not use explosive ordnance in Impact Area 1.<br>• The Navy will only target Impact Areas 1, 2, and 3 during air-to-ground bombing, missile, and gunnery exercises.<br>• The Navy will only fire from the west during ship-based bombardment.<br>• Navy personnel will not be authorized on FDM without approval from Joint Region Marianas Operations.<br>• During training activities involving aircraft dropping explosive or non-explosive ordnance on a surface target, mitigation will include visual observation immediately before and during the exercise. Firing will cease if a sea turtle is observed (on shore) in the vicinity of the intended impact location. Firing will recommence if the sea turtle is observed exiting the vicinity of the intended impact location, or if the intended impact location has been repositioned to a new location (i.e., to where the sea turtle is no longer within the vicinity of the intended impact location). |

# REFERENCES

Boebel, O. (2017). *Exploring the Thermal Limits of IR-Based Automatic Whale Detection*. Arlington, VA: Office of Naval Research Program.

Dolman, S. J., C. R. Weir, & M. Jasny. (2009). Comparative review of marine mammal guidance implemented during naval exercises. *Marine Pollution Bulletin, 58*, 465–477.

Dunlop, R. A., M. J. Noad, R. D. McCauley, E. Kniest, R. Slade, D. Paton, & D. H. Cato. (2016). Response of humpback whales (*Megaptera novaeangliae*) to ramp-up of a small experimental air gun array. *Marine Pollution Bulletin, 103*(1–2), 72–83.

Maloni, M., J. A. Paul, & D. M. Gligor. (2013). Slow steaming impacts on ocean carriers and shippers. *Maritime Economics & Logistics, 15*(2), 151–171.

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*. Washington, DC: U.S. Department of Defense.

U.S. Department of the Navy. (2010). *Navy Integrated Comprehensive Monitoring Plan*. Washington, DC: U.S. Department of the Navy.

U.S. Department of the Navy. (2013a). *U.S. Navy Strategic Planning Process for Marine Species Monitoring*. Washington, DC: Chief of Naval Operations, Energy & Environmental Readiness Division.

U.S. Department of the Navy. (2013b). *Annual Report: Wildlife Surveys on Tinian and FDM*. Naval Base Guam, GU: Joint Region Marianas.

U.S. Department of the Navy. (2015). *Final Mariana Islands Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement*. Pearl Harbor, HI: Naval Facilities Engineering Command, Pacific.

U.S. Department of the Navy. (2016). *Building and Maintaining a Comprehensive Database and Prioritization Scheme for Overlapping Habitat Data*.

U.S. Department of the Navy. (2017a). *Marine Mammal Strandings Associated with U.S. Navy Sonar Activities*. San Diego, CA: U.S. Navy Marine Mammal Program and SPAWAR Naval Facilities Engineering Command.

U.S. Department of the Navy. (2017b). *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*. San Diego, CA: Space and Naval Warfare System Command, Pacific.

U.S. Department of the Navy. (2017c). *Dive Distribution and Group Size Parameters for Marine Species Occurring in the U.S. Navy's Atlantic and Hawaii-Southern California Training and Testing Study Areas*. Newport, RI: Naval Undersea Warfare Center Division.

U.S. Department of the Navy. (2018). *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (Technical Report prepared by NUWC Division Newport, Space and Naval Warfare Systems Center Pacific, G2 Software Systems, and the National Marine Mammal Foundation). Newport, RI: Naval Undersea Warfare Center.

U.S. Fish and Wildlife Service. (2015). *Biological Opinion for the Mariana Islands Training and Testing Program*. Honolulu, HI: U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office.

von Benda-Beckmann, A. M., P. J. Wensveen, P. H. Kvadsheim, F. P. Lam, P. J. Miller, P. L. Tyack, & M. A. Ainslie. (2014). Modeling effectiveness of gradual increases in source level to mitigate effects of sonar on marine mammals. *Conservation Biology, 28*(1), 119–128.

Wensveen, P. J., P. H. Kvadsheim, F.-P. A. Lam, A. M. Von Benda-Beckmann, L. D. Sivle, F. Visser, C. Curé, P. Tyack, & P. J. O. Miller. (2017). Lack of behavioural responses of humpback whales (*Megaptera novaeangliae*) indicate limited effectiveness of sonar mitigation. *The Journal of Experimental Biology, 220*, 1–12.

Williams, B. K., R. C. Szaro, & C. D. Shapiro. (2009). *Adaptive Management: The U.S. Department of the Interior Technical Guide*. Washington, DC: U.S. Department of the Interior.

Zitterbart, D. P., L. Kindermann, E. Burkhardt, & O. Boebel. (2013). Automatic round-the-clock detection of whales for mitigation from underwater noise impacts. *PLoS ONE, 8*(8), e71217.

# 6 Additional Regulatory Considerations

# Supplemental Environmental Impact Statement/

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# 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 in addition to the ones discussed 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 in this Supplemental Environmental Impact Statement/ Overseas Environmental Impact Statement (SEIS/OEIS) would comply with applicable federal, state, and local laws, regulations, and executive orders. The United States (U.S.) Department of the Navy (Navy) has consulted and will continue to consult with regulatory agencies, as appropriate, during the NEPA process and before implementing the Proposed Action.

Table 6.1-1 summarizes environmental compliance requirements that were considered in preparing this SEIS/OEIS (including those that may be secondary considerations in the resource evaluations). Section 3.0.2 (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. Section 1.6 (The Environmental Planning Process) provides brief excerpts of the primary federal statutes, executive orders, and guidance that form the regulatory framework for the resource evaluations in Chapter 3 (Affected Environment and Environmental Consequences). Documentation of consultation and coordination with regulatory agencies is provided in Appendix C (Agency Correspondence).

**Table 6.1-1: Summary of Environmental Compliance for the Proposed Action**

| Statutes, Regulations, International Standards, and Guidance | Status of Compliance |
|---|---|
| **Statutes and Regulations** | |
| *Abandoned Shipwreck Act*<br>(43 United States Code [U.S.C.] sections 2101-2106) | 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*<br>(33 U.S.C. sections 1901–1915) | The Navy complies with these regulations and operates in a manner that minimizes or eliminates any adverse effects to the marine environment. See Section 3.1 (Sediments and Water Quality) for the assessment. |
| *Clean Air Act* (CAA) (42 U.S.C. sections 7401 et seq.)<br>*CAA General Conformity Rule* (40 C.F.R. section 93[B])<br>State Implementation Plan (SIP) | The Proposed Action would not conflict with attainment and maintenance goals established in the State Implementation Plan. As determined previously, a CAA conformity determination will not be required because emissions attributable to the alternatives including the Proposed Action would be below *de minimis* thresholds. See the Section 3.1 (Air Quality) for discussion of training and testing activities and compliance with the CAA. |
| *Clean Water Act* (CWA) (33 U.S.C. 1251 et seq.) | No permits are required under the CWA Sections 401, 402, or 404 (b) (1) for the Proposed Action. |
| *Coastal Zone Management Act* (16 U.S.C. sections 1451-1464) | The Navy will continue compliance with *the Coastal Zone Management Act*. See Section 6.1.1 (Coastal Zone Management Act Compliance). |
| *Endangered Species Act* (ESA)<br>(16 U.S.C. sections 1531 et seq.) | This SEIS/OEIS analyzes potential effects to species listed under the ESA and is administered by both the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS).<br><br>In accordance with Section 7 of the ESA (50 C.F.R. section 402), during the preparation of the 2015 MITT Final EIS/OEIS, the Navy prepared a biological assessment and submitted it to the USFWS. A Biological Opinion (BO) was issued by USFWS and remains valid. The Navy will continue to adhere to any BO terms and conditions listed therein.<br><br>The Navy is preparing a Biological Assessment that will be submitted to NMFS as part of formal consultation. A BO may be issued by NMFS, and the Navy will adhere to any BO terms and conditions listed therein.<br><br>In addition, the Navy will apply for a Letter of Authorization (LOA), which is expected to impose terms and conditions that, when implemented, would make ESA Section 9 prohibitions inapplicable to covered Navy activities. The MMPA LOA permit may be issued by NMFS prior to the issuance of the Record of Decision (ROD) on this SEIS/OEIS. |

## Table 6.1-1: Summary of Environmental Compliance for the Proposed Action (continued)

| **Statutes, Regulations, International Standards, and Guidance** | **Status of Compliance** |
|---|---|
| **Statutes and Regulations (continued)** | |
| *Historic Sites, Buildings and Antiquities Act, 1935* (54 U.S.C. 320101 et seq.)<br>*Antiquities Act* (54 U.S.C. sections 320301–320303) | Status remains unchanged since the 2015 MITT Final EIS/OEIS. See Section 3.11 (Cultural Resources) for the assessment. |
| *Magnuson-Stevens Fishery Conservation and Management Act* (16 U.S.C. sections 1801–1882) | The Proposed Action may have potential impacts on essential fish habitat and managed species. Consultation with NMFS is conducted for affected species and their habitats (see Section 6.1.3, Magnuson-Stevens Fishery Conservation and Management Act). |
| *Marine Mammal Protection Act* (MMPA) (16 U.S.C. sections 1431 et seq.) | This SEIS/OEIS updates the analysis and will be the basis for a request for a new LOA permit for activities beginning in 2020. |
| *Migratory Bird Treaty Act* (16 U.S.C. sections 703–712) | The Proposed Action is not anticipated to result in significant adverse effects on migratory bird populations. The Navy would not need to confer with the U.S. Fish and Wildlife Service as a result of the Proposed Action. |
| *Military Munitions Rule* | Status remains unchanged since the 2015 MITT Final EIS/OEIS. |
| *National Fishery Enhancement Act* (33 U.S.C. section 2101 et seq.) | Status remains unchanged since the 2015 MITT Final EIS/OEIS. See Section 3.9 (Fishes) for the assessment. |
| *National Historic Preservation Act* (54 U.S.C. section 306108) | The Programmatic Agreement expires in December 2019 and the Navy is pursuing consultation to continue compliance with the National Historic Preservation Act.<br>The Proposed Action is consistent with the national policy for the preservation of historic sites, buildings, and objects of national significance. Furthermore, the Navy will comply, as applicable, with the Section 106 consultation requirements. |
| *National Marine Sanctuaries Act* (16 U.S.C. sections 1431–1445c-1) | There are no National Marine Sanctuaries within the MITT Study Area. |
| *Rivers and Harbors Act* (33 U.S.C. section 401 et seq.) | No permit is required under the Rivers and Harbors Act because no construction in navigable waterways is proposed. |
| *The Sikes Act of 1960* (16 U.S.C. sections 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). | Status remains unchanged since the 2015 MITT Final EIS/OEIS. 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. |

### Table 6.1-1: Summary of Environmental Compliance for the Proposed Action (continued)

| Statutes, Regulations, International Standards, and Guidance | Status of Compliance |
|---|---|
| **Statutes and Regulations (continued)** | |
| *Submerged Lands Act of 1953* (43 U.S.C. sections 1301–1315) | The Proposed Action is consistent with the Submerged Lands Act regulations. |
| *Sunken Military Craft Act* (Public Law 108–375, 10 U.S.C. section 113 Note and 118 Stat. 2094–2098) | The *Sunken Military Craft Act* does not apply to actions taken by, or at the direction of, the United States. |
| **Executive Orders** | |
| Executive Order 11990*, Protection of Wetlands* | Implementation of the Proposed Action would not affect wetlands as defined in Executive Order 11990. |
| Executive Order 12114, *Environmental Effects Abroad of Major Department of Defense Actions* | The Navy prepared this SEIS/OEIS in accordance with Executive Order 12114 and Navy-implementing regulations found at 32 CFR part 187, *Environmental Effects Abroad of Major Department of Defense Actions*. |
| Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* | Status remains unchanged since the 2015 MITT Final EIS/OEIS. See Section 3.12 (Socioeconomic Resources and Environmental Justice) for the assessment. |
| Executive Order 12962*, Recreational Fisheries* | Status remains unchanged since the 2015 MITT Final EIS/OEIS. See Section 3.12 (Socioeconomic Resources and Environmental Justice) 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 3.0.3 (Resources and Issues Not Carried Forward for More Detailed Discussion). |
| Executive Order 13089*, Coral Reef Protection* | Status remains unchanged since the 2015 MITT Final EIS/OEIS. |
| Executive Order 13112*, Invasive Species* | Status remains unchanged since the 2015 MITT Final EIS/OEIS. |
| Executive Order 13158, *Marine Protected Areas* | Status remains unchanged since the 2015 MITT Final EIS/OEIS. See Section 6.1.2 (Marine Protected Areas) for more information. |

**Table 6.1-1: Summary of Environmental Compliance for the Proposed Action (continued)**

| Statutes, Regulations, International Standards, and Guidance | Status of Compliance |
|---|---|
| **Executive Orders (continued)** | |
| Executive Order 13783, *Promoting Energy Independence and Economic Growth* | The Proposed Action is consistent with the policy and immediate review of all agency actions that potentially burden the safe, efficient development of domestic energy resources. This Executive Order revokes Executive Order 13653, *Preparing the United States for the Impacts of Climate Change*. |
| Executive Order 13792, *Review of Designations Under the Antiquities Act* | On April 26, 2017, Executive Order 13792 was issued; it directed the Secretary of the Interior to review designations of national monuments made since 1996. |
| Executive Order 13834, *Efficient Federal Operations* | The Proposed Action is consistent with the federal government's order to prioritize actions that reduce waste, cut costs, enhance the resilience of Federal infrastructure and operations, and enable more effective accomplishment of an agency's mission. This Executive Order revokes Executive Order 13693, *Planning for Federal Sustainability in the Next Decade*. |
| Executive Order 13840, *Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States* | The Proposed Action is consistent with the comprehensive national policy for the *Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States* (which revoked and replaced Executive Order 13547, *Stewardship of the Ocean, Our Coasts, and the Great Lakes*). |
| **International Standards** | |
| International Convention for the Prevention of Pollution from Ships | Status remains unchanged since the 2015 MITT Final EIS/OEIS. |

Notes: CFR = Code of Federal Regulations, EIS = Environmental Impact Statement, ESA = Endangered Species Act, MBTA = Migratory Bird Treaty Act, MIRC = Mariana Islands Range Complex, MITT = Mariana Islands Training and Testing, MMPA = Marine Mammal Protection Act, OEIS = Overseas Environmental Impact Statement, SEIS = Supplemental Environmental Impact Statement, U.S. = United States

### 6.1.1 Coastal Zone Management Act Compliance

The 2015 MITT Final EIS/OEIS describes the *Coastal Zone Management Act of 1972* (16 United States Code section 1451, et seq.). This description, and the definitions from the 2015 MITT Final EIS/OEIS, have not changed. See Section 4.3.5.3 (Development of Coastal Lands) in the 2015 MITT Final EIS/OEIS for additional information regarding management of the coastal zones within the MITT Study Area.

As described in the 2015 MITT Final EIS/OEIS, a Consistency Determination (CD) or a Negative Determination may be submitted for review of federal agency activities.

#### 6.1.1.1 Guam Coastal Management Program

The Guam Coastal Management Program has not changed from its description in the 2015 MITT Final EIS/OEIS. The Navy will comply with Guam's Coastal Management Program to the maximum extent practicable. The Navy will submit a CD or Negative Determination to the Bureau of Statistics and Plans addressing the proposed training and testing activities that may affect Guam's coastal zone.

#### 6.1.1.2 Commonwealth of the Northern Mariana Islands Coastal Zone Management Program

The Commonwealth of the Northern Mariana Islands (CNMI) Coastal Zone Management Act has not changed from its description in the 2015 MITT Final EIS/OEIS. The Navy will comply with CNMI's Coastal Management Program to the maximum extent practicable. The Navy will submit a CD or Negative Determination to the CNMI Division of Coastal Resources Management addressing the proposed training and testing activities that may affect the CNMI coastal zone.

### 6.1.2 Marine Protected Areas

The National System of Marine Protected Areas includes marine protected areas managed under six systems: (1) the National Marine Sanctuary System, (2) Marine National Monuments, (3) the National Wildlife Refuge System, (4) State and Local Marine Protected Areas, (5) the National Parks System, and (6) the National Estuarine Research Reserve System. The 2015 MITT Final EIS/OEIS discussed Marine Protected Areas that overlapped with the Study Area (U.S. Department of the Navy, 2015). There are no National Marine Sanctuary System or National Estuarine Research Reserve System areas in the Study Area. The Mariana Trench Marine National Monument (Proclamation No. 8335, 74 *Federal Register* 1557) is located within the Study Area, but was designated in 2009 with specific language 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)."

There are three national wildlife refuge areas within the Study Area: the Guam National Wildlife Refuge, the Mariana Arc of Fire National Wildlife Refuge, and the Mariana Trench National Wildlife Refuge. The Guam National Wildlife Refuge is the only one included in the National System of Marine Protected Areas. There are 12 state or local marine protected areas within the Study Area, none of which are included in the National System of Marine Protected Areas. Finally, the War in the Pacific National Historical Park is within the Study Area, however, it is not included in the National System of Marine Protected Areas. Activities proposed and regulations in these areas have not changed substantially since the 2015 MITT Final EIS/OEIS was published. Further analysis and discussion of Marine Protected Areas can be found in the 2015 MITT Final EIS/OEIS, Chapter 6 (Additional Regulatory Considerations), Table 6.1-2. Executive Order 13792, *Review of Designations Under the Antiquities Act*, authorized a review of certain designated National Monuments under the Antiquities Act by the Secretary of the Interior. No changes have been made currently to the National Monument in the Study Area.

### 6.1.3 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act of 1976 (16 U.S.C. section 1801–1891[d]), as amended by the 1996 Sustainable Fisheries Act (Public Law 104–297), and the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (Public Law 109-479), governs marine fisheries management in U.S. waters in order to promote long-term economic and biological sustainability for fisheries up to 200 nautical miles from shore. Its main objectives are to prevent overfishing, rebuild overfished stocks, increase long-term economic and social benefits, and ensure a safe and sustainable supply of seafood (National Oceanic and Atmospheric Administration Fisheries, 2017). The Sustainable Fisheries Act of 1996 amended the law to establish procedures that identify, conserve, and enhance Essential Fish Habitat (EFH) for species regulated under a federal fisheries management plan. Consultation with the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) on all actions or proposed actions that may adversely affect EFH is required for federal agencies under section 305(b)(2) of the Magnuson-Stevens Act.

The Magnuson-Stevens Fishery Conservation and Management Act defines an adverse effect as,

> "any impact that reduces quality and/or quantity of Essential Fish Habitat. Adverse effects may include direct or indirect physical, chemical or biological alterations of the waters or substrate and the loss of, or injury to, benthic organisms, prey species and their habitat and other ecosystem components, if such modifications reduce the quality and/or quantity of Essential Fish Habitat. Adverse effects to Essential Fish Habitat may result from actions occurring within Essential Fish Habitat or outside of Essential Fish Habitat and maybe include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions" (50 Code of Federal Regulations 600.810).

The regional Fisheries Management Councils may also designate areas called Habitat Areas of Particular Concern (HAPC). Designated HAPCs are discrete subsets of EFH that provide extremely important ecological functions or are especially vulnerable to degradation.

The Navy completed a previous EFH consultation with NMFS for the MITT Study Area in 2014. From the 2014 consultation, it was determined that certain proposed activities would affect some elements of EFH. NMFS provided conservation recommendations and the Navy agreed to certain measures to avoid, minimize, mitigate, or offset effects. EFH and HAPC designations in the Study Area have not changed and the previous 2014 consultation is still valid for the proposed training and testing activities that have not changed. The Navy is currently conducting a supplemental EFH consultation with the NMFS Pacific Island Regional Office considering activities that are new or that have changed since the 2014 EFH consultation and that have the potential to adversely affect EFH and managed species.

## 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 SEIS/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. This analysis has not changed since the analysis conducted in the 2015 MITT Final EIS/OEIS. See Section 6.2 (Relationship Between Short-Term Use of The Environment and Maintenance and

Enhancement of Long-Term Productivity) of the 2015 MITT Final EIS/OEIS for more information (U.S. Department of the Navy, 2015).

## 6.3 Irreversible or Irretrievable Commitment of Resources

NEPA 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 United States Code section 4332). This analysis has not changed since it was conducted in the 2015 MITT Final EIS/OEIS. See Section 6.3 (Irreversible or Irretrievable Commitment of Resources) of the 2015 MITT Final EIS/OEIS for more information (U.S. Department of the Navy, 2015).

## 6.4 Energy Requirements and Conservation Potential of Alternatives

Under the operational strategy report in 2011, the Department of Defense (DoD) published an implementation plan to integrate operational energy considerations and transformation into existing programs, processes, and institutions (U.S. Department of Defense, 2012). The Navy consumes approximately 26 percent of the total DoD usage of petroleum between all branches (U.S. Department of Defense, 2016a). In Fiscal Year 2015, the Navy reduced its petroleum consumption by 25.1 percent compared to the Fiscal Year 2005 baseline (U.S. Department of Defense, 2016b). In 2016, the DoD published a new Operational Energy Strategy (U.S. Department of Defense, 2016a) to update the 2011 strategy and transform the way energy is consumed in military operations. The 2011 strategy set the overall direction for operational energy security (U.S. Department of Defense, 2011). The 2016 strategy shifts focus towards three objectives: (1) increasing future warfighting capability by including energy throughout future force development, (2) identifying and reducing logistic and operational risks from operational energy vulnerabilities, and (3) enhancing the force's mission effectiveness through updated equipment and improvements in training, exercises, and operations (U.S. Department of Defense, 2016a). These documents guide the DoD in how to better use energy resources and transform the way we power current and future forces.

Training and testing activities within the Study Area would increase energy demand over the No Action Alternative. The energy demand would arise from fuel (e.g., gasoline, diesel) 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 outlined in the air quality emissions calculation spreadsheets available on the project website. Calculations from the air quality analysis in this SEIS/OEIS found that aircraft fuel consumption is estimated to decrease by approximately 5 percent per year under both Alternative 1 and Alternative 2, when compared to current annual rates of aircraft fuel consumption. Vessel fuel consumption is estimated to increase by approximately 8 percent per year under both Alternative 1 and Alternative 2, when compared to current annual rates of vessel fuel consumption. Conservative assumptions were made in developing the estimates, and therefore the actual amount of fuel consumed during training and testing events may be less than estimated. The alternatives could result in a net cumulative reduction in the global energy (fuel) supply.

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's energy vision given in the Operational Energy Strategy report (U.S. Department of Defense, 2016a) is consistent with energy conservation practices and states that the Navy values energy as a strategic resource, understands how energy security is fundamental to executing our mission afloat and ashore and is resilient to any potential energy future.

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. 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 which are improvements to existing shipboard technologies that will both help with Fleet readiness and decrease the ships' energy consumption and greenhouse gas emissions.

# REFERENCES

National Oceanic and Atmospheric Administration Fisheries. (2017). *Magnuson-Stevens Fishery Conservation and Management Act*. Retrieved from https://www.fisheries.noaa.gov/resource/document/magnuson-stevens-fishery-conservation-and-management-act.

U.S. Department of Defense. (2011). *Energy for the Warfighter: Operational Energy Strategy*. Washington, DC: Assistant Secretary of Defense for Operational Energy Plans & Programs.

U.S. Department of Defense. (2012). *Operational Energy Strategy: Implementation Plan*. Washington, DC: Assistant Secretary of Defense for Operational Energy Plans & Programs.

U.S. Department of Defense. (2016a). *2016 Operational Energy Strategy*. Washington, DC: U.S. Department of Defense.

U.S. Department of Defense. (2016b). *Department of Defense Annual Energy Management Report Fiscal Year 2015*. Washington, DC: Office of the Assistant Secretary of Defense (Energy, Installations, and Environment).

U.S. Department of the Navy. (2015). *Final Mariana Islands Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement*. Pearl Harbor, HI: Naval Facilities Engineering Command, Pacific.

# 7 List of Preparers

# Supplemental Environmental Impact Statement/

# Overseas Environmental Impact Statement

# Mariana Islands Training and Testing

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There are no figures in this chapter.

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# 8 Public Involvement and Distribution

# Supplemental Environmental Impact Statement/

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# 8 Public Involvement and Distribution

This chapter describes the efforts to involve the public in preparing the Supplemental Environmental Impact Statement (SEIS)/Overseas Environmental Impact Statement (OEIS) for Mariana Islands Training and Testing (MITT).

## 8.1 Project Website

A public website was established for this project: https://www.mitt-eis.com. The website address was included in the *Notice of Intent to Prepare a Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement* (Figure 8-1). It was also included in newspaper advertisements, agency letters, and postcards for the Notice of Intent. The scoping fact sheet booklet, public notifications, maps, technical reports, informational videos, and various other materials are available on the project website and will be made available throughout the course of the project.

## 8.2 Scoping Period

The public scoping period began with issuance of the Notice of Intent in the *Federal Register* on July 28, 2017, originally announcing the scoping period to end September 11, 2017, but was delayed slightly by the publication authority. However, the *Federal Register* notice was published on August 1, 2017, with a September 15, 2017, scoping period end date. Comments on the scope of the analysis were provided by mail and through the SEIS/OEIS website at: https://www.mitt-eis.com.

### 8.2.1 Public Scoping Notification

The Navy made significant efforts to notify the public to ensure maximum public participation during the scoping process. A summary of these efforts follows.

#### 8.2.1.1 Notification Letters

Notification letters were mailed on July 27, 2017, to 291 federal and local elected officials and government agencies. Entities that received the scoping notification letter can be found in Table 8-1, and an example of the letter can be found in Figure 8-2.

**Federal Register** / Vol. 82, No. 146 / Tuesday, August 1, 2017 / Notices **35767**

SIDCO/SUBPART C DCO REGULATIONS—RECORDKEEPING COLLECTION—Continued

| | Estimated number of recordkeepers per year | Records to be kept annually by each | Total annual responses | Estimated average number of hours per record | Estimated total number of hours of annual burden in fiscal year |
|---|---|---|---|---|---|
| Liquidity Resource Due Diligence and Testing | 7 | 4 | 28 | 10 | 280 |
| Financial and Liquidity Resources, Excluding Due Diligence | 7 | 4 | 28 | 10 | 280 |
| Generally | 7 | 28 | 196 | 10 | 1960 |
| Totals | ............ | 118 | 662 | 31 | 4570 |

[FR Doc. 2017–16019 Filed 7–31–17; 8:45 am]

BILLING CODE 6351–01–P

**DEPARTMENT OF DEFENSE**

**Department of the Navy**

**Meeting of the Board of Visitors of Marine Corps University**

**AGENCY:** Department of the Navy, DOD.

**ACTION:** Notice of open meeting.

**SUMMARY:** The Board of Visitors of the Marine Corps University (BOV MCU) will meet to review, develop and provide recommendations on all aspects of the academic and administrative policies of the University; examine all aspects of professional military education operations; and provide such oversight and advice, as is necessary, to facilitate high educational standards and cost effective operations. The Board will be focusing primarily on the internal procedures of Marine Corps University. All sessions of the meeting will be open to the public.

**DATES:** The meeting will be held on Thursday, September 14, 2017, from 9:00 a.m. to 4:30 p.m. and Friday, September 15, 2017, from 8:00 a.m. to 2:30 p.m. Eastern Time Zone.

**ADDRESSES:** The meeting will be held at Marine Corps University in Quantico, Virginia. The address is: 2076 South St., Quantico, VA.

**FOR FURTHER INFORMATION CONTACT:** Dr. Kim Florich, Director of Faculty Development and Outreach, Marine Corps University Board of Visitors, 2076 South Street, Quantico, Virginia 22134, telephone number 703–432–4682.

Dated: July 24, 2017.

A.M. Nichols,

*Lieutenant Commander, Judge Advocate General's Corps, U.S. Navy, Federal Register Liaison Officer.*

[FR Doc. 2017–16150 Filed 7–31–17; 8:45 am]

BILLING CODE 3810–FF–P

**DEPARTMENT OF DEFENSE**

**Department of the Navy**

**Notice of Intent To Prepare a Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement for Mariana Islands Training and Testing**

**AGENCY:** Department of the Navy, DOD.

**ACTION:** Notice.

**SUMMARY:** Pursuant to the National Environmental Policy Act (NEPA) of 1969 and regulations implemented by the Council on Environmental Quality, the Department of the Navy (DoN) announces its intent to prepare a supplement to the 2015 Final Mariana Islands Training and Testing (MITT) Environmental Impact Statement/ Overseas Environmental Impact Statement (EIS/OEIS).

**DATES:** Public scoping meetings will not be held, but public comments will be accepted during the scoping period from August 1, 2017 to September 15, 2017.

**ADDRESSES:** The DoN invites scoping comments on the MITT Supplemental EIS/OEIS from all interested parties. Substantive comments may be provided by mail to the address below and through the project Web site at *http://mitt-eis.com/*. Comments must be postmarked or received by September 15, 2017, for consideration during the development of the Draft Supplemental EIS/OEIS.

**FOR FURTHER INFORMATION CONTACT:** Naval Facilities Engineering Command Pacific, Attention: MITT Supplemental EIS/OEIS Project Manager, 258 Makalapa Drive, Suite 100, Pearl Harbor, HI 96860–3134.

**SUPPLEMENTARY INFORMATION:** The Navy will assess the potential environmental impacts associated with ongoing and proposed military readiness activities conducted within the MITT EIS/OEIS Study Area (hereafter known as the "Study Area"). The Supplement to the 2015 Final EIS/OEIS is being prepared to support ongoing and future activities conducted at sea and on Farallon de Medinilla (FDM) within the Study Area beyond 2020. Military readiness activities include training and research, development, testing, and evaluation (hereafter known as "testing"). The Supplemental EIS/OEIS will include an analysis of training and testing activities using new information available after the release of the 2015 Final MITT EIS/OEIS. New information includes an updated acoustic effects model, updated marine mammal density data, and other best available science. Proposed activities are generally consistent with those analyzed in the 2015 Final MITT EIS/OEIS and are representative of training and testing activities the DoN has been conducting in the Study Area for decades.

The Study Area remains unchanged since the 2015 Final MITT EIS/OEIS. The Study Area includes the existing Mariana Islands Range Complex (MIRC); areas on the high seas to the north and west of the MIRC; a transit corridor between the MIRC and the Hawaii Range Complex, starting at the International Date Line; and Apra Harbor and select DoN pierside and harbor locations. The Study Area includes only the in-water components of the range complex and FDM; land components associated with the range complex are not included in the Study Area.

As part of this process the DoN will seek the issuance of regulatory permits and authorizations under the Marine Mammal Protection Act and Endangered Species Act to support training and testing requirements within the Study Area, beyond 2020, thereby ensuring critical Department of Defense requirements are met.

Pursuant to 40 CFR 1501.6, the DoN will invite the National Marine Fisheries Service to be a cooperating agency in preparation of the Supplemental EIS/OEIS.

**Figure 8-1: Notice of Intent**

35768 Federal Register / Vol. 82, No. 146 / Tuesday, August 1, 2017 / Notices

The DoN's lead action proponent is Commander, U.S. Pacific Fleet. Additional action proponents include Naval Sea Systems Command, Naval Air Systems Command, and the Office of Naval Research.

The DoN's Proposed Action is to conduct military training and testing activities within the Study Area. Activities include the use of active sonar and explosives while employing appropriate marine species protective mitigation measures. The Proposed Action does not alter the DoN's original purpose and need as presented in the 2015 MITT Final EIS/OEIS.

The purpose of the Proposed Action is to maintain a ready force, which is needed to ensure the military can accomplish its mission to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas, consistent with Congressional direction in section 5062 of Title 10 of the U.S. Code. A Supplemental EIS/OEIS is considered the appropriate document, as there is recent scientific information including revised acoustic criteria to consider, in furtherance of NEPA, relevant to the environmental effects of the DoN's Proposed Action, and the analysis will support Marine Mammal Protection Act authorization requests.

Proposed training and testing activities are generally consistent to those analyzed in the 2015 MITT Final EIS/OEIS. The Supplemental EIS/OEIS will propose changes to the tempo and types of training and testing activities, accounting for the introduction of new technologies, the evolving nature of international events, advances in war fighting doctrine and procedures, and changes in the organization of vessels, aircraft, weapon systems, and military personnel. The MITT Supplemental EIS/OEIS will reflect the compilation of training and testing activities required to fulfill the DoN's military readiness requirements beyond 2020, and therefore includes the analysis of newly proposed activities and changes to previously analyzed activities.

In the Supplemental EIS/OEIS, the DoN will evaluate the potential environmental impacts of a No Action Alternative and action alternatives. Resources to be evaluated include, but are not limited to, marine mammals, sea turtles, essential fish habitat, and threatened and endangered species.

The scoping process is used to identify public concerns and local issues to be considered during the development of the Draft Supplemental EIS/OEIS. Federal agencies, local agencies, the public, and interested persons are encouraged to provide substantive comments to the DoN on environmental resources and issue areas of concern the commenter believes the DoN should consider.

Comments must be postmarked or received online by September 15, 2017, for consideration during the development of the Draft Supplemental EIS/OEIS. Comments can be mailed to: Naval Facilities Engineering Command Pacific, Attention: MITT Supplemental EIS/OEIS Project Manager, 258 Makalapa Drive, Suite 100, Pearl Harbor, HI, 96869–3134. Comments can be submitted online via the project Web site at *http://mitt-eis.com/*.

Dated: July 20, 2017.

**A.M. Nichols,**

*Lieutenant Commander, Judge Advocate General's Corps, U.S. Navy, Federal Register Liaison Officer.*

[FR Doc. 2017–15939 Filed 7–31–17; 8:45 am]

**BILLING CODE 3810–FF–P**

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## DEPARTMENT OF EDUCATION

### Final Waiver and Extension of the Project Period for the Native American Career and Technical Education Program

[Catalog of Federal Domestic Assistance (CFDA) Number: 84.101A]

**AGENCY:** Office of Career, Technical, and Adult Education, Department of Education.

**ACTION:** Final waiver and extension of the project period.

**SUMMARY:** For the 24-month projects originally funded in fiscal year (FY) 2013 and extended for an additional 24-months in FY 2015 under the Native American Career and Technical Education Program (NACTEP), the Secretary: Waives the requirements in Education Department regulations that generally prohibit project extensions involving the obligation of additional Federal funds; and extends the project period for the current 30 NACTEP grantees for an additional 12 months under the existing program authority. This waiver and extension will allow the 30 current NACTEP grantees to seek FY 2017 continuation awards for the project period through FY 2018.

**DATES:** As of August 1, 2017, the waiver and extension of the project period are finalized.

**FOR FURTHER INFORMATION CONTACT:** Gwen Washington by telephone at (202) 245–7790 or by email at *gwen.washington@ed.gov*. You may also contact Linda Mayo by telephone at (202) 245–7792 or by email at *linda.mayo@ed.gov*. If you use a telecommunications device for the deaf (TDD) or a text telephone (TTY), call the Federal Relay Service, toll free, at 1–800–877–8339.

**SUPPLEMENTARY INFORMATION:** On April 26, 2017, we published a notice in the **Federal Register** (82 FR 19240) proposing to waive the requirements of 34 CFR 75.261(a) and (c)(2) that generally prohibit project period extensions involving the obligation of additional Federal funds. In that notice, the Secretary also proposed to extend the NACTEP project period for up to an additional 12 months. The proposed waiver and extension of project period would enable the Secretary to provide continuation awards to the current NACTEP grantees through FY 2018 under the existing program authority.

That notice contained background information and our reasons for proposing the waiver and extension of the project period. This notice makes the waiver and extension of the project period final. Any activities carried out during the period of a NACTEP continuation award must be consistent with, or a logical extension of, the scope, goals, and objectives of the grantee's application as approved in the FY 2013 NACTEP competition. The requirements applicable to continuation awards for this competition set forth in the 2013 notice inviting applications and the requirements in 34 CFR 75.253 will apply to any continuation awards sought by the current NACTEP grantees.

We will make decisions regarding the continuation awards based on grantee program narratives, budgets and budget narratives, program performance reports, and the requirements in 34 CFR 75.253. We will not announce a new competition or make new awards in FY 2017.

The final waiver and project period extension will not exempt the current NACTEP grantees from the appropriation account closing provisions of 31 U.S.C. 1552(a), nor will it extend the availability of funds previously awarded to current NACTEP grantees. As a result of 31 U.S.C. 1552(a), appropriations available for a limited period may be used for payment of valid obligations for only five years after the expiration of their period of availability for Federal obligation. After that time, the unexpended balance of those funds is canceled and returned to the U.S. Department of the Treasury and is unavailable for restoration for any purpose (31 U.S.C. 1552(b)).

*Public Comment:* In response to our invitation in the proposed waiver and extension, we received 85 comments.

**Figure 8-1: Notice of Intent (continued)**

### Table 8-1: Federal and Local Entities that Received the Scoping Notification Letter

| ***Guam*** |
|---|
| ***Federal Elected Officials and Federal Agencies*** |
| U.S. Congress<br>National Oceanic and Atmospheric Administration<br>    National Ocean Service<br>    National Marine Fisheries Service, Habitat Division, Guam Office<br>U.S. Army Corps of Engineers<br>U.S. Fish & Wildlife Service<br>    Guam National Wildlife Refuge<br>U.S. Department of Agriculture<br>    Natural Resource Conservation Service, West Area Office<br>    Animal and Plant Health Inspection Service, Wildlife Services<br>National Park Service<br>    War in the Pacific National Historic Park<br>Western Pacific Regional Fishery Management Council<br>    Guam Education & Outreach<br>Department of Transportation/Federal Aviation Administration |
| ***Local Elected Officials and Local Agencies*** |
| Office of the Governor<br>Office of the Senator<br>34th Guam Legislature<br>Mayors' Council of Guam<br>Office of the Mayor<br>    Village of Agana Heights<br>    Village of Agat<br>    Village of Asan-Maina<br>    Village of Barrigada<br>    Village of Chalan Pago-Ordot<br>    Village of Dededo<br>    Village of Hagåtña<br>    Village of Inarajan<br>    Village of Mangilao<br>    Village of Merizo<br>    Village of Mongmong-Toto-Maite<br>    Village of Piti<br>    Village of Santa Rita<br>    Village of Sinajana<br>    Village of Talofofo<br>    Village of Tamuning-Tumon-Harmon<br>    Village of Umatac<br>    Village of Yigo<br>    Village of Yona<br>A.B. Won Pat International Airport<br>Consolidated Utility Services<br>Department of Labor<br>Guam Ancestral Lands Commission<br>Guam Army National Guard<br>Guam Bureau of Statistics and Plans<br>    Coastal Management Program<br>Guam Chamorro Land Trust Commission |

| |
|---|
| Guam Consolidated Commission on Utilities |
| Guam Department of Agriculture |
| Division of Aquatic and Wildlife Resources |
| Guam Department of Education |
| Guam Department of Land Management |
| Guam Department of Parks and Recreation |
| Historic Preservation Office |
| Guam Department of Public Works |
| Guam Economic Development and Commerce Authority |
| Guam Environmental Protection Agency |
| Water Resources Management Program |
| Guam Homeland Security |
| Office of Civil Defense |
| Guam Land Use Commission |
| Guam Visitors Bureau |
| Guam Waterworks Authority |
| Northern Guam Pacific Islands Area Soil and Water Conservation Districts |
| Port Authority of Guam |
| U.S. Marshals Service, District of Guam |
| University of Guam |
| Water and Environmental Research Institute |
| Marine Laboratory |
| Cooperative Extension Service |
| ***Saipan*** |
| ***Federal Elected Officials and Federal Agencies*** |
| U.S. Congress |
| National Oceanic and Atmospheric Administration |
| National Marine Fisheries Service |
| Commonwealth of the Northern Mariana Islands (CNMI) Field Office |
| U.S. Department of the Interior |
| Office of Insular Affairs |
| U.S. Department of Agriculture |
| Natural Resources Conservation Service |
| Saipan Service Center |
| Tinian & Aguiguan Service Center |
| Western Pacific Regional Fishery Management Council |
| ***Local Elected Officials and Local Agencies*** |
| Office of the Governor |
| CNMI Senate |
| CNMI House of Representatives |
| CNMI Office of the Mayor |
| CNMI Public Information and Protocol Office |
| CNMI Bureau of Environmental and Coastal Quality |
| Division of Environmental Quality |
| Division of Coastal Resources Management |
| Marine Monitoring |
| CNMI Coastal Resources Management Program |
| CNMI Department of Commerce |
| Military Integration Management Committee |
| CNMI Department of Community and Cultural Affairs |
| Historic Preservation Office |
| CNMI Department of Land and Natural Resources |

| |
|---|
| Division of Fish and Wildlife<br>Division of Agriculture<br>Division of Parks and Recreation<br>Soil and Water Conservation District<br>CNMI Department of Public Lands<br>CNMI Department of Public Safety<br>Office of the Commissioner<br>Tinian Fire Division<br>CNMI Military and Veteran Affairs<br>CNMI Northern Marianas College Cooperative, Research, Extension and Education Service<br>CNMI Office of Veteran Affairs<br>CNMI Zoning Office<br>Commonwealth Ports Authority<br>Marianas Visitors Authority<br>Saipan International Airport<br>Port of Saipan |
| ***Tinian*** |
| ***Federal Elected Officials*** |
| U.S. Congress |
| ***Local Elected Officials and Local Agencies*** |
| Office of the Mayor<br>Municipality of Tinian and Aguiguan<br>CNMI Department of Public Lands<br>CNMI Department of Commerce<br>CNMI Department of Land and Natural Resources |
| ***Rota*** |
| ***Federal Elected Officials*** |
| U.S. Congress |
| ***Local Elected Officials and Local Agencies*** |
| Office of the Mayor<br>15th Rota Municipal Council<br>CNMI Department of Lands and Natural Resources<br>Commonwealth Ports Authority<br>Department of Lands and Natural Resources<br>Division of Fish and Wildlife<br>Department of Public Lands, Rota Office<br>Rota Gaming Commission<br>Rota Health Center<br>Rota Municipal Treasury |
| ***Federal Agencies outside of Guam, Saipan, Tinian, and Rota*** |
| Advisory Council on Historic Preservation<br>U.S. Department of State<br>Bureau of Oceans and International Environmental and Scientific Affairs<br>U.S. Environmental Protection Agency<br>Region IX<br>Pacific Islands Contact Office, Honolulu<br>Communities and Ecosystems Division<br>Enforcement Division<br>Office of Federal Activities<br>National Environmental Policy Act Compliance Division<br>Council on Environmental Quality<br>Department of the Interior |

- Environmental Policy & Compliance
- Office of Insular Affairs

Federal Aviation Administration
- Air Traffic Division, Western Pacific Region (AWP-532)
- Military Program
- Western Pacific Region
- Bureau of Certification and Licensing

Federal Maritime Commission
- Office of the Secretary

Marianas Trench Marine National Monument

Marine Mammal Commission

U.S. Department of Transportation
- Maritime Administration

National Oceanic and Atmospheric Administration
- Office of Law Enforcement, Honolulu District
- National Marine Fisheries Service
    - Headquarters
    - Habitat Division
    - Protected Resources Division
    - Office for Coastal Management
    - Office of Protected Resources
    - Pacific Islands Fisheries Science Center
    - Pacific Islands Regional Office

U.S. Coast Guard Headquarters
- Office of Environmental Management (CG-47)

U.S. Department of the Interior
- Office of Environmental Policy and Compliance
- Office of Insular Affairs

U.S. Fish and Wildlife Service
- Pacific Islands Office
- Pacific Region

U.S. Geological Survey
- Pacific Coastal and Marine Science Center
- Pacific Islands Water Science Center

U.S. Department of Agriculture Forest Service
- Pacific Southwest Region 5
- Pacific Southwest Research Station
    - Institute of Pacific Islands Forestry

U.S. Department of Agriculture
- Animal and Plant Health Inspection Service
    - Wildlife Services
- Natural Resources Conservation Service
    - Office of the Chief

Western Pacific Regional Fishery Management Council

**DEPARTMENT OF THE NAVY**
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N465/0822
July 19, 2017

Name
Organization
Address 1
Address 2

Dear Name:

SUBJECT: NOTICE OF INTENT TO PREPARE A SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT FOR MARIANA ISLANDS TRAINING AND TESTING

This letter is to inform you that the Department of the Navy (Navy) is preparing a supplement to the 2015 Final Mariana Islands Training and Testing (MITT) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) to assess the potential environmental impacts associated with ongoing military readiness activities conducted within the MITT EIS/OEIS Study Area (hereafter referred to as the "Study Area"). Military readiness activities include training and research, development, testing, and evaluation (hereafter referred to as "training and testing"). The Navy is requesting your comments on the scope of the analysis, including potential environmental issues or viable alternatives to be considered during the development of the Draft Supplemental EIS/OEIS.

The Navy previously completed an EIS/OEIS in May 2015 for training and testing activities occurring within the Study Area. The supplement to the 2015 Final EIS/OEIS is being prepared to support ongoing and future activities conducted at-sea and on Farallon de Medinilla (FDM) within the Study Area beyond 2020. Proposed activities are generally consistent with those analyzed in the 2015 Final EIS/OEIS and are representative of activities the military has conducted in the Study Area for decades.

The supplement to the 2015 Final EIS/OEIS will include an analysis of training and testing activities using new information available after the release of the 2015 Final EIS/OEIS. New information includes an updated acoustic effects model, updated marine mammal density data, and evolving and emergent best available science. As part of this process, the Navy will seek the issuance of federal regulatory permits and authorizations under the Marine Mammal Protection Act and the Endangered Species Act.

The Study Area remains unchanged since the 2015 Final EIS/OEIS (Enclosure 1). The Study Area includes the existing Mariana Islands Range Complex (MIRC); areas on the high seas to the north and west of the MIRC; a transit corridor between the MIRC and the Hawaii

**Figure 8-2: Stakeholder Scoping Notification Letter**

5090
Ser N465/0822
July 19, 2017

Range Complex, starting at the International Date Line; and Apra Harbor and select Navy pierside and harbor locations. The supplement to the 2015 Final EIS/OEIS will only analyze those training and testing activities conducted at sea and on FDM within the Study Area. Other activities and land components associated with the MIRC will not be included in the supplement.

The Proposed Action is to conduct at-sea training and testing activities within the Study Area. Activities include the use of active sonar and explosives while employing marine species protective mitigation measures. The purpose of the Proposed Action is to maintain a ready force, which is needed to ensure the military can accomplish its mission to maintain, train, and equip combat-ready forces, consistent with Congressional direction in Section 5062 of Title 10 of the U.S. Code.

To achieve and maintain military readiness, the Navy proposes to:

- Conduct at-sea training and testing activities at levels required to support military readiness requirements beyond 2020; and
- Accommodate evolving mission requirements, including those resulting from the development, testing, and introduction of new vessels, aircraft, and weapons systems into the fleet.

Public comments will be accepted during the 45-day scoping period beginning July 28, 2017 through September 11, 2017. Comments must be postmarked or received online by **September 11, 2017,** Chamorro Standard Time (ChST), for consideration in the Draft Supplemental EIS/OEIS. Comments may be submitted online at **www.MITT-EIS.com**, or by mail to:

Naval Facilities Engineering Command Pacific
Attention: MITT Supplemental EIS/OEIS Project Manager
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

If you would like additional information or to receive a project briefing, please contact Mr. John Van Name at 808-471-1714 or john.vanname@navy.mil.

Please help the Navy inform the community about the Draft Supplemental EIS/OEIS for at-sea training and testing by sharing this information with your staff and interested individuals.

Sincerely,

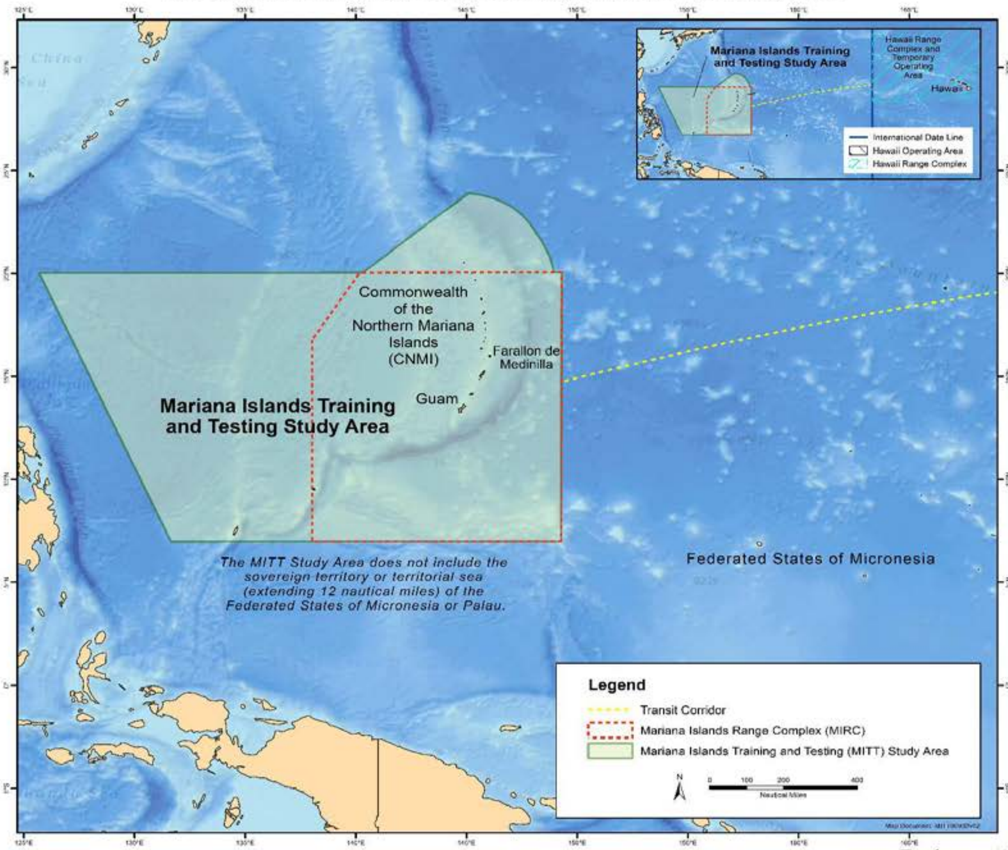
FOR L. M. FOSTER
By direction

Enclosure: 1. Mariana Islands Training and Testing Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement Study Area

2

**Figure 8-2: Stakeholder Scoping Notification Letter (continued)**

Enclosure: 1. Mariana Islands Training and Testing Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement Study Area




Enclosure (1)

**Figure 8-2: Stakeholder Scoping Notification Letter (continued)**

#### 8.2.1.2 Postcard Mailers

A postcard was mailed first-class to 341 individuals, community groups, and nongovernmental organizations on July 27, 2017. The postcard provided information about the Proposed Action, the website address, and how to submit public comments. An example of the postcard is shown in Figure 8-3.

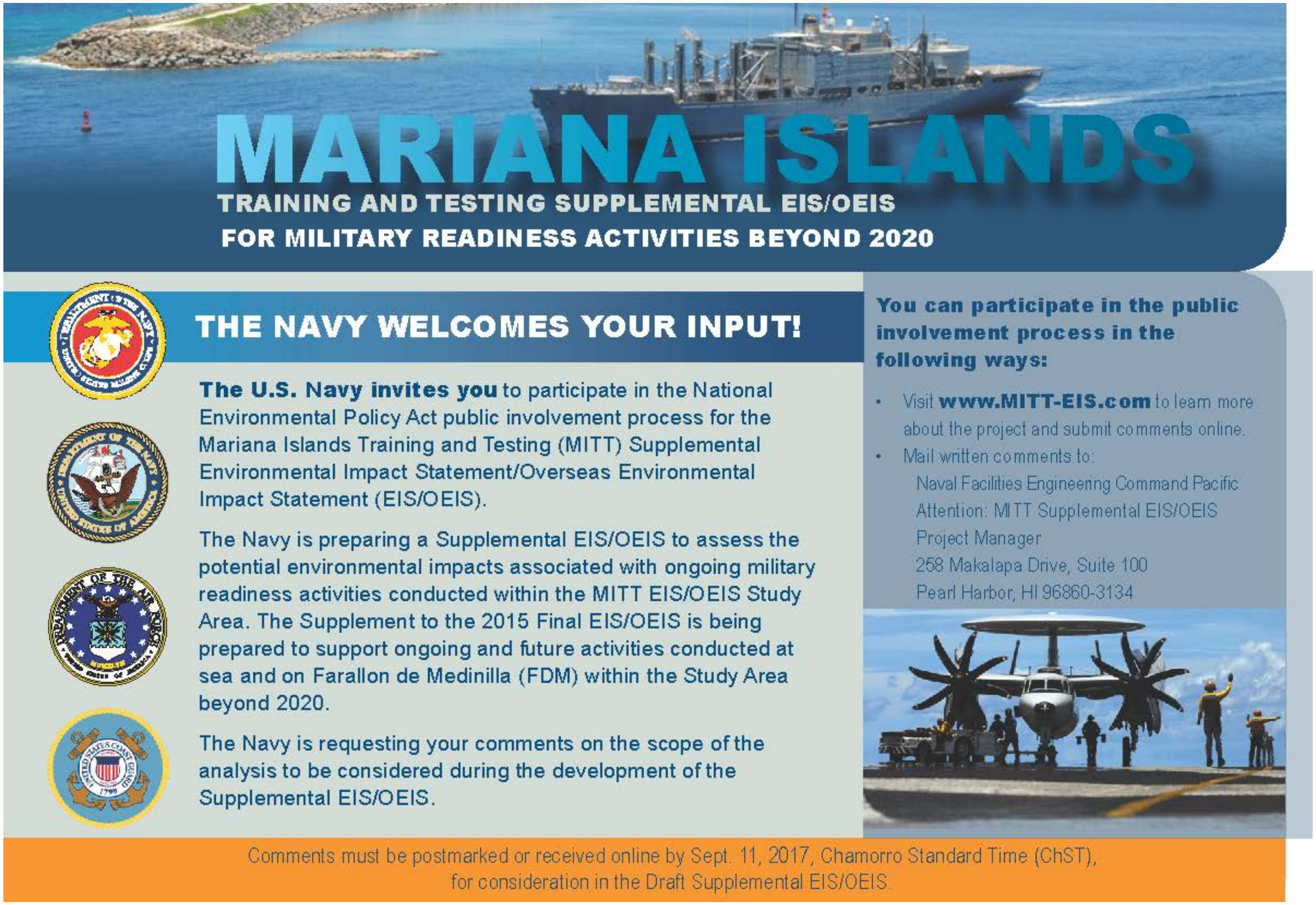



**Figure 8-3: Postcard Mailer for Scoping (Front)**

**Proposed Action:**

The Proposed Action is to conduct at-sea training and testing activities within the Study Area. Activities include the use of active sonar and explosives while employing marine species protective mitigation measures. Proposed training and testing activities are generally consistent with those analyzed in the 2015 Final EIS/OEIS and are representative of activities the military has conducted in the Study Area for decades.

Naval Facilities Engineering
Command Pacific
Attention: MITT Supplemental
EIS/OEIS Project Manager
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

**For more information or to submit comments online, visit www.MITT-EIS.com.**

**Figure 8-3: Postcard Mailer for Scoping (Back)**

#### 8.2.1.3 Newspaper Advertisements

Display advertisements were placed in local newspapers to advertise the public's opportunity to comment on the scope of the analysis. The advertisements included a description of the Proposed Action, the address of the project website, the duration of the comment period, and information on how to provide comments. The newspapers and publication dates are indicated in Table 8-2. An example of the advertisement is shown in Figure 8-4.

**Table 8-2: Newspaper Publications**

| Newspaper | Newspaper Coverage | Publication Dates |
|---|---|---|
| Pacific Daily News | Hagåtña, Guam; and neighboring islands | Friday, July 28, 2017<br>Saturday, July 29, 2017<br>Sunday, July 30, 2017 |
| Marianas Variety | Saipan, Tinian, Rota, Federated States of Micronesia | Friday, July 28, 2017<br>Monday, July 31, 2017<br>Tuesday, August 1, 2017 |
| Saipan Tribune | Saipan, Tinian, Rota | Friday, July 28, 2017<br>Monday, July 31, 2017<br>Tuesday, August 1, 2017 |


**Figure 8-4: Newspaper Announcement of Scoping**

#### 8.2.1.4 Press Release

A press release to announce the Notice of Intent and request public input was distributed to local and regional media outlets on July 28, 2017. The press release provided information on the Proposed Action, address of the project website, duration of the comment period, and how to submit comments. The press release from the Commander, Joint Region Marianas is shown in Figure 8-5.

**COMMANDER, JOINT REGION MARIANAS**
**Public Affairs Office**
**Main: (671) 349-4055/3209**
**Fax: (671) 349-1201**
**E-Mail: CJRMPAO@fe.navy.mil**

FOR IMMEDIATE RELEASE
*Press Release 17-063*

## U.S. Navy Seeks Public Input on Training and Testing Supplemental Environmental Impact Analysis

**ASAN, Guam (July 28, 2017)** –The U.S. Navy is preparing a Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) to assess the potential environmental impacts associated with ongoing at-sea military readiness activities conducted within the Mariana Islands Training and Testing (MITT) EIS/OEIS Study Area (hereafter referred to as the "Study Area").

Military readiness activities include training and research, development, testing, and evaluation (hereafter referred to as "training and testing"). The Navy is requesting public comments on the scope of the analysis, including potential environmental issues and viable alternatives to be considered during the development of the Draft Supplemental EIS/OEIS.

The Navy previously completed an EIS/OEIS in May 2015 for at-sea training and testing activities occurring within the Study Area. The supplement to the 2015 Final EIS/OEIS is being prepared to support ongoing and future activities conducted at sea and on Farallon de Medinilla (FDM) within the Study Area beyond 2020. Proposed training and testing activities are generally consistent with those analyzed in the 2015 Final EIS/OEIS and represent activities the military has conducted in the Study Area for decades.

The Supplemental EIS/OEIS will include an analysis of training and testing activities using new information available after the release of the 2015 Final EIS/OEIS. New information includes an updated acoustic effects model, updated marine mammal density data, and evolving and emergent best available science. As part of this process, the Navy will seek the issuance of federal regulatory permits and authorizations under the Marine Mammal Protection Act and the Endangered Species Act.

**Proposed Action:**
The Proposed Action is to conduct at-sea training and testing activities within the Study Area. At-sea training and testing activities include the use of active sonar and explosives while employing marine species protective mitigation measures.

-more-

**Figure 8-5: Commander, Joint Region Marianas Press Release**

The purpose of the Proposed Action is to maintain a ready force, which is needed to ensure the military can accomplish its mission to maintain, train, and equip combat-ready forces, consistent with Congressional direction in Section 5062 of Title 10 of the U.S. Code.

To achieve and maintain military readiness, the Navy proposes to:

- Conduct at-sea training and testing activities at levels required to support military readiness requirements beyond 2020; and
- Accommodate evolving mission requirements, including those resulting from the development, testing, and introduction of new vessels, aircraft, and weapons systems into the fleet.

The Study Area remains unchanged since the 2015 Final EIS/OEIS and includes the existing Mariana Islands Range Complex (MIRC); areas on the high seas to the north and west of the MIRC; a transit corridor between the MIRC and the Hawaii Range Complex, starting at the International Date Line; and Apra Harbor and select Navy pierside and harbor locations. In the supplement to the 2015 Final EIS/OEIS, the Navy will only analyze those training and testing activities conducted at sea and on FDM within the Study Area. Other activities and land components associated with the MIRC are not included in the supplement.

**Scoping Comment Period for the Supplemental EIS/OEIS:**
The 45-day scoping comment period is July 28-Sept. 11. Comments must be postmarked or received online by **Sept. 11, 2017**, Chamorro Standard Time (ChST), for consideration in the development of the Draft Supplemental EIS/OEIS. All comments submitted during the 45-day public comment period will become part of the public record. Comments may be submitted online at: **www.MITT-EIS.com**, or by mail to:

Naval Facilities Engineering Command Pacific
Attention: MITT Supplemental EIS/OEIS Project Manager
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

For additional project information, please visit the project website at **www.MITT-EIS.com.**

**Please help inform your community by sharing the information in this press release.**

-30-

For more information, contact the Joint Region Marianas Public Affairs Office
at (671) 349-4055/3209.

**Figure 8-5: Commander, Joint Region Marianas Press Release (continued)**

### 8.2.2 Public Scoping Comments

Scoping comments were submitted in two ways:

- Written letters (received any time during the public comment period)
- Comments submitted directly on the project website (received any time during the public comment period)

The Navy received a total of 36 written and electronic comments from federal agencies, state agencies, nongovernmental organizations, individuals, and community groups. Thirty website comments were submitted using the electronic comment form on the project website. Six written comments were mailed. A sampling of some of the specific concerns follows.

#### 8.2.2.1 Description of the Proposed Action and Alternatives

Comments stated that the description of the action and proposed activities is vague in the SEIS/OEIS and that it should include an explanation of the differences between the 2015 Record of Decision and the action proposed in this SEIS/OEIS. Comments included a request that a range of alternatives be considered, including time or seasonal restrictions, restrictions in biologically sensitive areas, reduced training and testing tempo, and mitigated alternatives.

#### 8.2.2.2 National Environmental Policy Act and Public Involvement

Comments stated that there is a lack of detail regarding the scope of the Proposed Action presented to the public. It was suggested the website include the updated acoustic effects model, updated marine mammal density data, and the 2015 MITT Final EIS/OEIS. The scoping period was thought to be too short and should be extended.

#### 8.2.2.3 Location of Activities

Comments stated that military training should not be conducted in the CNMI.

#### 8.2.2.4 Indirect and Cumulative Impacts

Comments included requests that all Department of Defense actions in the Mariana Islands be analyzed for cumulative effects. Comments also included requests to analyze indirect and cumulative impacts as they relate to seagrass, coral reefs, invertebrates, sea turtles, fish populations, and loss of habitat, as well as the ocean as an ecosystem. Comments also included recommendations that recreational fishing, commercial fishing, and transport be analyzed from a cumulative perspective. Comments in this category expressed concern about the overall impact of military activity in Guam and the overall MITT Study Area.

#### 8.2.2.5 Sediments and Water Quality Impacts

Comments stated that there was a lack of studies regarding impacts on the waters around Farallon de Medinilla (FDM) and documentation of the loss of land at FDM in regard to erosion. Requests were made to provide a detailed analysis of the residence times of constituents, effects of deposition, bioaccumulation of metals and other pollutants, and concentration of explosives and unexploded ordnance in the ocean environment, due to concerns about military expended materials becoming marine debris.

#### 8.2.2.6 Socioeconomic Resources

Comments stated that military training activities are disturbing economically important fishing areas, restricting access to prime fishing grounds, and resulting in contamination in the local food supply. Issues raised in regard to socioeconomic impacts included increased transit times around restricted areas and associated loss of revenue due to transit times and restricted access to fishing areas.

#### 8.2.2.7 Terrestrial Species and Habitats/Marine Birds

Comments included requests for the reevaluation of booby populations and to address impacts on the great frigate bird, red-tailed tropicbird, white-tailed tropicbird, brown noddy, and black noddy on FDM.

#### 8.2.2.8 Marine Resources

Comments stated concerns regarding direct and cumulative impacts from military expended material and debris on the marine environment. Comments included suggestions to analyze sonar, chemical pollutants, and marine debris associated with training activities on all marine species. Monitoring results should be made available and integrated into the analysis. Impacts should also be analyzed in regard to invasive species and marine biosecurity threats. Impacts on coastal resources should be substantively analyzed under a range of alternatives and specific mitigation. Impacts on Habitat Area of Concern for Coral Reef Ecosystem Management Unit Species and Bottomfish Management Units Species should also be analyzed. Commenters stated that there were a lack of studies documenting the amount of ordnance debris and unexploded ordnance in the water and impacts on and around FDM, including coral reefs.

#### 8.2.2.9 Marine Mammal Impacts/Sea Turtles

Comments in this category included concerns regarding the health and safety effects on marine mammals from training activities. Commenters expressed concern regarding impacts on marine mammals from sonar and explosives as well as impacts on humpback whale calving grounds.

#### 8.2.2.10 Fish/Marine Habitat

Comments stated that training activities are disturbing pelagic and economically important fishing areas and causing fish to leave the Study Area. There were also concerns regarding acoustic disturbance to fish.

#### 8.2.2.11 Cultural Resources

Comments stated the U.S. Navy has not consulted with indigenous people for conducting military training in the Mariana Islands. Direct and cumulative impacts need to be identified due to the loss of access to FDM for cultural use.

#### 8.2.2.12 Public Health and Safety

Comments included concerns regarding overall impacts and risks to public health and safety in regard to unexploded ordnance, water contamination, and proper safety measures.

#### 8.2.2.13 Mitigation Measures

Comments included requests to provide details associated with the actions the Navy will take to avoid harming protected marine mammals and coral reefs as well as the effectiveness of past mitigation measures. Comments stated that the public needs a better understanding of how mitigation measures avoid impacts on marine mammals and the effectiveness of those measures.

#### 8.2.2.14 Other

This category includes comments that were considered to be outside the scope of this analysis or not considered applicable to the analysis. For example, there were comments related to the potential dangers posed by North Korea, direct compensation for loss of fishing grounds or the development of fishery infrastructure, the militarization of the Mariana Islands, lack of specific surveys, and third-party assessments of impacts and surveys.

## 8.3 Notification of Availability of the Draft Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement

The Draft SEIS/OEIS public review and comment period will begin with issuance of the Notice of Availability and Notice of Public Meetings in the *Federal Register*. The *Federal Register* notices will include notification of the availability of the Draft SEIS/OEIS and where it can be accessed; an overview of the Proposed Action and its purpose and need; public commenting information; and the locations, dates, and times of public meetings. The purpose of the public meetings is to inform the public about the Proposed Action and to solicit public comments on the environmental issues addressed and analyzed in the Draft SEIS/OEIS. Comments will be accepted by mail, through the SEIS/OEIS website at https://www.mitt-eis.com, and at the public meetings.

### 8.3.1 Notification of Draft Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement and Public Meetings

The Navy will make significant efforts to facilitate maximum public participation during the Draft SEIS/OEIS public review and comment period. A summary of these efforts follows.

#### 8.3.1.1 Notification Letters

Stakeholder letters will be mailed to interested federal and local government agencies, nongovernmental organizations, and persons expressing an interest in the Proposed Action and the Draft SEIS/OEIS.

#### 8.3.1.2 Postcards

Postcards will be mailed to recipients on the project mailing list, including individuals; nongovernmental organizations; community and business groups; fishing, aviation, and recreation groups; and private companies. The postcards will include the dates, locations, and times of the public meetings, as well as the website address for more information, commenting information, and a brief summary of the Proposed Action.

#### 8.3.1.3 Press Releases

Press releases to announce the availability of the Draft SEIS/OEIS and public meetings will be distributed. Press releases will provide a description of the Proposed Action, project website, duration of the comment period and commenting methods, information repositories, and location, dates, and times of the public meetings. The press releases will also provide information on the availability of the Navy to meet with the media in advance of the meetings.

#### 8.3.1.4 Newspaper Advertisements

To announce the availability of the Draft SEIS/OEIS and public meetings, advertisements will be placed in area newspapers as shown in Table 8-3. The advertisements will include a description of the Proposed Action, the project website, the duration of the comment period, and information on how to provide comments.

**Table 8-3: Newspaper Announcements of Draft Supplemental EIS/OEIS and Public Meetings**

| Newspaper | Area Covered |
|---|---|
| Pacific Daily News | Hagatna, Guam and neighboring islands |
| Marianas Variety | Saipan, Tinian, Rota, FSM |
| Saipan Tribune | Saipan, Tinian, Rota |

### 8.3.2 Public Meetings

The Navy will hold public meetings to inform the public about the Proposed Action and to solicit public comments on the Draft SEIS/OEIS. The public meetings will include informational poster stations staffed by Navy representatives. Members of the public may arrive at any time during the public meetings.

## 8.4 Distribution of the Draft Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement

All of the parties being notified of the availability of the Draft SEIS/OEIS will be directed to access the document electronically on the project website (https://www.mitt-eis.com), or to access hard copies as available at the information repositories discussed in Section 8.4.2 (Information Repositories).

### 8.4.1 Federal Agencies

The U.S. Environmental Protection Agency will receive a hard copy and electronic version of the Draft SEIS/OEIS. Regional offices of the U.S. Environmental Protection Agency will receive electronic versions of the Draft SEIS/OEIS. The National Marine Fisheries Service headquarters office will receive a hard copy and electronic copy of the Draft SEIS/OEIS.

### 8.4.2 Information Repositories

The Draft SEIS/OEIS will be mailed in hard copy form along with an electronic CD/DVD to the information repository locations shown in Table 8-4.

**Table 8-4: Information Repositories**

| Repository Name | Mailing Address | Phone |
|---|---|---|
| Robert F. Kennedy Memorial Library<br>University of Guam | UOG Station,<br>Mangilao, Guam 96923 | (671) 735-2331 |
| Nieves M. Flores Memorial Library | 254 Martyr St.<br>Hagatna, Guam 96910 | (671) 475-4751 |
| Tinian Public Library | P.O. Box 520704, San Jose Village<br>Tinian, MP 96952 | (670) 433-0504/433-0647 |
| Antonio C. Atalig Memorial Library<br>(Rota Public Library) | P.O. Box 537<br>Rota, MP 96951 | (670) 532-0120 |
| Joeten-Kiyu Public Library | P.O. Box 501092<br>Beach Road and Insatto Street<br>Saipan, MP 96950-1092 | (670) 235-7322 |

# Appendix A: Training and Testing Activities Descriptions

# Supplemental Environmental Impact Statement/

# Overseas Environmental Impact Statement

# Mariana Islands Training and Testing

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# List of Tables

There are no tables in this appendix.

# APPENDIX A TRAINING AND TESTING ACTIVITIES DESCRIPTIONS

## A.1 TRAINING ACTIVITIES

The Navy's 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 a primary mission area, but are an essential part of Navy training. In addition, because the Navy conducts a number of activities within larger training exercises, descriptions of those larger exercises are also included here. It is important to note that these larger exercises are comprised entirely of individual activities described in the primary mission areas.

### A.1.1 MAJOR TRAINING EXERCISES

A major training exercise is comprised of several "unit level" range exercises 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 in naval tactical tasks. In a major training exercise, most of the operations and activities being directed and coordinated by the strike group commander are identical in nature to the operations conducted during individual, crew, and smaller-unit training events. In a major training exercise, however, these disparate training tasks are conducted in concert, rather than in isolation.

Major training exercises are listed below.

### A.1.1.1 Joint Expeditionary Exercise

<table>
<tr><th colspan="4">Major Training Exercises – Medium Integrated Anti-Submarine Warfare</th></tr>
<tr><th colspan="4">Joint Expeditionary Exercise</th></tr>
<tr><td>Short Description</td><td colspan="2">Typically a 10-day exercise that could include a Carrier Strike Group and Expeditionary Strike Group, Marine Expeditionary Units, Army Infantry Units, and Air Force aircraft together in a joint environment that includes planning and execution efforts as well as military training activities at sea, in the air, and ashore.</td><td>Typical Duration<br>10 days</td></tr>
<tr><td>Long Description</td><td colspan="3">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.<br>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.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Aircraft carrier, amphibious warfare ship, fixed-wing aircraft, rotary-wing aircraft, support craft, surface combatant<br>Targets: Submarines<br>Systems being Trained/Tested: Mid-frequency sonar systems, sonobuoys</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Towed in-water device safety<br>Vessel safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Mariana Islands Range Complex<br>Bays/Estuaries/Pierside:<br>Apra Harbor</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Sonar and other transducers<br>Aircraft noise<br>Weapons noise<br>Vessel noise<br>Explosive:<br>In-air explosions<br>In-water explosions</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Vessel and in-water devices<br>Military expended materials<br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions</td><td>Energy:<br>In-air electromagnetic devices<br>In-water electromagnetic devices<br>Entanglement:<br>Decelerator/Parachutes<br>Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Metals<br>Explosives<br>Other materials<br>Chemicals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike<br>Explosives</td><td>Socioeconomic Resources:<br>Accessibility<br>Physical disturbance and strike<br>Airborne acoustics</td><td>Public Health and Safety:<br>Underwater energy<br>In-air energy<br>Physical interactions</td></tr>
</table>

| Major Training Exercises – Medium Integrated Anti-Submarine Warfare | | | |
|---|---|---|---|
| **Joint Expeditionary Exercise** | | | |
| **Military Expended Material** | **Ingestible Material:**<br>Decelerators/parachutes - small<br>**Non-Ingestible Material:**<br>Expended bathythermograph, expended bathythermograph wire, sonobuoy (non-explosive), sonobuoy wires | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | **Mid-Frequency:**<br>MF1 MF4<br>MF5 MF12 | **Anti-Submarine Warfare:**<br>ASW2 ASW3 | |
| **Explosive Bins** | None. Presented in appropriate worksheets for unit-level activities that could be conducted during this exercise. | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Towed in-water devices | |
| **Assumptions Used for Analysis** | All military expended materials, ordnance, and explosives use is included in individual events. Additional activities utilizing sources not listed in the Sonar and Other Transducer Bins section above may occur during this exercise. All acoustic sources which may be used during training and testing activities have been accounted for in the modeling and analysis presented in this SEIS/OEIS. | | |

### A.1.1.2 Joint Multi-Strike Group Exercise

<table>
<tr><th colspan="3">Major Training Exercises</th></tr>
<tr><th colspan="3">Joint Multi-Strike Group Exercise – Large Integrated Anti-Submarine Warfare</th></tr>
<tr><td>Short Description</td><td>Typically a 10-day Joint exercise, in which up to three carrier strike groups would conduct training exercises simultaneously.</td><td>Typical Duration<br>10 days</td></tr>
<tr><td>Long Description</td><td colspan="2">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.</td></tr>
<tr><td>Typical Components</td><td colspan="2">Platforms: Aircraft carrier, fixed-wing aircraft, rotary-wing aircraft, submarines, surface combatant<br>Targets: Sub-surface targets<br>Systems being Trained/Tested: High and mid-frequency sonar systems, sonobuoys</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Towed in-water device safety<br>Vessel safety</td><td>Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Mariana Islands Range Complex<br>Bays/Estuaries/Pierside:<br>Apra Harbor</td></tr>
<tr><td>Stressors to Biological Resources</td><td colspan="2">Acoustic:<br>Sonar and other transducers<br>Aircraft noise<br>Vessel noise<br>Weapons noise<br>Explosive:<br>In-air explosions<br>In-water explosions<br>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Vessel and in-water devices<br>Military expended materials<br>Ingestion:<br>Military expended materials – other than munitions<br>Energy:<br>In-Air electromagnetic devices<br>In-water electromagnetic devices<br>Entanglement:<br>Decelerator/Parachutes<br>Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="2">Air Quality:<br>Criteria air pollutants<br>Sediments and Water Quality:<br>Metals<br>Explosives<br>Other materials<br>Chemicals</td></tr>
<tr><td>Stressors to Human Resources</td><td colspan="2">Cultural Resources:<br>Physical disturbance and strike<br>Explosives<br>Socioeconomic Resources:<br>Accessibility<br>Physical disturbance and strike<br>Airborne acoustics<br>Public Health and Safety:<br>Underwater energy<br>In-air energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Decelerators/parachutes - small<br>Non-Ingestible Material:<br>Acoustic countermeasures, expended bathythermograph, expended bathythermograph wire, sonobuoy (non-explosive), sonobuoy wires</td><td>Military Recoverable Material<br>None</td></tr>
<tr><td>Sonar and Other Transducer Bin</td><td colspan="2">Mid-Frequency:<br>MF1 MF3<br>MF4 MF5<br>MF11 MF12<br>Anti-Submarine Warfare:<br>ASW2 ASW3<br>ASW4<br>High-Frequency:<br>HF1</td></tr>
</table>

| Major Training Exercises | | |
|---|---|---|
| **Joint Multi-Strike Group Exercise – Large Integrated Anti-Submarine Warfare** | | |
| **Explosive Bins** | None. Presented in appropriate worksheets for unit-level activities that could be conducted during this exercise. | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Towed in-water devices |
| **Assumptions Used for Analysis** | All military expended materials, ordnance, and explosive use is included in individual events. Additional activities utilizing sources not listed in the Sonar and Other Transducer Bins section above could be used during this exercise, and details can be found in the worksheets for those explosive events. All acoustic sources which may be used during training and testing activities have been accounted for in the modeling and analysis presented in this SEIS/OEIS. | |

### A.1.1.3 Marine Air Ground Task Force Exercise (Amphibious) - Battalion

<table>
<tr><th colspan="5">Major Training Exercises – Medium Coordinated Anti-Submarine Warfare</th></tr>
<tr><th colspan="5">Marine Air Ground Task Force Exercise (Amphibious) -Battalion</th></tr>
<tr><td rowspan="2">Short Description</td><td colspan="3" rowspan="2">Typically a 10-day exercise that 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.</td><td>Typical Duration</td></tr>
<tr><td>10 days</td></tr>
<tr><td>Long Description</td><td colspan="4">This exercise 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.</td></tr>
<tr><td>Typical Components</td><td colspan="4">Platforms: Amphibious warfare ship, rotary-wing aircraft, surface combatant<br>Targets: None<br>Systems being Trained/Tested: Sonar systems</td></tr>
<tr><td rowspan="2">Standard Operating Procedures (Section 2.3.3)</td><td rowspan="2">Aircraft safety<br>Towed in-water device safety<br>Vessel safety</td><td colspan="3">Typical Locations</td></tr>
<tr><td colspan="2">Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area to nearshore<br>Mariana Islands Range Complex<br>Tinian; Guam; Rota; Saipan; Farallon de Medinilla</td><td>Bays/Estuaries/Pierside:<br>Apra Harbor; Tinian; Guam</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Sonar and other transducers<br>Aircraft noise<br>Vessel noise<br>Weapons noise<br><br>Explosive:<br>In-Air Explosions<br>In-Water Explosions</td><td colspan="2">Physical Disturbance and Strike:<br>Aircraft and Aerial Targets<br>Vessel and in-water devices<br>Military expended materials<br><br>Ingestion:<br>Military Expended Materials – Other than Munitions</td><td>Energy:<br>In-Air Electromagnetic Devices<br>In-Water Electromagnetic Devices<br><br>Entanglement:<br>Decelerators/Parachutes<br>Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="2">Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Metals, Other materials<br>Explosives, Chemicals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Explosives<br>Physical disturbance and strike</td><td colspan="2">Socioeconomic Resources:<br>Accessibility<br>Physical disturbance and strike<br>Airborne Acoustics</td><td>Public Health and Safety:<br>Underwater energy<br>In-air energy<br>Physical interactions</td></tr>
</table>

| Major Training Exercises – Medium Coordinated Anti-Submarine Warfare<br>Marine Air Ground Task Force Exercise (Amphibious) -Battalion | | | |
|---|---|---|---|
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>Expended bathythermograph, expended bathythermograph wire | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | **Mid-Frequency:**<br>MF1 MF4<br>MF12 | **Anti-Submarine Warfare:**<br>ASW3 | |
| **Explosive Bins** | None. Presented in appropriate worksheets for unit-level activities that could be conducted during this exercise. | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Towed in-water devices | |
| **Assumptions Used for Analysis** | All military expended materials, ordnance, and explosive use is included in individual events. Additional activities utilizing sources not listed in the Sonar and Other Transducer Bins section above may occur during this exercise. All acoustic sources which may be used during training and testing activities have been accounted for in the modeling and analysis presented in this SEIS/OEIS. | | |

### A.1.2 Air Warfare Training

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 guns for close-in point defense. Strike/fighter aircraft carry anti-aircraft weapons, including air-to-air missiles and aircraft guns. 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. 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.1.2.1 Air Combat Maneuver

<table>
<tr><th colspan="2">Air Warfare</th></tr>
<tr><th colspan="2">Air Combat Maneuver (ACM)</th></tr>
<tr><td>Short Description</td><td>Aircrews engage in flight maneuvers designed to gain a tactical advantage during combat.<br>Typical Duration<br>1–2 hours</td></tr>
<tr><td>Long Description</td><td>Basic flight maneuvers in which fixed-wing aircrew engage in offensive and defensive maneuvering against each other. During air combat maneuver engagements, no ordnance is fired, however, 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.</td></tr>
<tr><td>Typical Components</td><td>Platforms: Fixed-wing aircraft<br>Targets: Aircraft targets<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Typical Locations<br>Range Complexes/Testing Ranges: Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace<br>Bays/Estuaries/Pierside: None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic: Aircraft noise<br>Explosive: None<br>Physical Disturbance and Strike: Aircraft and aerial targets<br>Ingestion: None<br>Energy: In-air electromagnetic devices<br>Entanglement: None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality: Criteria air pollutants<br>Sediments and Water Quality: Metals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources: None<br>Socioeconomic Resources: Airborne acoustics<br>Physical disturbance and strike<br>Public Health and Safety: None</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material: None<br>Non-Ingestible Material: None<br>Military Recoverable Material<br>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td>None</td></tr>
<tr><td>Explosive Bins</td><td>None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td>None</td></tr>
<tr><td>Assumptions Used for Analysis</td><td>No munitions fired. Flare and chaff may be used. All flare and chaff accounted for in flare exercise and chaff exercise events.<br><br>This activity occurs greater than 12 NM from land (FDM excepted).</td></tr>
</table>

### A.1.2.2 Air Defense Exercise

| Air Warfare | | | |
|---|---|---|---|
| **Air Defense Exercise (ADEX)** | | | |
| **Short Description** | Aircrew and ship crews conduct defensive measures against threat aircraft or simulated missiles. | **Typical Duration**<br>1–4 hours | |
| **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 through engagement sequence. Aircraft operate at varying altitudes and speeds. This exercise may include Air Intercept Control exercises that 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 search radars in the process of detecting, classifying, and tracking enemy aircraft or missiles up to the point of engagement. | | |
| **Typical Components** | **Platforms:** Surface vessels, fixed-wing aircraft<br>**Targets:** Aircraft targets<br>**Systems being Trained/Tested:** None | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Vessel safety<br>Aircraft safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>Vessel noise<br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>**Ingestion:**<br>None | **Energy:**<br>In-Air Electromagnetic Devices<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>None | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement | | |

| Air Warfare | |
|---|---|
| **Air Defense Exercise (ADEX)** | |
| **Assumptions Used for Analysis** | No munitions are fired. |

### A.1.2.3 Air Intercept Control

<table>
<tr><th colspan="4">Air Warfare</th></tr>
<tr><th colspan="4">Air Intercept Control (AIC)</th></tr>
<tr><td>Short Description</td><td colspan="2">Aircrew and air controllers conduct aircraft intercepts of other aircraft.</td><td>Typical Duration<br>1–2 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">Fighter jet aircrews maneuver to defend against threat aircraft.<br>An event involves two or more fighter aircraft.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Fixed-wing aircraft<br>Targets: Aircraft Targets<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges: Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace<br>Bays/Estuaries/Pierside: None</td></tr>
<tr><td>Stressors to Biological Resources</td><td colspan="3">Acoustic: Aircraft noise<br>Physical Disturbance and Strike: Aircraft and aerial targets<br>Energy: None<br>Explosive: None<br>Ingestion: None<br>Entanglement: None</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="3">Air Quality: Criteria air pollutants<br>Sediments and Water Quality: None</td></tr>
<tr><td>Stressors to Human Resources</td><td colspan="3">Cultural Resources: None<br>Socioeconomic Resources: Airborne acoustics; Physical Disturbance and Strike<br>Public Health and Safety: None</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material: None<br>Non-Ingestible Material: None</td><td>Military Recoverable Material</td><td>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">None</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="3">No munitions are fired.<br>This activity would occur greater than 12 NM from land (FDM excepted).</td></tr>
</table>

### A.1.2.4 Gunnery Exercise Air-to-Air Medium-Caliber

<table>
<tr><td colspan="3">Air Warfare</td></tr>
<tr><td colspan="3">Gunnery Exercise Air-to-Air Medium-Caliber (GUNEX A-A)</td></tr>
<tr><td>Short Description</td><td>Fixed-wing aircrews fire medium-caliber guns at air targets.</td><td>Typical Duration<br>1–2 hours</td></tr>
<tr><td>Long Description</td><td colspan="2">Fixed-wing aircrews maneuver aircraft in a gunnery pattern to achieve a weapons firing solution with integrated medium-caliber guns. Typically involves two or more fixed-wing aircraft and a target banner towed by a contract aircraft (e.g., Lear jet). The target banner is recovered after the event.</td></tr>
<tr><td>Typical Components</td><td colspan="2">Platforms: Fixed-wing aircraft<br>Targets: Air targets<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Weapons firing safety<br>Target deployment and retrieval safety</td><td>Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td colspan="2">Acoustic:<br>Aircraft noise<br>Weapons noise<br>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Military expended materials<br>Energy:<br>In-air electromagnetic devices<br>Explosive:<br>None<br>Ingestion:<br>Military expended materials – munitions<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="2">Air Quality:<br>Criteria air pollutants<br>Sediments and Water Quality:<br>Metals</td></tr>
<tr><td>Stressors to Human Resources</td><td colspan="2">Cultural Resources:<br>Physical disturbance and strike<br>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike<br>Public Health and Safety:<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Medium-caliber projectiles (non-explosive), medium-caliber casings<br>Non-Ingestible Material: None</td><td>Military Recoverable Material<br>Air target (towed target)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="2">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="2">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="2">None</td></tr>
</table>

| Air Warfare | |
|---|---|
| **Gunnery Exercise Air-to-Air Medium-Caliber (GUNEX A-A)** | |
| **Assumptions Used for Analysis** | This activity is conducted at an altitude of 15,000 feet and above, during the daytime, and beyond 12 nautical miles from shore (FDM excepted).<br><br>A towed air target is a banner target and will be recovered. Only non-explosive munitions used. |

### A.1.2.5 Gunnery Exercise Surface-to-Air Large Caliber

| | | | |
|---|---|---|---|
| **Air Warfare** | | | |
| **Gunnery Exercise Surface-to-Air Large-Caliber (GUNEX S-A)** | | | |
| **Short Description** | Surface ship crews fire large-caliber guns at air targets. | **Typical Duration** | Up to 3 hours |
| **Long Description** | Surface ship crews defend against threat aircraft or missiles with large-caliber guns to disable or destroy the threat.<br>An event involves one ship and a simulated threat aircraft or missile that is detected by the ship's radar. Large-caliber guns fire explosive and non-explosive projectiles at the threat before it reaches the ship. The target is towed by a contract air services jet. | | |
| **Typical Components** | **Platforms:** Surface combatant<br>**Targets:** Air targets<br>**Systems being Trained/Tested:** None | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Weapons firing safety<br>Vessel safety<br>Target deployment and retrieval safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>Weapons noise<br>Vessel noise<br>**Explosive:**<br>In-air explosions | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Military expended materials<br>**Ingestion:**<br>Military expended materials – munitions | **Energy:**<br>In-air electromagnetic devices<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Metals<br>Explosives | Other materials |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>Physical interactions<br>In-air energy |
| **Military Expended Material** | **Ingestible Material:**<br>Large caliber projectile (explosive) fragments<br>**Non-Ingestible Material:**<br>Large caliber casings, Large caliber projectile (non-explosive) | **Military Recoverable Material** | Air targets (towed target) |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | None. Only in-air detonations. | | |

| Air Warfare | | |
|---|---|---|
| **Gunnery Exercise Surface-to-Air Large-Caliber (GUNEX S-A)** | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors** *(Section 5.3.2)*<br>Weapons firing noise | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | The target is a fiberglass-finned target that is towed approximately 3 nautical miles behind the towing aircraft.<br>All projectiles are assumed to be non-explosive or explode in-air well above the water's surface.<br>This activity would occur greater than 12 NM from land (FDM excepted). | |

### A.1.2.6 Gunnery Exercise Surface-to-Air Medium-Caliber

<table>
<tr><th colspan="4">Air Warfare</th></tr>
<tr><th colspan="4">Gunnery Exercise Surface-to-Air Medium-Caliber (GUNEX S-A)</th></tr>
<tr><td>Short Description</td><td colspan="2">Surface ship crews fire medium-caliber guns at air targets.</td><td>Typical Duration<br>1–2 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">Surface ship crews defend against threat aircraft or missiles with medium-caliber guns to disable or destroy the threat.<br><br>An event involves one ship and a simulated threat aircraft or anti-ship missile that is detected by the ship's radar. Medium-caliber guns fire non-explosive projectiles to disable or destroy the threat before it reaches the ship. The target is towed by a contract air services jet.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Aircraft carrier, amphibious warfare ship, surface combatant<br>Targets: Air targets<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Weapons firing safety<br>Vessel safety<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td colspan="3">Acoustic:<br>Aircraft noise<br>Vessel noise<br>Weapons noise<br><br>Explosive:<br>None<br><br>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Military expended materials<br><br>Ingestion:<br>Military expended materials – munitions<br><br>Energy:<br>In-air electromagnetic devices<br><br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="3">Air Quality:<br>Criteria air pollutants<br><br>Sediments and Water Quality:<br>Metals</td></tr>
<tr><td>Stressors to Human Resources</td><td colspan="3">Cultural Resources:<br>Physical disturbance and strike<br><br>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike<br><br>Public Health and Safety:<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Medium-caliber projectiles (non-explosive), medium-caliber casings<br><br>Non-Ingestible Material: None</td><td>Military Recoverable Material</td><td>Air targets (towed target)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None.</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">None</td></tr>
</table>

| Air Warfare | |
|---|---|
| **Gunnery Exercise Surface-to-Air Medium-Caliber (GUNEX S-A)** | |
| **Assumptions Used for Analysis** | The target is a fiberglass finned target that is towed approximately 3 nautical miles behind the towing aircraft.<br>This activity would occur greater than 12 NM from land (FDM excepted). |

### A.1.2.7 Missile Exercise Air-to-Air

| Air Warfare | | | |
|---|---|---|---|
| **Missile Exercise Air-to-Air (MISSILEX A-A)** | | | |
| **Short Description** | Fixed-wing aircrews fire air-to-air missiles at air targets. | **Typical Duration** | 1–2 hours |
| **Long Description** | An event involves two or more fixed-wing aircraft and a target. Missiles are either high-explosive warheads or non-explosive practice munitions. The target is an unmanned aerial target drone a tactical air-launched decoy, or a parachute suspended illumination flare. Target drones deploy parachutes and are recovered by small boat or rotary-wing aircraft. Missiles may also be employed when training against threat missiles. These events typically occur at high altitudes. | | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, support craft<br>**Targets:** Air targets<br>**Systems being Trained/Tested:** None | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Weapons firing safety<br>Vessel safety<br>Target Deployment and Retrieval Safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>Vessel noise<br>Weapons noise<br>**Explosive:**<br>In-air explosions | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Military expended materials<br>**Ingestion:**<br>Military expended materials – munitions<br>Military expended materials – other than munitions | **Energy:**<br>In-air electromagnetic devices<br>**Entanglement:**<br>Decelerators/parachutes |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Explosives<br>Metals<br>Chemicals | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>Missile (explosive) fragments<br>**Non-Ingestible Material:**<br>Air target (decoy), illumination flares, decelerators/parachutes – medium and large, end caps, o-ring | **Military Recoverable Material** | Air targets (drones, air-launched decoy, or illumination flare, see Figure A-1, Figure A-2, Figure A-3) |
| **Sonar and Other Transducer Bins** | None | | |

| Air Warfare | |
|---|---|
| **Missile Exercise Air-to-Air (MISSILEX A-A)** | |
| **Explosive Bins** | None. Only in-air detonations. |
| **Procedural Mitigation Measures** | None |
| **Assumptions Used for Analysis** | Assumes that all missiles are explosive, although non-explosive practice munitions may be used. All missiles explode at high altitude.<br>All propellant and explosives are consumed.<br>Tactical air-launched decoys and illumination flares are expended and not recovered.<br>This activity would occur greater than 12 NM from land (FDM excepted). |

**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.1.2.8 Missile Exercise Surface-to-Air

<table>
<tr><th colspan="4">Air Warfare</th></tr>
<tr><th colspan="4">Missile Exercise Surface-to-Air (MISSILEX S-A)</th></tr>
<tr><td>Short Description</td><td colspan="2">Surface ship crews fire surface-to-air missiles at air targets.</td><td>Typical Duration<br>1–2 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">Surface ship crews defend against threat missiles and aircraft with ship-launched surface-to-air missiles.<br><br>The event involves a simulated threat aircraft or anti-ship missile which is detected by the ship's radar. Ship-launched surface-to-air missiles are fired (high-explosive) to disable or destroy the threat. The target typically is a remote-controlled drone. Surface-to-air missiles may also be used to train against land attack missiles.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Aircraft carrier, amphibious warfare ship, rotary-wing aircraft, surface combatant<br>Targets: Air targets<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Weapons firing safety<br>Vessel safety<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Aircraft noise<br>Vessel noise<br>Weapons noise<br>Explosive:<br>In-air explosions</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Military expended materials<br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions</td><td>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>Decelerators/parachutes</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Explosives<br>Metals<br>Chemicals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Missile (explosive) fragments<br>Non-Ingestible Material:<br>decelerators/parachutes – medium and large</td><td>Military Recoverable Material</td><td>Air targets (decoy or drone)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None. Only in-air detonations.</td></tr>
</table>

| Air Warfare | |
|---|---|
| **Missile Exercise Surface-to-Air (MISSILEX S-A)** | |
| **Procedural Mitigation Measures** | **Acoustic Stressors** *(Section 5.3.2)*<br>Weapons firing noise<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | Assumes that all surface-to-air missiles are high-explosive. Missile explodes well above surface. All explosive and propellant are consumed. Target typically not destroyed, unmanned drones are recovered when possible.<br>This activity would occur greater than 12 NM from land (FDM exempt). |

## A.1.3 Amphibious Warfare Training

Amphibious warfare is a type of naval warfare involving the utilization of naval firepower, logistics, and Marine Corps landing forces to project military power ashore. Amphibious warfare encompasses a broad spectrum of activities 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 activities include 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 Amphibious Rehearsal, No Landing

<table>
<tr><th colspan="4">Amphibious Warfare</th></tr>
<tr><th colspan="4">Amphibious Rehearsal, No Landing</th></tr>
<tr><td>Short Description</td><td colspan="2">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.</td><td>Typical Duration<br>1–2 days</td></tr>
<tr><td>Long Description</td><td colspan="3">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.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Amphibious warfare ship, fleet support ship, small boat<br>Targets: None<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges: Mariana Islands Training and Testing Study Area and Nearshore<br>Bays/Estuaries/Pierside: Apra Harbor</td></tr>
<tr><td>Stressors to Biological Resources</td><td colspan="3">Acoustic: Vessel noise<br>Explosive: None<br>Physical Disturbance and Strike: Vessel and in-water devices<br>Ingestion: None<br>Energy: None<br>Entanglement: None</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="3">Air Quality: Criteria air pollutants<br>Sediments and Water Quality: None</td></tr>
<tr><td>Stressors to Human Resources</td><td colspan="3">Cultural Resources: Physical disturbance and strike<br>Socioeconomic Resources: Accessibility; Physical disturbance and strike<br>Public Health and Safety: Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material: None<br>Non-Ingestible Material: None</td><td>Military Recoverable Material</td><td>None</td></tr>
</table>

| Amphibious Warfare | |
|---|---|
| **Amphibious Rehearsal, No Landing** | |
| **Sonar and Other Transducer Bins** | None |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | Amphibious vehicles train to launch from, and return to, amphibious ships. Amphibious vehicles approach surf zone but turn away before entering surf zone or landing zone. Typical participants: amphibious vessels (e.g., LHA or LHD, LPD, LSD), landing craft (Landing Craft, Air Cushioned; Landing Craft, Utility), and amphibious assault vehicles. |

### A.1.3.2 Amphibious Assault

| Amphibious Warfare | | | |
|---|---|---|---|
| **Amphibious Assault** | | | |
| **Short Description** | Large unit forces move ashore from amphibious ships at sea for the immediate execution of inland objectives. | **Typical Duration** | Up to 2 weeks |
| **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.<br><br>Unit-Level Training exercises involve one or more amphibious ships, and their associated watercraft and aircraft, to move personnel and equipment from ship 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. | | |
| **Typical Components** | **Platforms:** Amphibious warfare ship, fixed-wing aircraft, rotary-wing aircraft, tilt-rotor aircraft, small boat<br>**Targets:** None<br>**Systems being Trained/Tested:** None | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Vessel safety<br>Aircraft safety<br>Amphibious assault and amphibious raid procedures | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Range Complex<br>Tinian; Guam | **Bays/Estuaries/Pierside:**<br>Tinian; Guam |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>Vessel noise<br><br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessels and in-water devices<br><br>**Ingestion:**<br>None | **Energy:**<br>None<br><br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>None | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Accessibility<br>Physical disturbance and strike | **Public Health and Safety:**<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>None<br><br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement | | |

| Amphibious Warfare | |
|---|---|
| **Amphibious Assault** | |
| **Assumptions Used for Analysis** | Typical event: 1–3 amphibious ships (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 Raid

<table>
<tr><th colspan="4">Amphibious Warfare</th></tr>
<tr><th colspan="4">Amphibious Raid</th></tr>
<tr><td>Short Description</td><td colspan="2">Small unit forces move from amphibious ships at sea for a specific short-term mission. These are quick operations with as few personnel as possible.</td><td>Typical Duration<br>4–8 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">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 kept as small as possible to maximize stealth and speed of the operation.<br><br>An event may employ assault amphibian vehicle units, small boats, combat swimmers, small unit live-fire and non-live-fire operations. Surveillance or reconnaissance unmanned surface and aerial vehicles may be used during this event.<br><br>Events are also conducted to train in the delivery of humanitarian assistance to remote locations or areas requiring assistance after natural disasters.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Amphibious warfare ship, small boat, unmanned aerial system-fixed wing<br>Targets: Land Targets<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Aircraft safety<br><br>Amphibious assault and amphibious raid procedures</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Range Complex<br>Tinian; Guam; Rota<br><br>Bays/Estuaries/Pierside:<br>Tinian; Guam</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Aircraft noise<br>Vessel noise<br><br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial target<br>Vessels and in-water devices<br><br>Ingestion:<br>None</td><td>Energy:<br>None<br><br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>None</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br><br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
</table>

| **Amphibious Warfare** | |
|---|---|
| **Amphibious Raid** | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | Weapons firing (if conducted) during this event is discussed in appropriate activity descriptions (e.g., surface-to-surface and air-to-surface small-caliber gunnery exercises).<br>During the conduct of amphibious raids personnel may exit the watercraft in the surf zone and divers and combat swimmers will stand in the surf zone and walk onto the beach. |

### A.1.3.4 Humanitarian Assistance Operations/Disaster Relief Operations

<table>
<tr><th colspan="4">Amphibious Warfare</th></tr>
<tr><th colspan="4">Humanitarian Assistance Operations/Disaster Relief Operations</th></tr>
<tr><td>Short Description</td><td colspan="2">Military units provide humanitarian assistance in times of disaster.</td><td>Typical Duration<br>Up to 2 weeks</td></tr>
<tr><td>Long Description</td><td colspan="3">Military units provide humanitarian assistance and disaster relief in times of natural disaster. Ships, aircraft, and amphibious landing crafts could be expected to participate in this operation during day or night. The rapid movement of relief supplies and logistics from ships and a logistic “hub” during extreme conditions is practiced during this event.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Amphibious warfare ship, fixed-wing aircraft, rotary-wing aircraft, tilt-rotor aircraft, and small boat<br>Targets: None<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Vessel safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Range Complex; Guam; Tinian; Rota; Saipan<br>Bays/Estuaries/Pierside:<br>Guam; Tinian; Rota; Saipan</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Aircraft noise<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Ingestion:<br>None</td><td>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>None</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">Physical Disturbance and Strike Stressors: (Section 5.3.4)<br>Vessel movement</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="3">Sea-, land-, and air-based activity. Logistics and aid distributed across island region via “hub” location.</td></tr>
</table>

### A.1.3.5 Naval Surface Fire Support Exercise – Land-Based Target

| Amphibious Warfare | | | |
|---|---|---|---|
| **Naval Surface Fire Support Exercise – Land-Based Target** | | | |
| **Short Description** | Surface ship crews fire large-caliber guns at land-based targets in support of forces ashore. | **Typical Duration**<br>4–6 hours | |
| **Long Description** | Surface ship crews use large-caliber guns to support forces ashore.<br>One or more ships position themselves offshore the target area and a land-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.<br>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. | | |
| **Typical Components** | **Platforms:** Surface combatant<br>**Targets:** Land targets<br>**Systems being Trained/Tested:** None | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Vessel safety<br>Weapons firing safety<br>Farallon de Medinilla Access Restrictions | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>R-7201 and Farallon de Medinilla | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Vessel noise<br>Weapons noise<br>**Explosive:**<br>In-air explosions | **Physical Disturbance and Strike:**<br>Vessels and in-water devices<br>**Ingestion:**<br>None | **Energy:**<br>In-water electromagnetic devices<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>None | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>None | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics | **Public Health and Safety:**<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>Large caliber casings | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Weapons firing noise | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement | |
| **Assumptions Used for Analysis** | Projectile impact is on land; however, potential nearshore in-water impacts are considered. | | |

### A.1.3.6 Noncombatant Evacuation Operation

| Amphibious Warfare | | | |
|---|---|---|---|
| **Noncombatant Evacuation Operation** | | | |
| **Short Description** | Military units evacuate noncombatants from hostile or unsafe areas | **Typical Duration** | 5 days |
| **Long Description** | Military units evacuate noncombatants from hostile or unsafe areas to safe havens.<br>Non-Combatant Evacuation Operation is conducted by military units, usually operating in conjunction with Navy ships and aircraft. Noncombatants are evacuated when their lives are endangered by war, civil unrest, or natural disaster. Expeditionary units train for evacuations in hostile environments that may require the use of force. Helicopters, landing crafts, and combat swimmers could be expected to participate in this operation during day or night. | | |
| **Typical Components** | **Platforms:** Amphibious warfare ship, surface vessels, fixed-wing aircraft, rotary-wing aircraft, tilt rotor aircraft, unmanned aerial vehicles<br>**Targets:** None<br>**Systems Being Trained/Tested:** None | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Vessel safety<br>Unmanned aerial and underwater vehicle procedures | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Range Complex<br>Guam; Tinian; Rota | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>Vessel noise<br>**Explosives:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>**Ingestion:**<br>None | **Energy:**<br>In-air electromagnetic devices<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Metals<br>Chemicals<br>Other materials | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Accessibility<br>Physical disturbance and strike | **Public Health and Safety:**<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | None | | |
| **In-Water Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement | | |
| **Assumptions Used for Analysis** | Sea-, land-, and air-based activity | | |

### A.1.3.7 Special Purpose Marine Air Ground Task Force Exercise

<table>
<tr><th colspan="4">Amphibious Warfare</th></tr>
<tr><th colspan="4">Special Purpose Marine Air-Ground Task Force Exercise</th></tr>
<tr><td>Short Description</td><td>Typically 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).</td><td colspan="2">Typical Duration<br>10 days</td></tr>
<tr><td>Long Description</td><td colspan="3">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.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Amphibious warfare ship, fixed-wing aircraft, rotary-wing aircraft, tilt-rotor aircraft, small boat<br>Targets: None<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Vessel safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area to nearshore; Mariana Islands Range Complex; Tinian; Guam; Rota; Saipan<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Aircraft noise<br>Vessel noise<br>Weapons noise<br>Explosive:<br>In-air explosions<br>In-water explosions</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Vessel and in-water devices<br>Military expended materials<br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions</td><td>Energy:<br>None<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Explosives<br>Metals<br>Chemicals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike<br>Explosives</td><td>Socioeconomic Resources:<br>Accessibility<br>Physical disturbance and strike<br>Airborne acoustics</td><td>Public Health and Safety:<br>Physical interactions<br>Underwater energy<br>In-Air Energy</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>None</td></tr>
</table>

| Amphibious Warfare | |
|---|---|
| **Special Purpose Marine Air-Ground Task Force Exercise** | |
| **Sonar and Other Transducer Bins** | None |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | Impacts from land based targeting are not analyzed. Only the at-sea components of this activity are analyzed in this document.<br>Additional activities utilizing sources not listed in the Sonar and Other Transducer Bins section above may occur during this exercise. All acoustic sources that may be used during training and testing activities have been accounted for in the modeling and analysis presented in this EIS/OEIS. |

### A.1.3.8 Unmanned Aerial Vehicle – Intelligence, Surveillance, and Reconnaissance

| | | | |
|---|---|---|---|
| **Amphibious Warfare** | | | |
| **Unmanned Aerial Vehicle – Intelligence, Surveillance, and Reconnaissance** | | | |
| **Short Description** | Military units employ unmanned aerial vehicles to launch, operate, and gather intelligence for specified amphibious missions. | **Typical Duration**<br>Varies | |
| **Long Description** | Unmanned aerial vehicles may be launched from ships, boats, submarines, or ground and are used to gather tactical or theater-level intelligence. | | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, unmanned aerial system – fixed wing, unmanned aerial system – rotary wing<br>**Targets:** None<br>**Systems being Trained/Tested:** None | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Unmanned aerial and underwater vehicle procedures | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Training and Testing Study Area | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>**Explosives:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>**Ingestion:**<br>None | **Energy:**<br>None<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>None | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Accessibility<br>Physical disturbance and strike<br>Airborne acoustics | **Public Health and Safety:**<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | None | | |
| **In-Water Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | None | | |
| **Assumptions Used for Analysis** | Sea-, land-, and air-based activity. Unmanned Aerial vehicles are typically recovered; however, units may be damaged and lost. Small expendable units may also be used. | | |

### A.1.4 Anti-Submarine Warfare Training

Anti-submarine warfare involves helicopter and maritime patrol aircraft, ships, and submarines. These units operate alone or in combination 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, 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).

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 are conducted in coordinated, at-sea operations during 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.1.4.1 Torpedo Exercise – Helicopter

| Anti-Submarine Warfare | | |
|---|---|---|
| **Anti-Submarine Warfare Torpedo Exercise – Helicopter (TORPEX)** | | |
| **Short Description** | Helicopter crews search for, track, and detect submarines. Recoverable air launched torpedoes are employed against submarine targets. | **Typical Duration**<br>2–5 hours |
| **Long Description** | Helicopters using sonobuoys and dipping sonar 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 (both passive and active) are typically employed by a helicopter operating at altitudes below 3,000 feet (ft.). Dipping sonar (both passive and active) is employed from an altitude of about 50 ft. after the search area has been narrowed based on the sonobuoy search. 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 occur during a coordinated larger exercise involving multiple aircraft and ships, including a major range event. Unmanned aerial systems, such as the MQ-8 Fire Scout, may also be used. The exercise torpedo is recovered by a special recovery helicopter or small craft. The preferred range for this exercise is an instrumented underwater range, but it may be conducted anywhere within the Study Area depending on training requirements and available assets. | |
| **Typical Components** | **Platforms:** Rotary-wing aircraft, unmanned aerial system - rotary wing, surface vessels, small boats<br>**Targets:** Sub-surface targets<br>**Systems being Trained/Tested:** Mid-frequency sonar, torpedoes | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Vessel safety<br>Aircraft safety<br>Unmanned aerial and underwater vehicle procedures<br>Target deployment and retrieval safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:** Mariana Islands Training and Testing Study Area<br>**Bays/Estuaries/Pierside:** None |
| **Stressors to Biological Resources** | **Acoustic:** Sonar and other transducers; Aircraft noise; Vessel noise<br>**Explosive:** None | **Physical Disturbance and Strike:** Aircraft and aerial target; Vessels and in-water devices; Military expended materials<br>**Ingestion:** Military expended materials – munitions; Military expended materials – other than munitions<br>**Energy:** In-air electromagnetic devices<br>**Entanglement:** Decelerators/parachutes; Wires and cables |
| **Stressors to Physical Resources** | **Air Quality:** Criteria air pollutants | **Sediments and Water Quality:** Chemicals; Metals; Other materials |
| **Stressors to Human Resources** | **Cultural Resources:** Physical disturbance and strike | **Socioeconomic Resources:** Accessibility; Airborne acoustics; Physical disturbance and strike<br>**Public Health and Safety:** Underwater energy; Physical interactions |

| Anti-Submarine Warfare | | | |
|---|---|---|---|
| **Anti-Submarine Warfare Torpedo Exercise – Helicopter (TORPEX)** | | | |
| **Military Expended Material** | **Ingestible Material:**<br>Decelerators/parachutes - small<br>**Non-Ingestible Material:**<br>Expended bathythermograph, expended bathythermograph wire, expendable transponder anchors, lightweight torpedo accessories, sonobuoy (non-explosive), sonobuoy wires, sub-surface target (mobile) | **Military Recoverable Material** | Lightweight torpedo (non-explosive), sub-surface target (mobile) |
| **Sonar and Other Transducer Bins** | **Mid-Frequency:**<br>MF4 MF5 | **Torpedoes:**<br>TORP1 | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement | |
| **Assumptions Used for Analysis** | This activity occurs greater than 3 NM from land.<br>Submarine may provide service as the target. | | |

### A.1.4.2 Torpedo Exercise – Maritime Patrol Aircraft

<table>
<tr><th colspan="3">Anti-Submarine Warfare</th></tr>
<tr><th colspan="3">Anti-Submarine Warfare Torpedo Exercise – Maritime Patrol Aircraft (TORPEX)</th></tr>
<tr><td>Short Description</td><td>Maritime patrol aircraft crews search for, track, and detect submarines. Recoverable air launched torpedoes are employed against submarine targets.</td><td>Typical Duration<br>2–8 hours</td></tr>
<tr><td>Long Description</td><td colspan="2">Fixed-wing maritime patrol aircraft employ 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.<br><br>Sonobuoys (both passive and active) are typically employed by a maritime patrol aircraft operating at altitudes below 3,000 feet. 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. 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 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 anywhere within the Study Area depending on training requirements and available assets.</td></tr>
<tr><td>Typical Components</td><td colspan="2">Platforms: Fixed-wing aircraft<br>Targets: Sub-surface targets<br>Systems being Trained/Tested: Mid-frequency sonar, torpedoes</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Target deployment and retrieval safety</td><td>Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td colspan="2">Acoustic:<br>Sonar and other transducers<br>Aircraft noise<br>Explosive:<br>None<br>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Military expended materials<br>Vessels and in-water devices<br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions<br>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>Decelerators/parachutes<br>Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="2">Air Quality:<br>Criteria air pollutants<br>Sediments and Water Quality:<br>Chemicals<br>Metals<br>Other materials</td></tr>
<tr><td>Stressors to Human Resources</td><td colspan="2">Cultural Resources:<br>Physical disturbance and strike<br>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike<br>Public Health and Safety:<br>Underwater energy<br>Physical interactions</td></tr>
</table>

| Anti-Submarine Warfare | | | |
|---|---|---|---|
| **Anti-Submarine Warfare Torpedo Exercise – Maritime Patrol Aircraft (TORPEX)** | | | |
| **Military Expended Material** | **Ingestible Material:**<br>Decelerators/parachutes - small<br>**Non-Ingestible Material:**<br>Expended bathythermograph, expended bathythermograph wire, lightweight torpedo accessories, sonobuoy (non-explosive), sonobuoy wires, sub-surface target (mobile) | **Military Recoverable Material** | Lightweight torpedo (non-explosive), sub-surface target (mobile) |
| **Sonar and Other Transducer Bins** | Mid-Frequency:<br>MF5 | Torpedoes:<br>TORP1 | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar | | |
| **Assumptions Used for Analysis** | Submarine may provide service as the target.<br>If target is air-dropped, one parachute per target.<br>This activity occurs greater than 3 NM from land. | | |

### A.1.4.3 Torpedo Exercise – Submarine

<table>
<tr><th colspan="4">Anti-Submarine Warfare</th></tr>
<tr><th colspan="4">Anti-Submarine Warfare Torpedo Exercise – Submarine (TORPEX)</th></tr>
<tr><td>Short Description</td><td>Submarine crews search for, track, and detect submarines. Exercise torpedoes are used during this event.</td><td colspan="2">Typical Duration<br>8 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">Submarine crews search for, detect and track a threat submarine to develop firing position to launch a torpedo. A single submerged submarine operates at slow speeds and various depths while using its hull mounted or towed array sonar to track a threat submarine. While passive sonar is most typically used for this training event, some active sonar may be used on occasion. Non-explosive exercise torpedoes may also be fired during training.<br><br>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 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 anywhere within the Study Area depending on training requirements and available assets.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Submarines, support boat, support aircraft<br>Targets: Sub-surface targets<br>Systems being Trained/Tested: Mid-frequency and high-frequency sonar, torpedoes</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Aircraft safety<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Sonar and other transducers<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Military expended materials<br>Ingestion:<br>Military expended materials – other than munitions</td><td>Energy:<br>None<br>Entanglement:<br>Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>None</td><td colspan="2">Sediments and Water Quality:<br>Metals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Underwater energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>Acoustic countermeasures, expended bathythermograph, expended bathythermograph wire, guidance wire, heavyweight torpedo accessories</td><td>Military Recoverable Material</td><td>Heavyweight (non-explosive) torpedo, sub-surface target (mobile)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td>Anti-Submarine Warfare:<br>ASW4<br>Torpedoes:<br>TORP2</td><td>High Frequency:<br>HF1</td><td>Mid-Frequency:<br>MF3</td></tr>
</table>

| Anti-Submarine Warfare | |
|---|---|
| **Anti-Submarine Warfare Torpedo Exercise – Submarine (TORPEX)** | |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | Torpedoes are recovered.<br>Guidance wire has a low breaking strength and breaks easily. Weights and flex tubing sink rapidly.<br>This activity occurs greater than 3 NM from land. |

### A.1.4.4 Torpedo Exercise – Surface

<table>
<tr><th colspan="4">Anti-Submarine Warfare</th></tr>
<tr><th colspan="4">Anti-Submarine Warfare Torpedo Exercise – Surface (TORPEX)</th></tr>
<tr><td>Short Description</td><td>Surface ship crews search for, track, and detect submarines. Exercise torpedoes are used during this event.</td><td colspan="2">Typical Duration<br>2–5 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">Surface ships search for, 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 ship operates at slow speeds while employing hull mounted or towed array sonar. Passive or active sonar is employed depending on the type of threat submarine, the tactical situation, and environmental conditions. The anti-submarine warfare target used for this exercise is a MK-39 Expendable Mobile Anti-Submarine Warfare (ASW) Training Target, MK-30 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.<br><br>The exercise torpedo is recovered by helicopter or small craft. The preferred area for this exercise is an instrumented underwater range, but it may be conducted anywhere within the Study Area depending on training requirements and available assets.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Surface combatant<br>Targets: Sub-surface targets<br>Systems being Trained/Tested: Mid-frequency sonar, torpedoes</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Towed in-water device safety<br>Vessel safety<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges: Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside: None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Sonar and other transducers<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Military expended materials<br>Ingestion:<br>Military expended materials – other than munitions</td><td>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>Decelerator/Parachutes<br>Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Metals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Underwater energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Decelerators/parachutes - small<br>Non-Ingestible Material:<br>Expended bathythermograph, expended bathythermograph wire, lightweight torpedo accessories, sonobuoy (non-explosive), sonobuoy wires</td><td>Military Recoverable Material</td><td>Lightweight torpedo (non-explosive), sub-surface target (mobile)</td></tr>
</table>

| Anti-Submarine Warfare | | | |
|---|---|---|---|
| **Anti-Submarine Warfare Torpedo Exercise – Surface (TORPEX)** | | | |
| **Sonar and Other Transducer Bins** | **Anti-Submarine Warfare:**<br>ASW3 | **Mid-Frequency:**<br>MF1 MF5 | **Torpedoes:**<br>TORP1 |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Towed In-water devices | |
| **Assumptions Used for Analysis** | Submarines may provide service as the target. Torpedoes are recovered.<br>This activity occurs greater than 3 NM from land. | | |

### A.1.4.5 Tracking Exercise – Helicopter

| Anti-Submarine Warfare | |
|---|---|
| **Anti-Submarine Warfare Tracking Exercise – Helicopter (TRACKEX)** | |
| **Short Description** | Helicopter crews search for, track, and detect submarines.<br>**Typical Duration:** 2–4 hours |
| **Long Description** | Helicopters using sonobuoys and dipping sonar 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.<br><br>Sonobuoys (both passive and active) are typically employed by a helicopter operating at altitudes below 3,000 ft. Dipping sonar (both passive and active) is employed from an altitude of about 50 ft. after the search area has been narrowed based on the sonobuoy search.<br><br>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 occur during a coordinated larger exercise involving multiple aircraft and ships, including a major range event. Unmanned aerial systems, such as the MQ-8 Fire Scout, may also be used. The preferred range for this exercise is an instrumented range, but it may be conducted anywhere within the Study Area depending on training requirements and available assets. |
| **Typical Components** | **Platforms:** Rotary-wing aircraft<br>**Targets:** Sub-surface targets<br>**Systems being Trained/Tested:** Mid Frequency Sonar (sonobuoys, dipping sonar) |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br><br>**Typical Locations**<br>**Range Complexes/Testing Ranges:** Mariana Islands Training and Testing Study Area; Transit Corridor<br>**Bays/Estuaries/Pierside:** None |
| **Stressors to Biological Resources** | **Acoustic:** Sonar and other transducers; Aircraft noise<br>**Explosive:** None<br>**Physical Disturbance and Strike:** Aircraft and aerial target; Vessels and in-water devices; Military expended materials<br>**Ingestion:** Military expended materials – other than munitions<br>**Energy:** In-air electromagnetic devices<br>**Entanglement:** Decelerators/parachutes; Wires and cables |
| **Stressors to Physical Resources** | **Air Quality:** Criteria air pollutants<br>**Sediments and Water Quality:** Chemicals; Metals; Other materials |
| **Stressors to Human Resources** | **Cultural Resources:** Physical disturbance and strike<br>**Socioeconomic Resources:** Accessibility; Airborne acoustics; Physical disturbance and strike<br>**Public Health and Safety:** Underwater energy; Physical interactions |

| Anti-Submarine Warfare | | | |
|---|---|---|---|
| **Anti-Submarine Warfare Tracking Exercise – Helicopter (TRACKEX)** | | | |
| **Military Expended Material** | **Ingestible Material:**<br>Decelerators/parachutes - small<br>**Non-Ingestible Material:**<br>Expended bathythermograph, expended bathythermograph wire, sonobuoy (non-explosive), sonobuoy wires, sub-surface target (mobile) | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | **Mid-Frequency:**<br>MF4 MF5 | | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar | | |
| **Assumptions Used for Analysis** | Submarines may provide service as the target.<br>This activity occurs greater than 3 NM from land. | | |

### A.1.4.6 Tracking Exercise – Maritime Patrol Aircraft

<table>
<tr><th colspan="2">Anti-Submarine Warfare</th></tr>
<tr><th colspan="2">Anti-Submarine Warfare Tracking Exercise – Maritime Patrol Aircraft (TRACKEX)</th></tr>
<tr><td>Short Description</td><td>Maritime patrol aircraft crews search for, track, and detect submarines.<br>Typical Duration: 2–8 hours</td></tr>
<tr><td>Long Description</td><td>Fixed-wing maritime patrol aircraft employ 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.<br><br>Sonobuoys (both passive and active) are typically employed by a maritime patrol aircraft operating at altitudes below 3,000 feet. 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. 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 (ASW) 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.</td></tr>
<tr><td>Typical Components</td><td>Platforms: Fixed-wing aircraft<br>Targets: Sub-surface targets<br>Systems being Trained/Tested: Mid-frequency sonar</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Target Deployment and Retrieval Safety<br><br>Typical Locations<br>Range Complexes/Testing Ranges: Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside: None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Sonar and other transducers<br>Aircraft noise<br>Explosive:<br>None<br>Physical Disturbance and Strike:<br>Aircraft and aerial target<br>Vessels and in-water devices<br>Military expended materials<br>Ingestion:<br>Military expended materials – other than munitions<br>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>Decelerators/parachutes<br>Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants<br>Sediments and Water Quality:<br>Chemicals<br>Metals<br>Other materials</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike<br>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike<br>Public Health and Safety:<br>Underwater energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Decelerators/parachutes - small<br>Non-Ingestible Material:<br>Expended bathythermograph, expended bathythermograph wire, sonobuoy (non-explosive), sonobuoy wires<br><br>Military Recoverable Material: Sub-surface target (mobile)</td></tr>
</table>

| Anti-Submarine Warfare | |
|---|---|
| **Anti-Submarine Warfare Tracking Exercise – Maritime Patrol Aircraft (TRACKEX)** | |
| **Sonar and Other Transducer Bins** | **Mid-Frequency:**<br>MF5 |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar |
| **Assumptions Used for Analysis** | Submarine may provide service as the target.<br>If target is air-dropped, one parachute per target.<br>This activity occurs greater than 3 NM from land. |

### A.1.4.7 Tracking Exercise – Submarine

<table>
<tr><th colspan="4">Anti-Submarine Warfare</th></tr>
<tr><th colspan="4">Anti-Submarine Warfare Tracking Exercise – Submarine (TRACKEX)</th></tr>
<tr><td>Short Description</td><td colspan="2">Submarine crews search for, track, and detect submarines.</td><td>Typical Duration<br>8 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">Submarine crews search for, detect and track a threat submarine to develop firing position to launch a torpedo.<br><br>A single submerged submarine operates at slow speeds and various depths while using its hull mounted or towed array sonar to track a threat submarine. Passive sonar is used almost exclusively. The target for this exercise is either an MK 39 expendable mobile anti-submarine warfare training target, MK 30 recoverable training target, or live submarine.<br><br>This exercise could occur anywhere throughout the MITT Study Area. 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.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Submarines<br>Targets: Sub-surface targets<br>Systems being Trained/Tested: Mid-frequency and high-frequency sonar</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Target Deployment and Retrieval Safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Transit Corridor<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Sonar and other transducers<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Vessel and in-water devices<br>Military expended materials<br>Ingestion:<br>None</td><td>Energy:<br>None<br>Entanglement:<br>Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>None</td><td colspan="2">Sediments and Water Quality:<br>Metals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Underwater energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>Acoustic countermeasures, expended bathythermograph, expended bathythermograph wire</td><td>Military Recoverable Material</td><td>Sub-surface target (mobile)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td>Anti-Submarine Warfare:<br>ASW4</td><td>High-Frequency:<br>HF1 HF3</td><td>Mid-Frequency:<br>MF3</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
</table>

| Anti-Submarine Warfare | |
|---|---|
| **Anti-Submarine Warfare Tracking Exercise – Submarine (TRACKEX)** | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar |
| **Assumptions Used for Analysis** | This activity occurs greater than 3 NM from land. |

### A.1.4.8 Tracking Exercise – Surface

<table>
<tr><th colspan="4">Anti-Submarine Warfare</th></tr>
<tr><th colspan="4">Anti-Submarine Warfare Tracking Exercise – Surface (TRACKEX)</th></tr>
<tr><td>Short Description</td><td colspan="2">Surface ship crews search for, track, and detect submarines.</td><td>Typical Duration<br>2–4 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">Surface ships search for, detect, and track threat submarines to determine a firing position to launch a torpedo and attack the submarine.<br><br>A surface ship operates at slow speeds while employing sonobuoys, hull mounted sonar, 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 either a MK-39 Expendable Mobile Anti-Submarine Warfare Training Target, MK-30 Recoverable Training Target, or live submarine.<br><br>Anti-Submarine Warfare (ASW) Tracking exercise – Ship could occur anywhere throughout the MITT Study Area. 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.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Surface combatant<br>Targets: Sub-surface targets<br>Systems being Trained/Tested: Mid-frequency sonar</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Towed in-water device safety<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Transit Corridor<br><br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Sonar and other transducers<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Military Expended Materials<br>Ingestion:<br>None</td><td>Energy:<br>In-air electromagnetic devices<br>In-water electromagnetic devices<br>Entanglement:<br>Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>None</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Underwater energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>Buoy (non-explosive), expended bathythermograph, expended bathythermograph wire, sub-surface target (mobile)</td><td>Military Recoverable Material</td><td>Sub-surface target (mobile)</td></tr>
</table>

| Anti-Submarine Warfare | |
|---|---|
| **Anti-Submarine Warfare Tracking Exercise – Surface (TRACKEX)** | |
| **Sonar and Other Transducer Bins** | **Anti-Submarine Warfare:** ASW1 ASW3 **Mid-Frequency:** MF1 MF11 MF12 |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Towed in-water devices |
| **Assumptions Used for Analysis** | A submarine may provide service as the target.<br>This activity occurs greater than 3 NM from land. |

### A.1.4.9 Surface Warfare Advanced Tactical Training

| Small Integrated Anti-Submarine Warfare Training | | |
|---|---|---|
| **Surface Warfare Advanced Tactical Training** | | |
| **Short Description** | Multiple ships and aircraft coordinate the use of sensors, including sonobuoys, to search, detect, and track a threat submarine. Surface Warfare Advanced Tactical Training exercises are not dedicated Anti-Submarine Warfare events and involve multiple warfare areas. | **Typical Duration**<br>Up to 15 days |
| **Long Description** | Surface Warfare Advanced Tactical Training (SWATT) is an intermediate training exercise designed primarily to increase operator proficiency and exercise combined force responses to surface warfare, anti-submarine warfare, air warfare and electromagnetic spectrum operations.<br>Surface Warfare Advanced Tactical Training is conducted after a carrier strike group's first Group Sail, and before Composite Training Unit Exercise, and consists of multiple surface warfare, anti-submarine, and air warfare live-fire events. Multiple ships and aircraft search for, locate, and track one submarine. Occurs once per carrier strike group training cycle.<br>All other warfare area training conducted during SWATT was analyzed as unit-level training (gunnery, missile exercise, etc.). | |
| **Typical Components** | **Platforms:** Multiple Surface Combatants, fixed-wing aircraft, helicopters, unmanned vehicles, and submarines<br>**Targets:** All surface, air and anti-submarine warfare targets (e.g., MK-30s, MK-39 Expendable Mobile Training Targets, recoverable or expendable floating targets)<br>**Systems being Trained/Tested:** Mid-frequency sonar, high-frequency sonar, lightweight torpedoes, high-frequency acoustic modems | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Vessel safety<br>Aircraft safety<br>Weapons firing safety<br>Towed in-water device safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Hawaii Range Complex<br>Southern California Range Complex<br>**Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Sonar and other transducers<br>Aircraft noise<br>Vessel noise<br>Weapons noise<br>**Explosive:**<br>In-air explosions<br>**Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Military expended materials<br>**Ingestion:**<br>Military expended materials – munitions<br>Military expended materials – other than munitions | **Energy:**<br>In-air electromagnetic devices<br>**Entanglement:**<br>Wires and cables<br>Decelerators/parachutes |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants<br>**Habitats:**<br>Physical disturbance and strike – military expended material | **Sediments and Water Quality:**<br>Explosives<br>Metals<br>Chemicals |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Physical disturbance and strike<br>**Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>Physical interactions |

<table>
<tr><th colspan="4">Small Integrated Anti-Submarine Warfare Training<br>Surface Warfare Advanced Tactical Training</th></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Target fragments, small-caliber projectiles, small decelerators/parachutes<br>Non-Ingestible Material:<br>Sonobuoys, large and medium-caliber projectiles, acoustic countermeasures</td><td>Military Recoverable Material</td><td>Anti-submarine warfare targets<br>Air warfare targets<br>Surface warfare targets</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">Mid-Frequency:<br>MF1<br>MF1K<br>MF3<br>MF4<br>MF5<br>MF6<br>MF12<br>High-Frequency:<br>HF1<br>Anti-Submarine Warfare:<br>ASW2<br>ASW3<br>ASW4<br>Torpedoes:<br>TORP1 TORP2<br>Acoustic Modems:<br>Yes</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">Acoustic Stressors: (Section 5.3.2)<br>Active sonar<br>Physical Disturbance and Strike: (Section 5.3.4)<br>Vessel movement<br>Towed in-water devices</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="3">All other warfare area training conducted during SWATT was analyzed as unit-level training (gunnery, missile exercise, etc.). All military expended materials, munitions, explosives and sonar use is included in individual unit-level events.<br>Additional activities utilizing sources not listed in the Sonar and Other Transducer Bins section above may occur during this exercise. All acoustic sources which may be used during training and testing activities have been accounted for in the modeling and analysis presented in this EIS/OEIS.</td></tr>
</table>

### A.1.4.10 Small Joint Coordinated ASW exercise (Multi-Sail/GUAMEX)

| Anti-Submarine Warfare | | | |
|---|---|---|---|
| **Small Joint Coordinated ASW Exercise (Multi-Sail/GUAMEX)** | | | |
| **Short Description** | Typically 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. | **Typical Duration**<br>5 days | |
| **Long Description** | This is an 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. Additional unit-level activities, such as MISSILEX may be conducted during these events. | | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, rotary-wing aircraft, submarines, surface combatant<br>**Targets:** Surface targets, sub-surface targets<br>**Systems being Trained/Tested:** Mid-frequency Sonar | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Towed in-water device safety<br>Vessel safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Training and Testing Study Area | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Sonar and other transducers<br>Aircraft noise<br>Vessel noise<br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessel and in-water devices<br>Military expended materials<br>**Ingestion:**<br>Military expended materials – munitions<br>Military expended material – other than munitions | **Energy:**<br>In-air electromagnetic devices<br>**Entanglement:**<br>Decelerator/Parachutes<br>Wires and cables |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Metals<br>Chemicals<br>Other materials | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Accessibility<br>Physical disturbance and strike<br>Airborne acoustics | **Public Health and Safety:**<br>Underwater energy<br>In-air energy<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>Decelerators/parachutes - small<br>**Non-Ingestible Material:**<br>Acoustic countermeasures, aircraft stores and ballast, expended bathythermograph, expended bathythermograph wire, sonobuoy (non-explosive), sonobuoy wires, sub-surface target (mobile) | **Military Recoverable Material** | None |

| Anti-Submarine Warfare | |
|---|---|
| **Small Joint Coordinated ASW Exercise (Multi-Sail/GUAMEX)** | |
| **Sonar and Other Transducer Bins** | **Anti-Submarine Warfare:** ASW2, ASW3, ASW4<br>**High-Frequency:** HF1<br>**Mid-Frequency:** MF1, MF3, MF4, MF5, MF11, MF12 |
| **Explosive Bins** | None. Presented in appropriate worksheets for unit-level activities that could be conducted during this exercise.. |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Towed in-water devices |
| **Assumptions Used for Analysis** | This activity occurs at least 3 NM from land (FDM excepted).<br>Additional activities utilizing sources not listed in the Sonar and Other Transducer Bins section above may occur during this exercise. All acoustic sources which may be used during training and testing activities have been accounted for in the modeling and analysis presented in this EIS. |

## A.1.5 Electronic Warfare

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.1.5.1 Counter Targeting Chaff Exercise – Aircraft

| **Electronic Warfare** | |
|---|---|
| **Counter Targeting Chaff Exercise – Aircraft** | |
| **Short Description** | Fixed-wing aircraft and helicopter aircrews deploy chaff to disrupt threat targeting and missile guidance radars.<br>**Typical Duration**: 1–2 hours |
| **Long Description** | Fixed-wing aircraft and helicopter aircrews deploy chaff to disrupt threat targeting and missile guidance radars.<br><br>Fixed-wing aircraft and helicopter aircrews 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.<br><br>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 to create a target that will lure enemy radar and weapons system away from the actual friendly platform. |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, rotary-wing aircraft<br>**Targets:** None<br>**Systems being Trained/Tested:** None |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>**Typical Locations**<br>**Range Complexes/Testing Ranges:** Mariana Islands Training and Testing Study Area<br>**Bays/Estuaries/Pierside:** None |
| **Stressors to Biological Resources** | **Acoustic:** Aircraft noise<br>**Explosive:** None<br>**Physical Disturbance and Strike:** Aircraft and aerial targets; Military expended materials<br>**Ingestion:** Military expended materials – other than munitions<br>**Energy:** In-air electromagnetic devices<br>**Entanglement:** None |
| **Stressors to Physical Resources** | **Air Quality:** Criteria air pollutants<br>**Sediments and Water Quality:** Other materials |
| **Stressors to Human Resources** | **Cultural Resources:** None<br>**Socioeconomic Resources:** Airborne acoustics<br>**Public Health and Safety:** Physical interactions |
| **Military Expended Material** | **Ingestible Material:** Per chaff: one chaff-air cartridge, one plastic endcap, chaff fibers<br>**Non-Ingestible Material:** None |
| **Military Recoverable Material** | None |

| Electronic Warfare | |
|---|---|
| **Counter Targeting Chaff Exercise – Aircraft** | |
| **Sonar and Other Transducer Bins** | None |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | None |
| **Assumptions Used for Analysis** | Chaff is usually expended while conducting other training activities, such as air combat maneuvering. Potential effects are analyzed under this activity.<br>This activity occurs greater than 12 NM from land. |

### A.1.5.2 Counter Targeting Chaff Exercise – Ship

<table>
<tr><th colspan="2">Electronic Warfare</th></tr>
<tr><th colspan="2">Counter Targeting Chaff Exercise – Ship</th></tr>
<tr><td>Short Description</td><td>Surface ship crews deploy chaff to disrupt threat targeting and missile guidance radars.<br>Typical Duration<br>1–2 hours</td></tr>
<tr><td>Long Description</td><td>Surface ship crews deploy chaff to disrupt threat targeting and missile guidance radars to defend against an attack.<br><br>Surface ship 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. The typical event duration is approximately one and one-half hours.<br><br>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 to create a target 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).</td></tr>
<tr><td>Typical Components</td><td>Platforms: Navy Ships<br>Targets: None<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br><br>Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Vessel noise<br>Explosive:<br>None<br>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Military expended materials<br>Ingestion:<br>Military expended materials – other than munitions<br>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants<br>Sediments and Water Quality:<br>Other materials</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>None<br>Socioeconomic Resources:<br>Accessibility<br>Public Health and Safety:<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Chaff-ship fibers<br>Non-Ingestible Material:<br>Chaff-ship cartridge<br>Military Recoverable Material<br>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td>None</td></tr>
<tr><td>Explosive Bins</td><td>None</td></tr>
</table>

| Electronic Warfare | |
|---|---|
| **Counter Targeting Chaff Exercise – Ship** | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | This activity occurs greater than 12 NM from land. |

### A.1.5.3 Counter Targeting Flare Exercise – Aircraft

| Electronic Warfare | | | |
|---|---|---|---|
| **Counter Targeting Flare Exercise - Aircraft** | | | |
| **Short Description** | Fixed-wing aircraft and helicopter aircrews deploy flares to disrupt threat infrared missile guidance systems. | **Typical Duration** | 1–2 hours |
| **Long Description** | Fixed-wing aircraft and helicopter aircrews deploy flares to disrupt threat infrared missile guidance systems. Range personnel acting as opposition forces may use pyrotechnics to simulate missile launch.<br><br>Aircraft detect electronic targeting signals from threat radars or missiles, or a threat missile plume, when launched and 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. | | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, rotary-wing aircraft<br>**Targets:** None<br>**Systems being Trained/Tested:** None | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Training and Testing Study Area | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Military expended materials<br>**Ingestion:**<br>Military expended materials – other than munitions | **Energy:**<br>In-air electromagnetic devices<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Metals Other materials | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>None | **Socioeconomic Resources:**<br>Airborne acoustics | **Public Health and Safety:**<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>Per flare: one casing, one compression pad or one plastic piston, one plastic endcap, one O-ring<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | None | | |

| Electronic Warfare | |
|---|---|
| **Counter Targeting Flare Exercise - Aircraft** | |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | None |
| **Assumptions Used for Analysis** | Approximately five flares per aircraft.<br>This activity typically occurs greater than 12 NM from land. However, rotary-wing events may occur closer to land (up to 3 NM when crew-served EW threat emitters [MANPADS] are employed). |

### A.1.5.4 Electronic Warfare Operations

<table>
<tr><th colspan="4">Electronic Warfare</th></tr>
<tr><th colspan="4">Electronic Warfare Operations</th></tr>
<tr><td>Short Description</td><td colspan="2">Aircraft and surface ship crews control portions of the electromagnetic spectrum used by enemy systems to degrade or deny the enemy's ability to take defensive actions.</td><td>Typical Duration<br>1–2 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">Aircraft and surface ship crews control the electromagnetic spectrum used by enemy systems to degrade or deny the enemy's ability 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 ships 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 ship maneuvers and either chaff, flares, active electronic countermeasures, or a combination of them to defeat the threat.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Fixed-wing aircraft, rotary-wing aircraft, surface combatant<br>Targets: Aircraft targets; electronic warfare targets<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Vessel safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Aircraft noise<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Ingestion:<br>None</td><td>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Metals<br>Other materials</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>None</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>Expendable decoys</td><td>Military Recoverable Material</td><td>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">Physical Disturbance and Strike Stressors: (Section 5.3.4)<br>Vessel movement</td></tr>
</table>

| Electronic Warfare | |
|---|---|
| **Electronic Warfare Operations** | |
| **Assumptions Used for Analysis** | All chaff and flares involved in this event are covered under chaff exercise and flare exercises, respectively. |

## A.1.6 Expeditionary Warfare

### A.1.6.1 Parachute Insertion

| Expeditionary Warfare | | | |
|---|---|---|---|
| **Parachute Insertion** | | | |
| **Short Description** | Military personnel train for covert insertion into target areas using parachutes. | **Typical Duration**<br>2–8 hours | |
| **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. | | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, rotary-wing aircraft, tilt-rotor aircraft, small boat<br>**Targets:** None<br>**Systems being Trained/Tested:** None | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Vessel safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Range Complex parachute drop zones; Guam; Tinian; Rota | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>Vessel noise<br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessel and in-water devices<br>**Ingestion:**<br>None | **Energy:**<br>None<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Other materials | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Accessibility<br>Physical disturbance and strike<br>Airborne acoustics | **Public Health and Safety:**<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | Decelerators/parachutes |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement | | |
| **Assumptions Used for Analysis** | Combat swimmers inserted at sea may transit through surf zone onto beach. | | |

## A.1.6.2 Personnel Insertion/Extraction

| Expeditionary Warfare | |
|---|---|
| **Personnel Insertion/Extraction** | |
| **Short Description** | Military personnel train for covert insertion and extraction into target areas using helicopters, fixed-wing (insertion only), small boats, and submersibles.<br>**Typical Duration**<br>2–8 hours |
| **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. |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, rotary-wing aircraft, tilt-rotor aircraft, small craft, submersibles<br>**Targets:** None<br>**Systems being Trained/Tested:** None |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Vessel safety<br>**Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Range Complex; Guam; Tinian; Rota; Saipan<br>**Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>Vessel noise<br>**Explosive:**<br>None<br>**Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessel and in-water devices<br>**Ingestion:**<br>None<br>**Energy:**<br>None<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants<br>**Sediments and Water Quality:**<br>None |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Physical disturbance and strike<br>**Socioeconomic Resources:**<br>Accessibility<br>Physical disturbance and strike<br>**Public Health and Safety:**<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>None<br>**Military Recoverable Material**<br>Decelerators/parachutes |
| **Sonar and Other Transducer Bins** | None |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | During the conduct of insertion/extraction activities personnel may exit the watercraft in the surf zone and divers and combat swimmers will stand in the surf zone and walk onto the beach. |

## A.1.7 Mine Warfare

Mine warfare 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 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.1.7.1 Civilian Port Defense

<table>
<tr><th colspan="4">Mine Warfare</th></tr>
<tr><th colspan="4">Civilian Port Defense</th></tr>
<tr><td>Short Description</td><td colspan="2">Maritime security personnel train to protect civilian ports and harbors against enemy efforts to interfere with access to those ports.</td><td>Typical Duration<br>Multiple days</td></tr>
<tr><td>Long Description</td><td colspan="3">Naval forces provide Mine Warfare capabilities to support Department of Homeland Security sponsored events. The three pillars of mine warfare, airborne (helicopter), surface (surface ships), and undersea (divers, marine mammals, and unmanned vehicles) mine countermeasures will be brought to bear in order to ensure strategic U.S. ports remain free of mine threats. Various mine warfare sensors, which utilize active acoustics, will be employed in the detection, classification, and neutralization of mines. Along with traditional mine warfare techniques, such as helicopter towed mine countermeasures, new technologies (unmanned vehicles) will be utilized.<br><br>Event locations and scenarios will vary according to Department of Homeland Security strategic goals and evolving world events.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Mine warfare ship, rotary-wing aircraft, small boat, unmanned underwater vehicle<br>Targets: Mine shapes<br>Systems being Trained/Tested: Mine detection systems, towed mine neutralization systems, airborne mine neutralization system</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Aircraft safety<br>Unmanned aerial and underwater vehicle procedures<br>Towed in-water device safety<br>Laser Procedures<br>Target deployment and retrieval safety<br>Pierside testing safety</td><td colspan="2">Typical Locations<br><br>Range Complexes/Testing Ranges:<br>Mariana Islands Range Complex<br><br>Bays/Estuaries/Pierside:<br>Mariana littorals<br>Inner and Outer Apra Harbor</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Sonar and other transducers<br>Aircraft noise<br>Vessel noise<br><br>Explosive:<br>In-air explosions<br>In-water explosions</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Seafloor devices<br>Military expended materials<br><br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions</td><td>Energy:<br>In-water electromagnetic devices<br>In-air electromagnetic devices<br>Entanglement:<br>Wires and cables<br>Decelerators/Parachutes</td></tr>
</table>

| Mine Warfare | | | |
|---|---|---|---|
| **Civilian Port Defense** | | | |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Explosives<br>Metals<br>Chemicals<br>Other materials | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Explosives<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>In-air energy<br>Underwater energy<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | Mine shapes (non-explosive) |
| **Sonar and Other Transducer Bins** | **High-Frequency:**<br>HF4 | **Synthetic Aperture Sonar:**<br>SAS2 | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Towed in-water devices | |
| **Assumptions Used for Analysis** | Non-permanent mine shapes will be laid in various places on the bottom and will be retrieved Shapes are varied, from about 1 m circular to about 2.5 meters long by 1 meter wide. They will be recovered using normal assets, with diver involvement. | | |

### A.1.7.2 Limpet Mine Neutralization System

<table>
<tr><th colspan="4">Mine Warfare</th></tr>
<tr><th colspan="4">Limpet Mine Neutralization System</th></tr>
<tr><td>Short Description</td><td colspan="2">Navy Explosive Ordnance Disposal divers place a small charge on a simulated underwater mine.</td><td>Typical Duration<br>2 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">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. Navy Explosive Ordnance Divers place a single shock wave generator of Limpet Mine Neutralizing Systems on the mine that is located mid-water column, within water depths of 10 to 20 feet. A bag is placed over the mine to catch falling debris.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Support craft<br>Targets: Mine Shapes<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>None<br>Bays/Estuaries/Pierside:<br>Mariana littorals<br>Inner and Outer Apra Harbor</td></tr>
<tr><td>Stressors to Biological Resources</td><td colspan="3">Acoustic:<br>Vessel noise<br>Explosive:<br>In-water explosions (de minimis)<br>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Ingestion:<br>None<br>Energy:<br>None<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="3">Air Quality:<br>Criteria air pollutants<br>Sediments and Water Quality:<br>Explosives<br>Metals<br>Chemicals</td></tr>
<tr><td>Stressors to Human Resources</td><td colspan="3">Cultural Resources:<br>Physical disturbance and strike<br>Socioeconomic Resources:<br>Accessibility<br>Physical disturbance and strike<br>Airborne acoustics<br>Public Health and Safety:<br>Physical interactions<br>Underwater energy</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>Sub-surface target (stationary)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">Physical Disturbance and Strike Stressors: (Section 5.3.4)<br>Vessel movement</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="3">De minimis small explosive charges would be used during this activity and not quantitatively analyzed and therefore are not included under munitions.</td></tr>
</table>

### A.1.7.3 Mine Neutralization – Remotely Operated Vehicle Sonar

| Mine Warfare | | | |
|---|---|---|---|
| **Mine Neutralization – Remotely Operated Vehicle Sonar** | | | |
| **Short Description** | Ship, small boat, and helicopter crews locate and disable mines using remotely operated underwater vehicles. | **Typical Duration** | 1–4 hours |
| **Long Description** | Ship, small boat, 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. | | |
| **Typical Components** | **Platforms:** Rotary-wing aircraft, surface combatants, small boat<br>**Targets:** Mine shapes<br>**Systems being Trained/Tested:** Towed sonar systems, underwater explosives | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Towed in-water device safety<br>Vessel safety<br>Target deployment and retrieval safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Training and Testing Study Area | **Bays/Estuaries/Pierside:**<br>Mariana littorals and Outer Apra Harbor |
| **Stressors to Biological Resources** | **Acoustic:**<br>Sonar and other transducers<br>Aircraft noise<br>Vessel noise<br>**Explosive:**<br>In-water explosions | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Military expended materials<br>Seafloor devices<br>**Ingestion:**<br>Military expended materials – munitions<br>Military expended materials – other than munitions | **Energy:**<br>In-air electromagnetic devices<br>In-water electromagnetic devices<br>**Entanglement:**<br>Wires and cables |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Explosives<br>Metals | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Explosives<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>Underwater energy<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>Neutralizer fragments<br>**Non-Ingestible Material:**<br>Fiber optic cable, fiber optic can | **Military Recoverable Material** | Mine shapes (non-explosive) |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | E4 | | |
| **Procedural Mitigation Measures** | **Explosive Stressors:** *(Section 5.3.3)*<br>Explosive Mine Countermeasure and Neutralization Activities | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Towed in-water devices | |

| Mine Warfare | |
|---|---|
| **Mine Neutralization – Remotely Operated Vehicle Sonar** | |
| **Assumptions Used for Analysis** | Fiber optic cable is only expended during use of explosive mine neutralizers. |

### A.1.7.4 Mine Countermeasure Exercise – Surface Ship Sonar

| | |
|---|---|
| **Mine Warfare** | |
| **Mine Countermeasure Exercise – Surface Sonar** | |
| **Short Description** | Ship crews detect, locate, identify, and avoid mines while navigating restricted areas or channels, such as while entering or leaving port.<br>**Typical Duration:** Up to 15 hours |
| **Long Description** | This event trains 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.<br>Ships will use active sonar to search the area ahead of the ship for moored mines or other hazards of navigation. |
| **Typical Components** | **Platforms:** Mine sweeper, Surface combatant<br>**Targets:** Mine shapes<br>**Systems being Trained/Tested:** High-frequency sonar, mid-frequency sonar |
| **Standard Operating Procedures** *(Section 2.3.3)* | Vessel safety<br>Target deployment and retrieval safety<br>**Typical Locations**<br>**Range Complexes/Testing Ranges:** Mariana Islands Training and Testing Study Area<br>**Bays/Estuaries/Pierside:** Apra Harbor |
| **Stressors to Biological Resources** | **Acoustic:** Sonar and other transducers; Vessel noise<br>**Explosive:** None<br>**Physical Disturbance and Strike:** Vessels and in-water devices; Seafloor devices<br>**Ingestion:** None<br>**Energy:** In-air electromagnetic devices<br>**Entanglement:** None |
| **Stressors to Physical Resources** | **Air Quality:** Criteria air pollutants<br>**Sediments and Water Quality:** None |
| **Stressors to Human Resources** | **Cultural Resources:** None<br>**Socioeconomic Resources:** Accessibility<br>**Public Health and Safety:** Underwater energy; Physical interactions |
| **Military Expended Material** | **Ingestible Material:** None<br>**Non-Ingestible Material:** None<br>**Military Recoverable Material:** Mine shapes (non-explosive) |
| **Sonar and Other Transducer Bins** | **High-Frequency Sonar:** HF4<br>Mid-Frequency Sonar: MF1K |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)* Active sonar<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)* Vessel movement |
| **Assumptions Used for Analysis** | Existing placed mine shapes or targets of opportunity (buoys) to be used. There is potential for temporarily placed mine shapes to be used. |

## A.1.7.5 Mine Countermeasure – Towed Mine Neutralization

<table>
<tr><th colspan="4">Mine Warfare</th></tr>
<tr><th colspan="4">Mine Countermeasures – Towed Mine Neutralization</th></tr>
<tr><td>Short Description</td><td colspan="2">Helicopter aircrews, manned and unmanned vehicles tow systems through the water which are designed to disable or trigger mines.</td><td>Typical Duration<br>Up to 12 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">Helicopter, vehicle operators and unmanned vehicles use towed devices to trigger mines that are designed to detonate 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 be conducted either with 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.<br><br>Devices used may 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.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Mine warfare ship, rotary-wing aircraft, unmanned surface vehicle<br>Targets: Mine Shapes<br>Systems being Trained/Tested: Electromagnetic devices</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Towed in-water device safety<br>Vessel safety<br>Unmanned surface vehicle safety<br>Pierside testing safety<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside:<br>Apra Harbor</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Aircraft noise<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial target<br>Vessels and in-water devices<br>Seafloor devices<br>Ingestion:<br>None</td><td>Energy:<br>In-water electromagnetic devices<br>In-air electromagnetic devices<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>None</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Underwater energy<br>In-air energy<br>Physical interactions</td></tr>
</table>

| Mine Warfare | | | |
|---|---|---|---|
| **Mine Countermeasures – Towed Mine Neutralization** | | | |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | Mine shape (non-explosive) |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Towed in-water devices | | |
| **Assumptions Used for Analysis** | Mechanical sweeping (cable cutting), acoustic and magnetic influence sweeping devices are towed from helicopters, surface vessels, and unmanned vehicles. Cable cutters utilize an insignificant charge (similar to a shotgun shell). Acoustic sweeps generate ship type noise via a mechanical system. Towing systems though minefields (or without mines, to train to deploy, tow, and recover) may involve instrumented mines.<br>Mine shapes would be recovered. | | |

### A.1.7.6 Mine Countermeasure – Towed Mine Detection

<table>
<tr><th colspan="4">Mine Warfare</th></tr>
<tr><th colspan="4">Mine Countermeasures – Towed Mine Detection</th></tr>
<tr><td>Short Description</td><td colspan="2">Helicopter aircrews, manned and unmanned vehicles detect mines using towed or laser mine detection systems.</td><td>Typical Duration<br>Typically 1.5 hours up to 4 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">Helicopter aircrews, manned and unmanned vehicles 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/items. Airborne devices utilize laser systems to locate mines located below the surface.<br><br>Devices used include the ANAQS-20/A, towed mine-hunting 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.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Mine warfare ship, rotary-wing aircraft, unmanned surface vehicles<br>Targets: Mine shapes<br>Systems being Trained/Tested: Mine detection systems</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Vessel safety<br>Unmanned surface vehicle safety<br>Laser Procedures<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside:<br>Apra Harbor</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Aircraft noise<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial target<br>Vessels and in-water devices<br>Seafloor devices<br>Ingestion:<br>None</td><td>Energy:<br>None<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>None</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Underwater energy<br>In-air energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>Mine shapes (non-explosive)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
</table>

| Mine Warfare | |
|---|---|
| **Mine Countermeasures – Towed Mine Detection** | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Towed in-water devices<br>Vessel movement |
| **Assumptions Used for Analysis** | Sonar mine detection systems towed from helicopters and surface vessels.<br>Airborne laser systems used to detect mine shapes.<br>Laser systems are similar to commercial Light Detection And Ranging systems. The in-air low energy laser stressor was used in analysis of potential impacts on human resources.<br>Mine shapes may be deployed via ship and will be recovered. |

### A.1.7.7 Mine Countermeasure Exercise – Towed Sonar

| Mine Warfare | | | |
|---|---|---|---|
| **Mine Countermeasure Exercise – Towed Sonar** | | | |
| **Short Description** | Surface ship crews detect and avoid mines while navigating restricted areas or channels using towed active sonar systems. | **Typical Duration** | 1–4 hours |
| **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. | | |
| **Typical Components** | **Platforms:** Surface combatant, unmanned aerial vehicles, unmanned surface vehicles<br>**Targets:** Mine shapes<br>**Systems being Trained/Tested:** High frequency sonar | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Unmanned aerial, surface, and subsurface vehicle safety<br>Vessel safety<br>Laser Procedures<br>Target deployment and retrieval safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Training and Testing Study Area | **Bays/Estuaries/Pierside:**<br>Apra Harbor |
| **Stressors to Biological Resources** | **Acoustic:**<br>Sonar and other transducers<br>Vessel noise<br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessel and in-water devices<br>Seafloor devices<br>**Ingestion:**<br>None | **Energy:**<br>In-air electromagnetic devices<br>In-water electromagnetic devices<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Explosives | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>Underwater energy<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | Mine shapes (non-explosive) |
| **Sonar and Other Transducer Bins** | **High Frequency:**<br>HF4 | | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Towed-in water devices | |

| **Mine Warfare** | |
|---|---|
| **Mine Countermeasure Exercise – Towed Sonar** | |
| **Assumptions Used for Analysis** | No explosives used.<br>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.<br>Existing placed mine shapes to be used. Potential for temporary placement of mine shapes. |

### A.1.7.8 Mine Laying

| Mine Warfare | | | |
|---|---|---|---|
| **Mine Laying** | | | |
| **Short Description** | Fixed-wing aircraft drop non-explosive mine shapes. | **Typical Duration** | 1 hour |
| **Long Description** | Fixed-wing aircraft lay offensive or defensive mines for a tactical advantage for friendly forces. Fixed-wing aircraft lay a precise minefield pattern for specific tactical situations. The aircrew typically makes multiple passes in the same flight pattern, and drop one or more training shapes per pass (four shapes total). Training shapes are non-explosive and are recovered when possible. | | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, support vessels<br>**Targets:** Mine shapes<br>**Systems being Trained/Tested:** None | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Target deployment and retrieval safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace, nearshore FDM. | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>Vessel noise<br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Military expended materials<br>Seafloor devices<br>**Ingestion:**<br>None | **Energy:**<br>None<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Metals | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>Mine shapes (non-explosive) | **Military Recoverable Material** | Mine shapes (non-explosive) |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Non-explosive bombs and mine shapes | | |
| **Assumptions Used for Analysis** | Mine laying is similar to a non-explosive bombing exercise.<br>While some mine shapes will be recovered if possible, assume they will not for the analysis.<br>Nearshore/shallow water events will be planned to minimize/avoid coral impacts. | | |

### A.1.7.9 Mine Neutralization – Explosive Ordnance Disposal

<table>
<tr><th colspan="4">Mine Warfare</th></tr>
<tr><th colspan="4">Mine Neutralization Explosive Ordnance Disposal</th></tr>
<tr><td>Short Description</td><td colspan="2">Personnel disable threat mines using explosive charges.</td><td>Typical Duration<br>Up to 4 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">Navy divers, typically explosive ordnance disposal personnel, disable threat mines with explosive charges to create a safe channel for friendly vessels to transit.<br><br>Personnel detect, identify, evaluate, and neutralize mines in the water with an explosive device and may involve detonation of one or more explosive typically up to 20 pounds (lb.) of TNT equivalent. These operations are normally conducted during daylight hours for safety reasons.<br><br>Time delay fuses may be used for these events.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Rotary-wing aircraft, small boats<br>Targets: Mine shapes<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Underwater detonation safety<br>Aircraft safety<br>Vessel safety<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Agat Bay underwater detonation site<br>Piti and Outer Apra Harbor underwater detonation sites<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Aircraft noise<br>Vessel noise<br><br>Explosive:<br>In-water explosions</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Military expended materials<br>Seafloor devices<br><br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions</td><td>Energy:<br>None<br><br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Explosives<br>Metals<br>Chemicals<br>Other materials</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Explosives<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Underwater energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Target fragments<br><br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>Mine shapes (non-explosive)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
</table>

| Mine Warfare | |
|---|---|
| **Mine Neutralization Explosive Ordnance Disposal** | |
| **Explosive Bins** | E5 E6 |
| **Procedural Mitigation Measures** | **Explosive Stressors:** *(Section 5.3.3)*<br>Explosive Mine Neutralization Activities Involving Navy Divers<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | Charge placed anywhere in water column, including bottom.<br>Mine shapes will be recovered when practicable. Some will explode, and fragments will not be recovered.<br>Agat Bay underwater detonation site has a maximum charge size of 20 lb. net explosive weight (NEW). Piti and Outer Apra Harbor underwater detonation sites have a maximum charge size of 10 lb. NEW. |

## A.1.7.10 Submarine Mine Exercise

| **Mine Warfare** | |
|---|---|
| **Submarine Mine Exercise** | |
| **Short Description** | Submarine crews practice detecting mines in a designated area. <br>**Typical Duration:** Varies |
| **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 high-frequency sonar to locate and avoid the mine shapes. Each mine avoidance exercise involves one submarine operating the high-frequency sonar to navigate through the training minefield |
| **Typical Components** | **Platforms:** Submarines<br>**Targets:** Mine shapes<br>**Systems being Trained/Tested:** High-frequency sonar (hull mounted) |
| **Standard Operating Procedures** *(Section 2.3.3)* | Vessel safety<br>Target deployment and retrieval safety<br>**Typical Locations**<br>**Range Complexes/Testing Ranges:** Mariana Islands Training and Testing Study Area; nearshore, littorals<br>**Bays/Estuaries/Pierside:** |
| **Stressors to Biological Resources** | **Acoustic:** Sonar and other transducers<br>**Explosive:** None<br>**Physical Disturbance and Strike:** Vessels and in-water devices; Military expended materials; Seafloor Devices<br>**Ingestion:** None<br>**Energy:** None<br>**Entanglement:** None |
| **Stressors to Physical Resources** | **Air Quality:** None<br>**Sediments and Water Quality:** None |
| **Stressors to Human Resources** | **Cultural Resources:** None<br>**Socioeconomic Resources:** None<br>**Public Health and Safety:** Underwater energy; Physical interactions |
| **Military Expended Material** | **Ingestible Material:** None<br>**Non-Ingestible Material:** None<br>**Military Recoverable Material:** Mine shapes (non-explosive) |
| **Sonar and Other Transducer Bins** | **High Frequency:** HF1 |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)* Active sonar<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)* Vessel movement |

| Mine Warfare | |
|---|---|
| **Submarine Mine Exercise** | |
| **Assumptions Used for Analysis** | There is potential for temporarily placed mine shapes to be used. |

### A.1.7.11 Surface Ship Object Detection

<table>
<tr><th colspan="5">Mine Warfare</th></tr>
<tr><th colspan="5">Surface Ship Object Detection</th></tr>
<tr><td>Short Description</td><td colspan="2">Ship crews detect and avoid mines while navigating restricted areas or channels using active sonar.</td><td colspan="2">Typical Duration<br>Up to 15 hours</td></tr>
<tr><td>Long Description</td><td colspan="4">Surface ship crews detect and avoid mines or other underwater hazardous objects while navigating restricted areas or channels using active sonar. A Littoral Combat Ship utilizes unmanned surface vehicles and remotely operated vehicles to tow mine detection (hunting) equipment. Systems will operate from a shallow zone greater than 40 feet (ft.) to deep water. Events could be embedded within major training exercises.</td></tr>
<tr><td>Typical Components</td><td colspan="4">Platforms: Surface combatant, unmanned surface vehicle<br>Targets: Sub-surface targets (mine shapes), targets of opportunity (buoys, fish aggregating devices)<br>Systems being Trained/Tested: High-frequency sonar, mid-frequency sonar, towed sonar systems</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Unmanned aerial and underwater vehicle procedures<br>Towed in-water device safety<br>Target deployment and retrieval safety</td><td colspan="3">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside:<br>Apra Harbor</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Sonar and other transducers<br>Vessel noise<br>Explosive:<br>None</td><td colspan="2">Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Seafloor devices<br>Ingestion:<br>None</td><td>Energy:<br>None<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="2">Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>None</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td colspan="2">Socioeconomic Resources:<br>Accessibility<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Underwater energy<br>In-air energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td colspan="2">Ingestible Material:<br>None<br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>Mine shapes (non-explosive)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="2">Mid-Frequency:<br>MF1K</td><td colspan="2">High-Frequency:<br>None</td></tr>
<tr><td>Explosive Bins</td><td colspan="4">None</td></tr>
</table>

| Mine Warfare | | |
|---|---|---|
| **Surface Ship Object Detection** | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:**<br>Active sonar | **Physical Disturbance and Strike:**<br>Vessel movement<br>Towed in-water devices |
| **Assumptions Used for Analysis** | No explosives are used.<br>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 ft. and greater.<br>Existing placed mine shapes/targets of opportunity to be used. There is the potential for temporary placement of mine shapes.<br>Potential locations for this activity include Mariana Littorals and Apra Harbor. | |

### A.1.7.12 Underwater Demolition Qualification and Certification

| Mine Warfare | | | |
|---|---|---|---|
| **Underwater Demolition Qualification and Certification** | | | |
| **Short Description** | Navy divers conduct various levels of training and certification in placing underwater demolition charges. | **Typical Duration** | Varies |
| **Long Description** | Underwater explosive charges, up to 20 lb. net explosive weight are detonated to complete training qualification or certification. | | |
| **Typical Components** | **Platforms:** Rotary-wing aircraft, small boats<br>**Targets:** Mine shapes<br>**Systems being Trained/Tested:** None | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Vessel safety<br>Underwater detonation safety<br>Target deployment and retrieval safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Agat Bay underwater detonation site<br>Piti and Outer Apra Harbor underwater detonation sites | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>Vessel noise<br>**Explosive:**<br>In-air explosions<br>In-water explosions | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Military expended materials<br>Seafloor devices<br>**Ingestion:**<br>Military expended materials – other than munitions | **Energy:**<br>None<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Explosives<br>Metals | Chemicals<br>Other materials |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Explosives<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>Underwater energy<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>Target fragments<br>**Non-Ingestible Material:**<br>Mine shape (non-explosive) | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | E5 | E6 | |
| **Procedural Mitigation Measures** | **Explosive Stressors:** *(Section 5.3.3)*<br>Explosive mine neutralization activities involving Navy divers | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement | |

| Mine Warfare | |
|---|---|
| **Underwater Demolition Qualification and Certification** | |
| **Assumptions Used for Analysis** | Agat Bay underwater detonation site has a maximum charge size of 20 lb. net explosive weight (NEW). Piti and Outer Apra Harbor underwater detonation sites have a maximum charge size of 10 lb. NEW. |

## A.1.8 Strike Warfare

### A.1.8.1 Bombing Exercise (Air-to-Ground)

| | | | |
|---|---|---|---|
| **Strike Warfare** | | | |
| **Bombing Exercise (Air-to-Ground)** | | | |
| **Short Description** | Fixed-wing aircraft drop bombs against a land target. | **Typical Duration**<br>1–2 hours | |
| **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. | | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft<br>**Targets:** Land targets<br>**Systems being Trained/Tested:** Targeting laser systems | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Laser Procedures | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Farallon de Medinilla, R-7201, R-7201A | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Military expended material<br>**Ingestion:**<br>None | **Energy:**<br>None<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria pollutants | **Sediments and Water Quality:**<br>Metals | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Explosives<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Airborne acoustics | **Public Health and Safety:**<br>None |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | None | | |
| **Assumptions Used for Analysis** | Bombs are released in accordance with range standard operating procedures. Land targets only. | | |

### A.1.8.2 Gunnery Exercise (Air-to-Ground)

| Strike Warfare | | | |
|---|---|---|---|
| **Gunnery Exercise (Air-to-Ground)** | | | |
| **Short Description** | Helicopter crews fire guns at stationary land targets; fixed-wing aircraft also strafe land targets. | **Typical Duration** | 1 hour |
| **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.<br>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. | | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, rotary-wing aircraft<br>**Targets:** Land targets<br>**Systems being Trained/Tested:** Targeting laser systems | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Weapons firing safety<br>Laser procedures | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Farallon de Medinilla, R 7201, R 7201A | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>Weapons noise<br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Military expended materials<br>**Ingestion:**<br>Military expended materials – munitions | **Energy:**<br>None<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria pollutants | **Sediments and Water Quality:**<br>Metals | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Explosives<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Airborne acoustics | **Public Health and Safety:**<br>None |
| **Military Expended Material** | **Ingestible Material:**<br>Projectile casings<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | None | | |
| **Assumptions Used for Analysis** | Land based targets only | | |

### A.1.8.3 Missile Exercise

| **Strike Warfare** | | | |
|---|---|---|---|
| **Missile Exercise (MISSILEX)** | | | |
| **Short Description** | Missiles or rockets are launched against a land target. | **Typical Duration** | 1–2 hours |
| **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. | | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, rotary-wing aircraft, surface ships, submarines<br>**Targets:** Land targets<br>**Systems being Trained/Tested:** Targeting Lasers | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Weapons firing safety<br>Vessel safety<br>Laser Procedures | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Farallon de Medinilla, R 7201, R 7201A | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>Weapons noise<br>Vessel noise<br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial target<br>Military expended materials<br>Vessel and in-water device<br>**Ingestion:**<br>None | **Energy:**<br>None<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria pollutants | **Sediments and Water Quality:**<br>Metals | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Explosives<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Airborne acoustics | **Public Health and Safety:**<br>None |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>Missile booster sections | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | Land based, various munitions included. | | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:**<br>*(Section 5.3.4)*<br>Vessel movement | | |
| **Assumptions Used for Analysis** | Land based targets only | | |

### A.1.9 Surface Warfare Training

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 small boats. Aircraft-to-surface warfare is conducted by long-range attacks using air-launched cruise missiles, precision guided munitions, or aircraft guns. 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 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.

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.1.9.1 Bombing Exercise Air-to-Surface

| **Surface Warfare** | |
|---|---|
| **Bombing Exercise Air-to-Surface** | |
| **Short Description** | Fixed-wing aircrews deliver bombs against surface targets.<br>**Typical Duration**<br>1 hour |
| **Long Description** | Fixed-wing aircraft conduct bombing exercises against stationary floating targets (e.g., MK-58 smoke buoy), towed targets, or maneuvering targets. An aircraft clears the area, deploys a smoke buoy, and then delivers high-explosive or non-explosive practice munitions bomb(s) on the target. A range boat may be used to deploy towed or maneuvering targets for an aircraft to attack.<br><br>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. The following munitions may be employed by strike fighter aircraft in the course of bombing exercise: Unguided munitions include non-explosive subscale bombs (MK-76 and BDU-45), explosive and non-explosive general purpose bombs (MK-80 series), MK-20 cluster bomb (explosive, non-explosive). Precision-guided munitions include laser-guided bombs (explosive, non-explosive), laser-guided training rounds (non-explosive), Joint Direct Attack Munition (explosive, non-explosive). |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, support craft<br>**Targets:** Surface targets<br>**Systems being Trained/Tested:** Aircraft platforms, bombs, non-explosive practice munitions, targeting lasers |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Weapons firing safety<br>Laser Procedures<br><br>**Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace<br>**Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Vessel noise<br>Aircraft noise<br>Weapons noise<br>**Explosive:**<br>In-water explosions<br>**Physical Disturbance and Strike:**<br>Aircraft and aerial target<br>Vessels and in-water devices<br>Military expended materials<br>**Ingestion:**<br>Military expended materials – munitions<br>Military expended materials – other than munitions<br>**Energy:**<br>None<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants<br>**Sediments and Water Quality:**<br>Explosives<br>Metals |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Explosives<br>Physical disturbance and strike<br>**Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike<br>**Public Health and Safety:**<br>Underwater energy<br>In-air energy<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>Bomb fragments, target fragments<br>**Non-Ingestible Material:**<br>Bomb (non-explosive), marine marker, surface target (stationary) |
| **Military Recoverable Material** | None |

| Surface Warfare | |
|---|---|
| **Bombing Exercise Air-to-Surface** | |
| **Sonar and Other Transducer Bins** | None |
| **Explosive Bins** | E9 E10 E12 |
| **Procedural Mitigation Measures** | **Explosive Stressors:** *(Section 5.3.3)*<br>Explosive bombs<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Non-explosive bombs and mine shapes |
| **Assumptions Used for Analysis** | Explosive bombs are assumed to explode just below the surface.<br>This activity would occur at least 12 NM from land (FDM excepted). |

### A.1.9.2 Gunnery Exercise Air-to-Surface Medium-Caliber

| Surface Warfare | | | |
|---|---|---|---|
| **Gunnery Exercise Air-to-Surface Medium-Caliber** | | | |
| **Short Description** | Fixed-wing and helicopter aircrews fire medium-caliber guns at surface targets. | **Typical Duration** | 1 hour |
| **Long Description** | Fighter and helicopter aircrew, 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 will fly a racetrack pattern around an at-sea target. Aircrew will engage the target with medium-caliber weapons. Targets range from a smoke float, or an empty steel drum, to high speed remote controlled boats and jet-skis. | | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, rotary-wing aircraft, support vessels<br>**Targets:** Surface targets<br>**Systems being Trained/Tested:** Medium-caliber gun systems | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Weapons firing safety<br>Target deployment and retrieval safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Vessel noise<br>Aircraft noise<br>Weapons noise<br>**Explosive:**<br>In-air explosions<br>In-water explosions | **Physical Disturbance and Strike:**<br>Aircraft and aerial target<br>Vessels and in-water devices<br>Military expended materials<br>**Ingestion:**<br>Military expended materials – munitions<br>Military expended materials – other than munitions | **Energy:**<br>None<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Metals<br>Explosives | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Physical disturbance and strike<br>Explosives | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>Underwater energy<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>Medium-caliber casings, medium caliber projectiles<br>**Non-Ingestible Material:**<br>Marine marker | **Military Recoverable Material** | Surface target (mobile and stationary) |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | E0 (*de minimis*), E1, and E2 | | |

| Surface Warfare | | |
|---|---|---|
| **Gunnery Exercise Air-to-Surface Medium-Caliber** | | |
| **Procedural Mitigation Measures** | **Explosive Stressors:** *(Section 5.3.3)*<br>Explosive medium-caliber and large-caliber projectiles | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Small-, medium-, and large-caliber non-explosive practice munitions |
| **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. Fixed-wing casings remain with aircraft, and helicopter shell casings are expended into the water.<br><br>This activity occurs greater than 3 NM from land (FDM excepted). | |

### A.1.9.3 Gunnery Exercise Air-to-Surface Small-Caliber

<table>
<tr><th colspan="2">Surface Warfare</th></tr>
<tr><th colspan="2">Gunnery Exercise Air-to-Surface Small-Caliber</th></tr>
<tr><td>Short Description</td><td>Helicopter and tilt-rotor aircrews, use small-caliber guns to engage surface targets.<br>Typical Duration<br>1 hour</td></tr>
<tr><td>Long Description</td><td>Helicopters and tilt-rotor aircraft, fly a racetrack pattern around an at-sea target. Targets simulate enemy ships, boats, and floating/near-surface mines. 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.</td></tr>
<tr><td>Typical Components</td><td>Platforms: Rotary-wing aircraft, tilt-rotor aircraft<br>Targets: Surface targets (e.g., MK 58 marine marker, empty steel drum, high speed remote controlled boats and jet-skis)<br>Systems being Trained/Tested: Small-caliber gun systems</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Weapons firing safety<br>Target deployment and retrieval safety<br><br>Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Aircraft noise<br>Vessel noise<br>Weapons noise<br>Explosive:<br>None<br>Physical Disturbance and Strike:<br>Aircraft and aerial target<br>Vessels and in-water devices<br>Military expended materials<br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions<br>Energy:<br>None<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants<br>Sediments and Water Quality:<br>Metals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike<br>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike<br>Public Health and Safety:<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Small-caliber projectile (non-explosive), small-caliber casings<br>Non-Ingestible Material:<br>MK 58 marine marker<br>Military Recoverable Material<br>Surface target (mobile)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td>None</td></tr>
<tr><td>Explosive Bins</td><td>None</td></tr>
</table>

| Surface Warfare | | |
|---|---|---|
| **Gunnery Exercise Air-to-Surface Small-Caliber** | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Weapons firing noise | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Small-, medium-, and large-caliber non-explosive practice munitions |
| **Assumptions Used for Analysis** | One target used per event. Expendable smoke float (50 percent), stationary target (45 percent), or remote controlled target (5 percent).<br>This activity occurs greater than 12 NM from land. | |

### A.1.9.4 Gunnery Exercise Surface-to-Surface Boat Medium-Caliber

<table>
<tr><th colspan="4">Surface Warfare</th></tr>
<tr><th colspan="4">Gunnery Exercise Surface-to-Surface Boat Medium-Caliber</th></tr>
<tr><td>Short Description</td><td>Small boat crews fire medium-caliber guns at surface targets.</td><td colspan="2">Typical Duration<br>1 hour</td></tr>
<tr><td>Long Description</td><td colspan="3">Small boat crews fire medium-caliber guns at surface targets. Boat crews may use high or low speeds to approach and engage targets simulating other boats, floating mines, or nearshore land targets with medium-caliber (up to and including 40 millimeter [mm]) weapons. A commonly used target is an empty steel drum. This event also includes use of anti-swimmer grenades, which may be employed within harbors.<br><br>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.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Small boat<br>Targets: Surface targets<br>Systems being Trained/Tested: Medium-caliber gun systems</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Weapons firing safety<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Vessel noise<br>Weapons noise<br>Explosive:<br>In-air explosions<br>In-water explosions</td><td>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Military expended materials<br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions</td><td>Energy:<br>None<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Explosives<br>Metals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Explosives<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Underwater energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Grenade (explosive) fragments, medium-caliber projectiles (non-explosive), medium-caliber casings, target fragments<br>Non-Ingestible Material:<br>Surface target (stationary)</td><td>Military Recoverable Material</td><td>Surface target (stationary and mobile)</td></tr>
</table>

| Surface Warfare | |
|---|---|
| **Gunnery Exercise Surface-to-Surface Boat Medium-Caliber** | |
| **Sonar and Other Transducer Bins** | None |
| **Explosive Bins** | E2 |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Weapons firing noise<br>**Explosive Stressors:** *(Section 5.3.3)*<br>Explosive medium-caliber and large-caliber projectiles<br>Maritime security operations – anti swimmer grenades<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Small-, medium-, and large-caliber non-explosive practice munitions |
| **Assumptions Used for Analysis** | Assume all events include the use of some explosive rounds. Most events will involve boat crews training with MK 203 40 mm grenade launcher.<br>One target used per event, typically a stationary target such as a 50-liter steel drum.<br>Explosive rounds would be fired greater than 12 NM from land. Non-explosive rounds would be fired greater than 3 NM from land. |

### A.1.9.5 Gunnery Exercise Surface-to-Surface Boat Small-Caliber

<table>
<tr><th colspan="4">Surface Warfare</th></tr>
<tr><th colspan="4">Gunnery Exercise Surface-to-Surface Boat Small-Caliber</th></tr>
<tr><td>Short Description</td><td colspan="2">Small boat crews fire small-caliber guns at surface targets.</td><td>Typical Duration<br>1 hour</td></tr>
<tr><td>Long Description</td><td colspan="3">Small boat crews fire small-caliber guns at surface targets. Boat crews may use high or low speeds to approach and engage targets simulating other boats, swimmers, floating mines, or nearshore land targets with small-caliber (up to and including .50-caliber) weapons. A commonly used target is an empty steel drum.<br><br>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.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Small Boat<br>Targets: Surface Targets<br>Systems being Trained/Tested: Small-caliber gun systems</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Weapons firing safety<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br><br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td colspan="3">Acoustic:<br>Vessel noise<br>Weapons noise<br><br>Explosive:<br>In-air explosions<br><br>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Military expended materials<br><br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions<br><br>Energy:<br>None<br><br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="3">Air Quality:<br>Criteria air pollutants<br><br>Sediments and Water Quality:<br>Metals</td></tr>
<tr><td>Stressors to Human Resources</td><td colspan="3">Cultural Resources:<br>Physical disturbance and strike<br><br>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike<br><br>Public Health and Safety:<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Small caliber projectile (non-explosive), small caliber casings<br><br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>Surface target (mobile and stationary)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
</table>

| Surface Warfare | |
|---|---|
| **Gunnery Exercise Surface-to-Surface Boat Small-Caliber** | |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Weapons firing noise<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Small-, medium-, and large-caliber non-explosive practice munitions |
| **Assumptions Used for Analysis** | Events will occur relatively nearshore due to short range of boats and safety concerns. Events mostly occur within 3 nautical miles of the shoreline, but can occur further from shore. |

### A.1.9.6 Gunnery Exercise Surface-to-Surface Ship Large-Caliber

<table>
<tr><th colspan="4">Surface Warfare</th></tr>
<tr><th colspan="4">Gunnery Exercise Surface-to-Surface Ship – Large-Caliber</th></tr>
<tr><td>Short Description</td><td colspan="2">Surface ship crews fire large-caliber guns at surface targets.</td><td>Typical Duration<br>Up to 3 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">This exercise involves ships' gun crews engaging surface targets at sea with their main battery large-caliber (typically 57 millimeter [mm], 76 mm, and 5-inch) guns. Targets include the QST-35 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.<br><br>The exercise proceeds with the target boat approaching from about 10 nautical miles distance. The target is tracked by radar and when within a predetermined range, it is engaged first with large-caliber "warning shots." As threats get closer all weapons may be used to disable the threat.<br><br>This exercise may involve a single firing ship, or be undertaken in the context of a coordinated larger exercise involving multiple ships, including a major training exercise.<br><br>Large-caliber guns will also be fired during weapon certification events and in conjunction with weapon maintenance.<br><br>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).</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Surface combatant<br>Targets: Surface targets<br>Systems being Trained/Tested: Large-caliber gun systems</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Weapons firing safety</td><td colspan="2">Typical Locations<br><br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace<br><br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Vessel noise<br>Weapons noise<br><br>Explosive:<br>In-air explosions<br>In-water explosions</td><td>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Military expended materials<br><br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions</td><td>Energy:<br>In-air electromagnetic devices<br><br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Explosives<br>Metals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Explosives<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>In-air energy<br>Underwater energy<br>Physical interactions</td></tr>
</table>

<table>
<tr><th colspan="4">Surface Warfare</th></tr>
<tr><th colspan="4">Gunnery Exercise Surface-to-Surface Ship – Large-Caliber</th></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Large caliber projectile (explosive) fragments, target fragments<br>Non-Ingestible Material:<br>Large caliber projectile (non-explosive), large caliber casings<br>Surface target (stationary)</td><td>Military Recoverable Material</td><td>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">E5</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">Acoustic Stressors: (Section 5.3.2)<br>Weapons firing noise<br>Physical Disturbance and Strike Stressors: (Section 5.3.4)<br>Vessel movement<br>Small-, medium-, and large-caliber non-explosive practice munitions<br>Explosive Stressors: (Section 5.3.3)<br>Explosive medium-caliber and large-caliber projectiles</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="3">For analytical purposes assume all high explosive rounds are fused to detonate upon impact with water surface or target.<br>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.<br>This activity would occur greater than 12 NM from land (FDM excepted).</td></tr>
</table>

## A.1.9.7 Gunnery Exercise Surface-to-Surface Ship Small- and Medium-Caliber

<table>
<tr><th colspan="3">Surface Warfare</th></tr>
<tr><th colspan="3">Gunnery Exercise Surface-to-Surface Ship Small- and Medium-Caliber</th></tr>
<tr><td>Short Description</td><td>Surface ship crews fire medium and small-caliber guns at surface targets.</td><td>Typical Duration<br>2–3 hours</td></tr>
<tr><td>Long Description</td><td colspan="2">Ships use small- and medium-caliber weapons to practice defensive marksmanship, typically against a stationary floating target (a 10 foot diameter red balloon [Killer Tomato]) and high speed mobile targets. Some targets are expended during the exercise and are not recovered.<br><br>Shipboard protection systems (Close-In Weapon System) utilizing medium-caliber projectiles would train against high speed mobile targets.</td></tr>
<tr><td>Typical Components</td><td colspan="2">Platforms: Small boat, surface combatant<br>Targets: Surface Targets (e.g., stationary floating target, high speed mobile target)<br>Systems being Trained/Tested: Medium and small-caliber gun systems</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Weapons firing safety<br>Target deployment and retrieval safety</td><td>Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td colspan="2">Acoustic:<br>Vessel noise<br>Weapons noise<br>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Military expended materials<br>Energy:<br>In-air electromagnetic devices<br>Explosive: In-air explosions<br>In-water explosions<br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="2">Air Quality:<br>Criteria air pollutant<br>Sediments and Water Quality:<br>Explosives<br>Metals</td></tr>
<tr><td>Stressors to Human Resources</td><td colspan="2">Cultural Resources:<br>Explosives<br>Physical disturbance and strike<br>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike<br>Public Health and Safety:<br>In-air energy<br>Underwater energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Medium-caliber projectiles (non-explosive), medium-caliber projectile (explosive) fragments, small caliber projectile (explosive) fragments, small caliber projectile (non-explosive), small caliber casings, target fragments<br>Non-Ingestible Material:<br>Surface target (stationary)</td><td>Military Recoverable Material<br>Surface target (mobile) surface target (stationary)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="2">None</td></tr>
</table>

| Surface Warfare | |
|---|---|
| **Gunnery Exercise Surface-to-Surface Ship Small- and Medium-Caliber** | |
| **Explosive Bins** | E1 |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Weapons firing noise<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Small-, medium-, and large-caliber non-explosive practice munitions<br>**Explosive Stressors:** *(Section 5.3.3)*<br>Explosive medium-caliber and large-caliber projectiles |
| **Assumptions Used for Analysis** | One target used per event. Approximately 50 percent of targets are "Killer Tomatoes" (usually recovered). 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.<br>This activity would occur greater than 12 NM from land (FDM excepted). |

### A.1.9.8 Laser Targeting – At-Sea

| Surface Warfare | | | |
|---|---|---|---|
| **Laser Targeting – At-Sea** | | | |
| **Short Description** | Fixed-wing and helicopter aircrews and shipboard personnel illuminate enemy targets with lasers. | **Typical Duration** | 1–2 hours |
| **Long Description** | Fixed-wing 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 surface missiles and guided rockets. Events where weapons are fired are addressed in the appropriate activity (e.g., air-to-surface missile exercise).<br><br>Lower powered lasers may also be used as non-lethal deterrents during maritime security operations (force protection). | | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, rotary-wing aircraft, navy ships and boats, unmanned aerial system – rotary-wing<br>**Targets:** Surface targets<br>**Systems being Trained/Tested:** Aircraft platforms, lasers | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Unmanned aerial and underwater vehicle procedures<br>Vessel safety<br>Laser procedures<br>Target deployment and retrieval safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace | **Bays/Estuaries/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>Vessel noise<br><br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial target<br>Vessel and in-water devices<br><br>**Ingestion:**<br>None | **Energy:**<br>Lasers<br><br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>None | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>None | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics | **Public Health and Safety:**<br>In-air energy<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>None<br><br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | Surface target (mobile) |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement | | |

| Surface Warfare | |
|---|---|
| **Laser Targeting – At-Sea** | |
| **Assumptions Used for Analysis** | Laser targeting for missile/rocket guidance will occur in areas where these events also occur.<br>Use of lasers as force protection non-lethal deterrents will primarily occur proximate to Navy homeports. |

### A.1.9.9 Maritime Security Operations

<table>
<tr><th colspan="4">Surface Warfare</th></tr>
<tr><th colspan="4">Maritime Security Operations</th></tr>
<tr><td>Short Description</td><td>Helicopter, surface ship, and small boat crews conduct a suite of maritime security operations at sea, to include visit, board, search and seizure, maritime interdiction operations, force protection, and anti-piracy operations.</td><td colspan="2">Typical Duration<br>Up to 3 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">Helicopter and surface ship crews conduct a suite of maritime security operations (e.g., visit, board, search and seizure, maritime interdiction operations, force protection, and anti-piracy operations). 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, explosive Anti-Swimmer Grenades, and surveillance or reconnaissance unmanned surface and aerial vehicles. The entire exercise may last 2–3 hours.<br><br>Vessel Visit, Board, Search, and Seizure: Military personnel from ships and aircraft board suspect vessels, potentially under hostile conditions.<br><br>Maritime Interdiction Operations: Ships and aircraft train in pursuing, intercepting, and ultimately detaining suspect vessels.<br><br>Maritime Infrastructure Protection and Harbor Defense: Naval personnel train to defend oil platforms, similar at-sea structures, harbors, piers, and other infrastructure.<br><br>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.<br><br>Ship Force Protection: Ship crews train in tracking multiple approaching, circling small craft, assessing threat potential, and communicating amongst crewmates and other vessels to ensure ships are protected against attack.<br><br>Anti-Piracy Training: Naval and U.S. Coast Guard 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>Typical Components</td><td colspan="3">Platforms: Amphibious warfare ship, rotary-wing aircraft, small boat, surface combatant, unmanned aerial vehicle, unmanned surface vehicle<br>Targets: Surface targets<br>Systems being Trained/Tested: Targeting systems, non-lethal deterrents, unmanned systems</td></tr>
<tr><td rowspan="2">Standard Operating Procedures<br>(Section 2.3.3)</td><td rowspan="2">Vessel safety<br>Aircraft safety<br>Unmanned aerial and underwater vehicle procedures<br>Unmanned surface vehicle safety<br>Laser procedures<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations</td></tr>
<tr><td>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Mariana Islands Range Complex</td><td>Bays/Estuaries/Pierside:<br>Apra Harbor</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Aircraft noise<br>Vessel noise</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial target<br>Vessels and in-water devices</td><td>Energy:<br>None<br>Entanglement:</td></tr>
</table>

| Surface Warfare | | | |
|---|---|---|---|
| **Maritime Security Operations** | | | |
| | Weapons noise<br>**Explosive:**<br>In-air explosions<br>In-water explosions | Military expended materials<br>**Ingestion:**<br>Military Expended Materials – Munitions | None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Explosives | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>None | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>In-air energy<br>Underwater energy<br>Lasers<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>Grenade (explosive) fragments<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | E2 | | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement | **Explosive Stressors:** *(Section 5.3.3)*<br>Maritime security operations – Anti-swimmer grenades | |
| **Assumptions Used for Analysis** | Maritime Security Operations is a broad term used to describe activities intended train naval forces in the skills necessary to protect naval vessels from small boat attack, counter piracy and drug operations (maritime interdiction operations and visit, board, search, and seizure), and protect key infrastructure (e.g., oil platforms). Maritime security operations need to remain broad as naval forces need to be able to tailor training events to respond to emergent threats. Maritime Security Operations events typically do not involve live fire of weapons; however, the use of various non-lethal deterrents is likely. All maritime security operations events involve vessel movement, sometimes at high rates of speed (naval vessels maneuvering to overtake suspect vessel or small boats (targets) closing in and maneuvering around naval vessels), and some event involve helicopters and boarding parties. Maritime security operations training events are conducted proximate to naval homeports including during times of transit in and out of port, as well as during major training exercises. | | |

### A.1.9.10 Missile Exercise Air-to-Surface

<table>
<tr><th colspan="4">Surface Warfare</th></tr>
<tr><th colspan="4">Missile Exercise Air-to-Surface (MISSILEX)</th></tr>
<tr><td>Short Description</td><td colspan="2">Fixed-wing and helicopter aircrews fire air-to-surface missiles at surface targets.</td><td>Typical Duration<br>2 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">Fighter, maritime patrol aircraft, and helicopter aircrews fire precision-guided missiles against surface targets. Aircraft involved may be unmanned.<br><br>Fixed-wing aircraft (fighters or maritime patrol aircraft) approach an at-sea surface target from high altitude, and launch high-explosive precision guided missiles.<br><br>Helicopters designate at-sea surface targets with a laser or optics for a precision guided missiles. Helicopter launched missiles typically pass through the target's "sail," and, if explosive, detonate at or just below, the water's surface.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Fixed-wing aircraft, rotary-wing aircraft, support vessel<br>Targets: Surface targets<br>Systems being Trained/Tested: Aircraft platforms</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Laser procedures<br>Weapons firing safety<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td colspan="3">Acoustic:<br>Vessel noise<br>Aircraft noise<br>Weapons noise<br>Explosive:<br>In-air explosions<br>In-water explosions<br>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Aircraft and aerial target<br>Military expended materials<br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions<br>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="3">Air Quality:<br>Criteria air pollutants<br>Sediments and Water Quality:<br>Explosives<br>Metals<br>Chemicals</td></tr>
<tr><td>Stressors to Human Resources</td><td colspan="3">Cultural Resources:<br>Explosives<br>Physical disturbance and strike<br>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike<br>Public Health and Safety:<br>Underwater energy<br>In-air energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Missile (explosive) fragments, target fragments<br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>Surface target (mobile and stationary)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">E6 E8 E10</td></tr>
</table>

| Surface Warfare | |
|---|---|
| **Missile Exercise Air-to-Surface (MISSILEX)** | |
| **Procedural Mitigation Measures** | **Acoustic Stressors** *(Section 5.3.2)*<br>Weapons firing noise<br>**Explosive Stressors:** *(Section 5.3.3)*<br>Explosive missiles and rockets<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Non-explosive missiles and rockets |
| **Assumptions Used for Analysis** | Assume one missile and one target per event.<br>While missiles could explode above the water's surface after contacting targets, analysis assumes all warheads explode at or just below the water's surface.<br>Targets are usually recovered but could be lost due to damage.<br>This activity occurs greater than 12 NM from land (FDM excepted). |

### A.1.9.11 Missile Exercise Air-to-Surface – Rocket

<table>
<tr><th colspan="4">Surface Warfare</th></tr>
<tr><th colspan="4">Missile Exercise Air-to-Surface – Rocket</th></tr>
<tr><td>Short Description</td><td>Helicopter aircrews fire both precision-guided and unguided rockets at surface targets.</td><td colspan="2">Typical Duration<br>1 hour</td></tr>
<tr><td>Long Description</td><td colspan="3">Helicopters designate an at-sea surface target with a laser or optics for precision-guided high explosive or non-explosive practice munitions rockets. Unguided rockets may also be used during this event.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Fixed-wing aircraft, rotary-wing aircraft, support vessel, unmanned aerial system - rotary wing<br>Targets: Surface targets<br>Systems being Trained/Tested: Aircraft platforms</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>laser safety<br>Weapons firing safety<br>Laser procedures<br>Unmanned aerial and underwater vehicle procedures<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Vessel noise<br>Aircraft noise<br>Weapons noise<br>Explosive:<br>In-air explosions<br>In-water explosions</td><td>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Aircraft and aerial target<br>Military expended materials<br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions</td><td>Energy:<br>In-air electromagnetic devices<br>Lasers<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Explosives<br>Metals<br>Chemicals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Explosives<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Underwater energy<br>In-air energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Rocket (explosive) fragments, target fragments<br>Non-Ingestible Material:<br>Mk 58 marine marker, rocket (non-explosive)</td><td>Military Recoverable Material</td><td>Surface target (mobile and stationary)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">E3</td></tr>
</table>

| Surface Warfare | |
|---|---|
| **Missile Exercise Air-to-Surface – Rocket** | |
| **Procedural Mitigation Measures** | **Acoustic Stressors** *(Section 5.3.2)*<br>Weapons firing noise<br>**Explosive Stressors:** *(Section 5.3.3)*<br>Explosive missiles and rockets<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Non-explosive missiles and rockets |
| **Assumptions Used for Analysis** | Assume all explosive rockets detonate in water.<br>Rockets may be used in conjunction with force protection events.<br>The in-air low energy laser stressor was used in analysis of potential impacts on human resources.<br>Targets are usually recovered but could be lost due to damage.<br>This activity would occur greater than 12 NM from land (FDM excepted). |

### A.1.9.12 Missile Exercise Surface-to-Surface

| **Surface Warfare** | |
|---|---|
| **Missile Exercise Surface-to-Surface** | |
| **Short Description** | Surface ship crews defend against surface threats (ships or small boats) and engage them with missiles.<br>**Typical Duration:** 2–5 hours |
| **Long Description** | Surface ships launch missiles at surface maritime targets with the goal of destroying or disabling enemy ships or boats.<br>After detecting and confirming a surface threat, the ship will fire a precision guided surface missile.<br>Events with destroyers and cruisers will involve long range (over the horizon) Harpoon (or similar) surface missiles. While past Harpoon events occurred during sinking exercises, the requirement exists for non-sinking exercise events to certify ship crews. If a sinking exercise target is unavailable, a towed sled would likely be used.<br>Events with littoral combat and patrol combatant ships will involve shorter range surface missiles, such as Hellfire and Griffin. Events with littoral combat and patrol combatant ships would be to certify ship's crew to defend against "close-in" (less than 10 miles) surface threats.<br>These exercises are live fire, meaning that a missile is fired down range. Surface missiles could be equipped with either high-explosive or non-explosive warheads. |
| **Typical Components** | **Platforms:** Surface combatant<br>**Targets:** Surface targets<br>**Systems being Trained/Tested:** None |
| **Standard Operating Procedures** *(Section 2.3.3)* | Vessel safety<br>Weapons firing safety<br>Target deployment and retrieval safety |
| **Typical Locations** | **Range Complexes/Testing Ranges:** Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace<br>**Bays/Estuaries/Pierside:** None |
| **Stressors to Biological Resources** | **Acoustic:** Vessel noise; Weapons noise<br>**Physical Disturbance and Strike:** Vessels and in-water devices; Military expended materials<br>**Energy:** In-air electromagnetic devices<br>**Explosive:** In-air explosions; In-water explosions<br>**Ingestion:** Military expended materials – munitions; Military expended materials – other than munitions<br>**Entanglement:** None |
| **Stressors to Physical Resources** | **Air Quality:** Criteria air pollutants<br>**Sediments and Water Quality:** Explosives; Chemicals; Metals |
| **Stressors to Human Resources** | **Cultural Resources:** Explosives; Physical disturbance and strike<br>**Socioeconomic Resources:** Accessibility; Airborne acoustics; Physical disturbance and strike<br>**Public Health and Safety:** In-air energy; Underwater energy; Physical interactions |

| Surface Warfare | | | |
|---|---|---|---|
| **Missile Exercise Surface-to-Surface** | | | |
| **Military Expended Material** | **Ingestible Material:**<br>Missile (explosive) fragments, target fragments<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | Surface target (mobile and stationary) |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | E6 E10 | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors** *(Section 5.3.2)*<br>Weapons firing noise<br>**Physical Disturbance and Strike Stressors***(Section 5.3.4)*<br>Vessel movement<br>**Explosive Stressors** (*Section 5.3.3*)<br>Explosive missiles and rockets | | |
| **Assumptions Used for Analysis** | Assume one missile and one target used per event.<br>While missile could explode above water's surface after contacting target, analysis assumes all warheads explode at or just below surface.<br>Targets are usually recovered but could be lost due to damage.<br>This activity would occur greater than 50 NM from land (FDM excepted). | | |

### A.1.9.13 Sinking Exercise

<table>
<tr><th colspan="4">Surface Warfare</th></tr>
<tr><th colspan="4">Sinking Exercise</th></tr>
<tr><td>Short Description</td><td colspan="2">Aircraft, ship, and submarine crews deliberately sink a seaborne target, usually a decommissioned ship made environmentally safe for sinking according to U.S. Environmental Protection Agency standards, with a variety of ordnance.</td><td>Typical Duration<br>4–8 hours, possibly over 1–2 days</td></tr>
<tr><td>Long Description</td><td colspan="3">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 to train in live ordnance delivery on a full size ship target.<br><br>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 (ft.).<br><br>Ship, aircraft, and submarine crews attack with coordinated tactics and deliver a variety of inert and high-explosive ordnance. Typically, the exercise lasts for 4 to 8 hours and possibly over 1 to 2 days; however, it is unpredictable and ultimately ends when the target ship sinks.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Fixed-wing aircraft, submarines, support craft, surface combatant<br>Targets: Ship hulk<br>Systems being Trained/Tested: Large-caliber gun systems, missile systems, bombs, torpedoes, small-caliber gun systems, targeting systems</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Aircraft safety<br>Weapons firing safety<br>Sinking exercise safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges: Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside: None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Aircraft noise<br>Vessel noise<br>Weapons noise<br>Explosive:<br>In-air explosions<br>In-water explosions</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial target<br>Vessels and in-water devices<br>Military expended materials<br>Seafloor devices<br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions</td><td>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Explosives<br>Metals<br>Chemicals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Explosives<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>In-air energy<br>Underwater energy<br>Physical interactions</td></tr>
</table>

<table>
<tr><th colspan="4">Surface Warfare</th></tr>
<tr><th colspan="4">Sinking Exercise</th></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Bomb (explosive) fragments, heavyweight torpedo (explosive) fragments, large caliber projectile (explosive) fragments, missile (explosive) fragments, small caliber projectile (non-explosive), small caliber casings<br><br>Non-Ingestible Material:<br>Ship hulk, heavyweight torpedo accessories, guidance wire, large caliber projectile (non-explosive), large caliber casings</td><td>Military Recoverable Material</td><td>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">Torpedoes:<br>TORP2</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">E5 E8 E10 E11 E12</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">Acoustic Stressors: (Section 5.3.2)<br>Weapons firing noise<br><br>Physical Disturbance and Strike Stressors: (Section 5.3.4)<br>Vessel movement<br><br>Explosive Stressors: (Section 5.3.3)<br>Sinking Exercises</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="3">Events occur greater than 50 nautical miles from shore and in water depths greater than 6,000 ft. during daylight hours only.<br>The participants and assets typically include:<br>• 1 full-size target ship hulk<br>• 1–5 CG, DDG, or LCS ships<br>• 1-10 Fixed-wing aircraft (e.g., F/A-18, or maritime patrol aircraft)<br>• 1 or 2 MH-60 helicopters<br>• 1 E-2 aircraft for Command and Control<br>• 1 submarine<br>• 1–3 range clearance aircraft<br>For purposes of analysis, the below represents the types of munitions that might be employed. Actual SINKEX ordnance expenditures will vary.<br>• 1–2 Harpoon surface-to-surface or air-to-surface missiles<br>• 2–4 Maverick or Hellfire air-to-surface missiles<br>• 2–12 MK-80 series general purpose bombs<br>• 200 rounds large-caliber projectiles<br>• 1–2 MK-48 heavyweight submarine-launched torpedo<br>• Assume 2 guidance wires expended per event<br>Acoustic effects modeling assumed only a percentage of munitions missed target and exploded in water. Precision guided munitions are assumed to impact target well above waterline and are not modeled (or reported) as in water explosions.</td></tr>
</table>

## A.1.10 Other Training Exercises

### A.1.10.1 Direct Action (Tactical Air Control Party)

| **Other Training Exercises** | |
|---|---|
| **Direct Action (Tactical Air Control Party)** | |
| **Short Description** | Military personnel train for controlling of combat support aircraft; providing airspace de-confliction and terminal control for Close Air Support.<br>**Typical Duration**<br>Multiple days |
| **Long Description** | Tactical Air Control personnel, once at Farallon de Medinilla, 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. |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, rotary-wing aircraft, small boats<br>**Targets:** None<br>**Systems being Trained/Tested:** Small-caliber rounds, explosive grenades and mortars |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Vessel safety<br>Laser procedures<br>Target Deployment and Retrieval Safety<br>Farallon de Medinilla Access Restrictions<br>**Typical Locations**<br>**Range Complexes/Testing Ranges:** Farallon de Medinilla<br>**Bays/Estuaries/Pierside:** None |
| **Stressors to Biological Resources** | **Acoustic:** Aircraft noise; Vessel noise<br>**Explosive:** None<br>**Physical Disturbance and Strike:** Aircraft and aerial targets; Vessel and in-water devices<br>**Ingestion:** None<br>**Energy:** None<br>**Entanglement:** None |
| **Stressors to Physical Resources** | **Air Quality:** Criteria air pollutants<br>**Sediments and Water Quality:** None |
| **Stressors to Human Resources** | **Cultural Resources:** None<br>**Socioeconomic Resources:** None<br>**Public Health and Safety:** None |
| **Military Expended Material** | **Ingestible Material:** None<br>**Non-Ingestible Material:** None<br>**Military Recoverable Material:** None |
| **Sonar and Other Transducer Bins** | None |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | May involve overnight camping on FDM. |

### A.1.10.2 Intelligence, Surveillance, Reconnaissance

<table>
<tr><th colspan="4">Other Training Exercises</th></tr>
<tr><th colspan="4">Intelligence, Surveillance, Reconnaissance</th></tr>
<tr><td>Short Description</td><td colspan="2">Personnel train to collect and report battlefield intelligence.</td><td>Typical Duration<br>Multiple days</td></tr>
<tr><td>Long Description</td><td colspan="3">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>Typical Components</td><td colspan="3">Platforms: Fixed-wing aircraft, small boat, unmanned aerial systems, submarines<br>Targets: None<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Unmanned Aerial and Underwater Vehicle Procedures<br>Vessel safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Range Complex; Guam; Tinian; Rota; Saipan<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td colspan="3">Acoustic:<br>Aircraft noise<br>Vessel noise<br>Explosive:<br>None<br>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Vessel and in-water devices<br>Ingestion:<br>Military expended materials – other than munitions<br>Energy:<br>None<br>Entanglement:<br>Decelerator/parachute<br>Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="3">Air Quality:<br>Criteria air pollutants<br>Sediments and Water Quality:<br>None</td></tr>
<tr><td>Stressors to Human Resources</td><td colspan="3">Cultural Resources:<br>None<br>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike<br>Public Health and Safety:<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Decelerator/parachute<br>Non-Ingestible Material:<br>Sonobuoys (non-explosive), sonobuoy wires</td><td>Military Recoverable Material</td><td>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">Physical Disturbance and Strike Stressors: (Section 5.3.4)<br>Vessel movement</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="3">None</td></tr>
</table>

### A.1.10.3 Precision Anchoring

<table>
<tr><th colspan="4">Other Training Exercises</th></tr>
<tr><th colspan="4">Precision Anchoring</th></tr>
<tr><td>Short Description</td><td colspan="2">Surface ship crews release and retrieve anchors in designated locations.</td><td>Typical Duration<br>Up to 1 hour</td></tr>
<tr><td>Long Description</td><td colspan="3">Ship crews choose the best available anchoring sites. The ship 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.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Navy Ships<br>Targets: None<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands anchorages<br>Bays/Estuaries/Pierside:<br>Apra Harbor</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Seafloor devices<br>Ingestion:<br>None</td><td>Energy:<br>None<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Chemicals<br>Other materials</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>Anchors</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">Physical Disturbance and Strike Stressors: (Section 5.3.4)<br>Vessel movement</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="3">None</td></tr>
</table>

### A.1.10.4 Search and Rescue At Sea

| Other Training Exercises | |
|---|---|
| **Search and Rescue At Sea** | |
| **Short Description** | Helicopter and ship crews rescue military personnel at sea. <br>**Typical Duration**<br>Up to 3 days |
| **Long Description** | Helicopter, ship, and submarine crews practice the skills required to recover personnel lost at sea. Helicopters locate survivors and deploy rescue swimmer and rescue basket. Survivors are winched up to the hovering helicopter. Surface ships would conduct man overboard drills and deploy a dummy figure in the water. Ship crews would launch a small boat, direct the recovery of the dummy, and recover the small boat. Submarine crews would maneuver submarine to effect recovery of personnel. |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, rotary-wing aircraft, surface ships, unmanned aerial vehicles<br>**Targets:** None<br>**Systems being Trained/Tested:** |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Unmanned Aerial and Underwater Vehicle Procedures<br>Vessel safety<br>**Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Test and Training Study Area<br>**Bays/Estuaries/Pierside:**<br>Apra Harbor and Mariana littorals |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>Vessel noise<br>**Explosive:**<br>None<br>**Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessel and in-water devices<br>Military expended materials<br>**Ingestion:**<br>None<br>**Energy:**<br>None<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants<br>**Sediments and Water Quality:**<br>None |
| **Stressors to Human Resources** | **Cultural Resources:**<br>None<br>**Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike<br>**Public Health and Safety:**<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>None<br>**Military Recoverable Material**<br>None |
| **Sonar and Other Transducer Bins** | None |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | None |

### A.1.10.5 Small Boat Attack

<table>
<tr><th colspan="4">Other Training Exercises</th></tr>
<tr><th colspan="4">Small Boat Attack</th></tr>
<tr><td>Short Description</td><td colspan="2">Afloat units defend against small boat or personal water craft attack</td><td>Typical Duration<br>6 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">For this activity, one or two small boats or personal watercraft conduct attack activities on units afloat, training ship crews how to respond to small boat attack in harbors, restricted channels, and nearshore areas using non-lethal means or armament appropriate to the threat and location.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Small boat, unmanned surface vehicle, ships<br>Targets: Surface targets<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Unmanned Aerial and Underwater Vehicle Procedures<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges: Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside: Apra Harbor and Mariana littorals</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Vessel and in-water devices<br>Military expended materials<br>Ingestion:<br>Military Expended Materials – Munitions<br>Military Expended Materials – Other than munitions</td><td>Energy:<br>None<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Metals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>None</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Physical interactions<br>In-air energy</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Small caliber projectile (non-explosive), small caliber casings, small caliber blanks<br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>Surface target (stationary)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">Physical Disturbance and Strike Stressors: (Section 5.3.4)<br>Vessel movement</td></tr>
</table>

| Other Training Exercises | |
|---|---|
| Small Boat Attack | |
| Assumptions Used for Analysis | |

### A.1.10.6 Submarine Navigation

| Other Training Exercises | | | |
|---|---|---|---|
| Submarine Navigation | | | |
| Short Description | Submarine crews operate sonar for navigation and detection while transiting into and out of port during reduced visibility. | **Typical Duration** | Up to 2 hours |
| Long Description | Submarine crews train to operate sonar for navigation. The ability to navigate using sonar is critical for detection while transiting into and out of port during periods of reduced visibility. During this activity the submarine will be surfaced. | | |
| Typical Components | **Platforms:** Submarines<br>**Targets:** None<br>**Systems being Trained/Tested:** High-frequency sonar, mid-frequency sonar (hull-mounted) | | |
| Standard Operating Procedures *(Section 2.3.3)* | Vessel safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Training and Testing Study Area | **Bays/Estuaries/Pierside:**<br>Apra Harbor and Mariana littorals |
| Stressors to Biological Resources | **Acoustic:**<br>Sonar and other transducers<br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Vessels and in-water devices<br>**Ingestion:**<br>None | **Energy:**<br>None<br>**Entanglement:**<br>None |
| Stressors to Physical Resources | **Air Quality:**<br>None | **Sediments and Water Quality:**<br>None | |
| Stressors to Human Resources | **Cultural Resources:**<br>None | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>Physical interactions<br>Underwater energy |
| Military Expended Material | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | None |
| Sonar and Other Transducer Bins | **High Frequency:**<br>HF1 | **Mid-Frequency:**<br>MF3 | |
| Explosive Bins | None | | |
| Procedural Mitigation Measures | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement | |

| Other Training Exercises | |
|---|---|
| **Submarine Navigation** | |
| **Assumptions Used for Analysis** | None |

### A.1.10.7 Submarine Sonar Maintenance

<table>
<tr><th colspan="4">Other Training Exercises</th></tr>
<tr><th colspan="4">Submarine Sonar Maintenance</th></tr>
<tr><td>Short Description</td><td colspan="2">Maintenance of submarine sonar and other system checks are conducted pierside or at sea.</td><td>Typical Duration<br>Up to 1 hour</td></tr>
<tr><td>Long Description</td><td colspan="3">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.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Submarines<br>Targets: None<br>Systems being Trained/Tested: Mid-frequency hull mounted sonar</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Pierside testing safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside:<br>Apra Harbor and Mariana littorals</td></tr>
<tr><td>Stressors to Biological Resources</td><td colspan="3">Acoustic:<br>Sonar and other transducers<br>Explosive:<br>None<br>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Ingestion:<br>None<br>Energy:<br>None<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="3">Air Quality:<br>None<br>Sediments and Water Quality:<br>None</td></tr>
<tr><td>Stressors to Human Resources</td><td colspan="3">Cultural Resources:<br>None<br>Socioeconomic Resources:<br>Airborne acoustics<br>Public Health and Safety:<br>Underwater energy</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">Mid-Frequency:<br>MF3</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">Acoustic Stressors: (Section 5.3.2)<br>Active sonar<br>Physical Disturbance and Strike Stressors: (Section 5.3.4)<br>Vessel movement</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="3">Conducted at pier or while underway</td></tr>
</table>

### A.1.10.8 Surface Ship Sonar Maintenance

<table>
<tr><th colspan="4">Other Training Exercises</th></tr>
<tr><th colspan="4">Surface Ship Sonar Maintenance</th></tr>
<tr><td>Short Description</td><td colspan="2">Maintenance of surface ship sonar and other system checks are conducted pierside or at sea.</td><td>Typical Duration<br>Up to 4 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">This scenario consists of surface ships performing periodic maintenance to the AN/SQS-53 sonar and other ship systems while in port or at sea. This maintenance takes up to four hours. Surface ships 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.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Surface combatant<br>Targets: None<br>Systems being Trained/Tested: Mid-frequency hull mounted</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Pierside testing safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside:<br>Apra Harbor and Mariana littorals</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Sonar and other transducers<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Ingestion:<br>None</td><td>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>None</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>None</td><td>Socioeconomic Resources:<br>None</td><td>Public Health and Safety:<br>Underwater energy</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">Mid-Frequency:<br>MF1</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td>Acoustic Stressors: (Section 5.3.2)<br>Active sonar</td><td colspan="2">Physical Disturbance and Strike Stressors: (Section 5.3.4)<br>Vessel movement</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="3">Conducted at pier or while underway</td></tr>
</table>

### A.1.10.9 Underwater Survey

<table>
<tr><th colspan="4">Other Training Exercises</th></tr>
<tr><th colspan="4">Underwater Survey</th></tr>
<tr><td>Short Description</td><td colspan="2">Navy divers train in survey of underwater conditions and features in preparation for insertion, extraction, or intelligence, surveillance, and reconnaissance activities.</td><td>Typical Duration<br>4 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">A survey of underwater terrain conditions nearshore 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.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Small boats<br>Targets: None<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges: Mariana Islands Training and Testing Study Area<br>Bays/Estuaries/Pierside: Apra Harbor and Mariana littorals</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Vessel and in-water devices<br>Ingestion:<br>None</td><td>Energy:<br>None<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>None</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>None</td><td>Socioeconomic Resources:<br>Accessibility<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">Physical Disturbance and Strike Stressors: (Section 5.3.4)<br>Vessel movement</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="3">Hand-held (or similar) de minimis sonar sources may be used. During the conduct of underwater survey activities personnel may stand in the surf zone and walk onto the beach.</td></tr>
</table>

### A.1.10.10 Unmanned Aerial Vehicle Training and Certification

<table>
<tr><th colspan="4">Other Training Exercises</th></tr>
<tr><th colspan="4">Unmanned Aerial System Training and Certification</th></tr>
<tr><td>Short Description</td><td colspan="2">Units conduct training with unmanned aerial vehicles from a variety of platforms including surface ships and submarines.</td><td>Typical Duration<br>2 days</td></tr>
<tr><td>Long Description</td><td colspan="3">Conduct unmanned aerial vehicle activity in support of tactical and theater requirements.<br>During training, personnel use radio frequency communications to control and communicate with the unmanned aerial system during its flight.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Submarines, surface ship, unmanned aerial system-fixed wing<br>Targets: Land targets, surface targets<br>Systems being Trained/Tested: None</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Unmanned aerial and underwater vehicle procedures<br>Vessel safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Mariana Islands Range Complex airfields (Orote Point Airfield, Guam; Northwest Airfield, Guam; North Airfield, Tinian)<br>Mariana Islands Special Use Airspace<br>Bays/Estuaries/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Military expended materials<br>Vessel and in-water devices<br>Ingestion:<br>None</td><td>Energy:<br>None<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td colspan="2">Air Quality:<br>Criteria air pollutants</td><td>Sediments and Water Quality:<br>None</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>None</td><td>Socioeconomic Resources:<br>None</td><td>Public Health and Safety:<br>None</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>Canister, weight, flotation collar</td><td>Military Recoverable Material</td><td>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">Physical Disturbance and Strike Stressors: (Section 5.3.4)<br>Vessel movement</td></tr>
</table>

| Other Training Exercises | |
|---|---|
| **Unmanned Aerial System Training and Certification** | |
| **Assumptions Used for Analysis** | Unmanned aerial vehicles are typically recovered; however, some units may be lost and some are designed to be expendable. Submarine launched unmanned aerial systems result in expenditure of ballast weight and launched capsule. |

### A.1.10.11 Unmanned Underwater Vehicle Training

<table>
<tr><th colspan="4">Other Training Exercises</th></tr>
<tr><th colspan="4">Unmanned Underwater Vehicle Training</th></tr>
<tr><td>Short Description</td><td colspan="2">Units conduct training with unmanned underwater vehicles from a variety of platforms including surface ships, small boats, and submarines.</td><td>Typical Duration<br>Up to 24 hours</td></tr>
<tr><td>Long Description</td><td colspan="3">Conduct unmanned underwater vehicle activities in support of tactical and theater requirements.<br>Unmanned underwater vehicle activities involves training with unmanned platforms on which various sensors and payloads are attached and used for different purposes, such as mine warfare, bottom mapping, and other missions. Vehicles may be crew served or mechanically launched from ships and submarines.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Surface ships, small boats, submarines, support craft, unmanned underwater vehicle<br>Targets: Mine shapes<br>Systems being Trained/Tested: Acoustic modem, high-frequency sonar, synthetic aperture sonar</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Unmanned aerial and underwater vehicle procedures<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Range Complex<br>Bays/Estuaries/Pierside:<br>Apra Harbor and Mariana littorals</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Sonar and other transducers<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Vessels and in-water devices<br>Military expended materials<br>Seafloor devices<br>Ingestion:<br>None</td><td>Energy:<br>None<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>None</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>None</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Physical interactions<br>In-air energy<br>Underwater energy</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>Anchors</td><td>Military Recoverable Material</td><td>Mine shapes (non-explosive)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td>Forward Looking Sonar:<br>FLS2</td><td>Acoustic Modems:<br>M3</td><td>Synthetic Aperture Sonar:<br>SAS2 SAS4</td></tr>
</table>

| Other Training Exercises | |
|---|---|
| **Unmanned Underwater Vehicle Training** | |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | None |

# A.2 Testing Activities

## A.2.1 Naval Air Systems Command Testing Activities

Naval Air Systems Command activities will generally fall under Fleet primary mission areas, such as the testing of airborne mine warfare and anti-submarine warfare weapons and systems. Naval Air Systems Command activities include, but are not limited to, the testing of new aircraft platforms (e.g., the P-8 maritime patrol aircraft), weapons, and systems (e.g., newly developed sonobuoys) that will ultimately be integrated into Fleet training activities. In addition to testing new platforms, weapons, and systems, Naval Air Systems Command also conducts lot acceptance testing of sonobuoys and follow-on testing and evaluation of updated systems in support of Fleet operational units. In general, the potential environmental effects from most Naval Air Systems Command testing events are similar to the associated Fleet training events.

While many of these systems tested by Naval Air Systems Command will ultimately be used by the Fleet, testing activities involving the same or similar systems may be conducted in different locations and manners than when conducted by the Fleet. Because of these differences, the results of the analysis for testing activities may differ from the results for training activities.

## A.2.1.1 Anti-Submarine Warfare

### A.2.1.1.1 Anti-Submarine Warfare Torpedo Test

<table>
<tr><th colspan="4">Anti-Submarine Warfare</th></tr>
<tr><th colspan="4">Anti-Submarine Warfare Torpedo Test</th></tr>
<tr><td>Short Description</td><td colspan="2">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, track, and attack a submarine or similar target.</td><td>Typical Duration<br>2–6 flight hours per event</td></tr>
<tr><td>Long Description</td><td colspan="3">Similar to a torpedo exercise, an anti-submarine warfare (ASW) torpedo test evaluates anti-submarine warfare systems onboard rotary-wing (e.g., MH-60R helicopter) and fixed-wing (marine patrol aircraft 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 ASW training target [EMATT], or MK-30). The focus of the anti-submarine warfare torpedo test is the operation of non-explosive torpedoes (e.g., MK-46 or MK-54), but other anti-submarine warfare systems are often used during the test. MK-39 (EMATT) or MK-30 targets simulate a submarine threat and are deployed at varying depths and speeds. If available, tests may be conducted using an actual submarine as the target. 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 or non- running and are non-explosive. Eighty-five percent of torpedoes are recovered. A parachute assembly 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.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Fixed-wing aircraft, rotary-wing aircraft, range support craft<br>Targets: Sub-surface targets<br>Systems being Trained/Tested: Torpedoes/torpedo launching systems</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Target Deployment and Retrieval Safety<br>Weapons firing safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges: Mariana Islands Training and Testing Study Area<br>Inland Waters/Pierside: None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Sonar and other transducers<br>Aircraft noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial target<br>Vessels and in-water devices<br>Military expended materials<br>Seafloor devices<br>Ingestion:<br>Military expended materials – other than munitions</td><td>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>Decelerators/parachutes<br>Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Metals<br>Chemicals<br>Other materials</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Underwater energy<br>Physical interactions</td></tr>
</table>

<table>
<tr><th colspan="4">Anti-Submarine Warfare</th></tr>
<tr><th colspan="4">Anti-Submarine Warfare Torpedo Test</th></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Decelerators/parachutes - small<br>Non-Ingestible Material:<br>Expended bathythermograph, expended bathythermograph wire, lightweight torpedo accessories, sonobuoy (non-explosive), sonobuoy wires,</td><td>Military Recoverable Material</td><td>Lightweight torpedo (non-explosive), sub-surface target (mobile)</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">Mid-Frequency: MF5<br>Torpedoes: TORP1</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">Acoustic Stressors: (Section 5.3.2)<br>Active sonar<br>Vessel movement<br>Physical Disturbance and Strike Stressors: (Section 5.3.4)<br>Vessel movement</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="3">Assume one torpedo accessory package (parachute, ballast) per torpedo. Assume one target per torpedo.<br>This activity would occur greater than 3 NM from land.</td></tr>
</table>

### A.2.1.1.2 Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft

<table>
<tr><th colspan="4">Anti-Submarine Warfare</th></tr>
<tr><th colspan="4">Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft</th></tr>
<tr><td>Short Description</td><td colspan="2">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><td>Typical Duration<br>8 flight hours per event</td></tr>
<tr><td>Long Description</td><td colspan="3">Similar to an anti-submarine warfare (ASW) tracking exercise-maritime patrol aircraft, an 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-8 fixed-wing aircraft conduct anti-submarine warfare testing using non-impulsive sonobuoys (e.g., AN/SSQ-62 DICASS), explosive sonobuoys (e.g., MK-61 SUS), passive sonobuoys (e.g., AN/SSQ-53 DIFAR), and smoke devices (e.g., MK-58). Targets (e.g., MK-39 Expendable Mobile ASW Training Target) may also be employed during an anti-submarine warfare scenario. If available, tests may be conducted using an actual submarine as the target. This activity would be conducted in deep (typically beyond 100 feet) waters. Some anti-submarine warfare maritime patrol aircraft tracking tests could be conducted as part of a coordinated event with Fleet training activities.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Fixed-wing aircraft, range support craft<br>Targets: Sub-surface targets<br>Systems being Trained/Tested: Sonobuoys/sonobuoy launching systems, data transmission systems</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Aircraft safety<br>Vessel safety<br>Target Deployment and Retrieval Safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Inland Waters/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Sonar and other transducers<br>Aircraft noise<br>Vessel noise<br>Explosive:<br>In-air explosions<br>In-water explosions</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial target<br>Vessels and in-water devices<br>Military expended materials<br>Ingestion:<br>Military expended materials – other than munitions</td><td>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>Decelerators/parachutes<br>Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Explosives<br>Metals<br>Chemicals<br>Other materials</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Explosives<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Underwater energy<br>Physical interactions</td></tr>
</table>

| Anti-Submarine Warfare | | | |
|---|---|---|---|
| **Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft** | | | |
| **Military Expended Material** | **Ingestible Material:**<br>Sonobuoy (explosive) fragments, decelerators/parachutes – small<br>**Non-Ingestible Material:**<br>Expended bathythermograph, expended bathythermograph wire, sonobuoy (non-explosive), sonobuoy wires | **Military Recoverable Material** | Sub-surface target (mobile) |
| **Sonar and Other Transducer Bins** | **Anti-Submarine Warfare:**<br>ASW2 ASW5<br>**Mid-Frequency:**<br>MF5 MF6 | | |
| **Explosive Bins** | E1 E3 | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** ***(Section 5.3.2)***<br>Active sonar<br>**Explosive Stressors:** (*Section 5.3.3*)<br>Explosive Sonobuoys | | |
| **Assumptions Used for Analysis** | This activity would occur greater than 3 NM from land. | | |

### A.2.1.2 Electronic Warfare

#### A.2.1.2.1 Intelligence Surveillance Reconnaissance/Electronic Warfare Testing

<table>
<tr><th colspan="4">Electronic Warfare</th></tr>
<tr><th colspan="4">ISR/EW Testing</th></tr>
<tr><td>Short Description</td><td colspan="2">Aircrews use all available sensors to collect data on threat vessels.</td><td>Typical Duration<br>2–20 flight hours per event</td></tr>
<tr><td>Long Description</td><td colspan="3">An air warfare intelligence, surveillance, and reconnaissance (ISR) test involves evaluating communications capabilities of aircraft, including unmanned aerial systems that can carry cameras, sensors, communications equipment, or other payloads. New systems are tested at sea to ensure proper communications between aircraft and ships.<br>ISR aircraft systems act as eyes in the sky, relaying raw imagery back to military personnel on the ground or to ships at sea. The data is processed, analyzed, and shared with U.S. Navy or other U.S. military aircraft or vessels. New ISR technology systems provide combat identification (friend or foe) and are used for aircraft and ship-based communications.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Unmanned aerial system – fixed-wing<br>Targets: None<br>Systems being Trained/Tested: ISR systems</td></tr>
<tr><td>Standard Operating Procedures<br>(Section 2.3.3)</td><td>Unmanned aerial and underwater vehicle procedures</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Range Complex; Guam; Tinian; Rota; Saipan<br>Inland Waters/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>None<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Ingestion:<br>None</td><td>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>None</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>None</td><td>Socioeconomic Resources:<br>Airborne acoustics</td><td>Public Health and Safety:<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>None</td><td>Military Recoverable Material</td><td>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
<tr><td>Procedural Mitigation Measures</td><td colspan="3">None</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="3">None</td></tr>
</table>

#### A.2.1.3 Surface Warfare

Surface warfare is a type of naval warfare in which aircraft, surface ships, and submarines employ weapons, sensors, and operations directed against enemy surface vessels. Naval Air Systems Command surface warfare tests include air-to-surface missile, gunnery, and bombing tests, rocket tests, laser targeting tests, and high-energy laser weapons tests.

A sinking exercise is a specialized Fleet training event that provides an opportunity for Naval Air Systems Command aircrew along with ship and submarine crews to deliver explosive ordnance on a deactivated vessel that has been cleaned and environmentally remediated. The vessel is deliberately sunk using multiple weapons systems. A Naval Air Systems Command testing event may take place in conjunction with a sinking exercise to test aircraft or aircraft systems in the delivery of explosive ordnance on a surface target.

#### A.2.1.3.1 Air-to-Surface Missile Test

| Surface Warfare | | |
|---|---|---|
| **Air-to-Surface Missile Test** | | |
| **Short Description** | 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 weapons system or as part of another systems integration test. | **Typical Duration**<br>2–4 flight hours per event |
| **Long Description** | Similar to a missile exercise air-to-surface, an air-to-surface missile test may involve both fixed-wing and rotary-wing aircraft launching missiles at surface maritime targets to evaluate the weapons system or as part of another systems integration test. Air-to-surface missile tests can include high explosive, non-explosive, or non-firing (captive air training missile) weapons. Laser targeting systems may also be used. Both stationary and mobile targets would be utilized during testing | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft<br>**Targets:** Surface targets<br>**Systems being Trained/Tested:** Missile firing/launching systems | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Aircraft safety<br>Laser Procedures<br>Weapons firing safety<br>Target deployment and retrieval safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:** Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace<br>**Inland Waters/Pierside:** None |
| **Stressors to Biological Resources** | **Acoustic:** Aircraft noise; Weapons noise<br>**Explosive:** In-air explosions; In-water explosions<br>**Physical Disturbance and Strike:** Aircraft and aerial targets; Military expended materials | **Ingestion:** Military expended materials – munitions; Military expended materials – Other than munitions<br>**Energy:** In-air electromagnetic devices<br>**Entanglement:** None |
| **Stressors to Physical Resources** | **Air Quality:** Criteria air pollutants | **Sediments and Water Quality:** Explosives; Metals; Chemicals; Other materials |
| **Stressors to Human Resources** | **Cultural Resources:** Explosives; Physical disturbance and strike<br>**Socioeconomic Resources:** Accessibility; Airborne acoustics; Physical disturbance and strike | **Public Health and Safety:** Physical interactions |
| **Military Expended Material** | **Ingestible Material:** Missile (explosive) fragments, target fragments<br>**Non-Ingestible Material:** None | **Military Recoverable Material:** Surface target (mobile and stationary) |
| **Sonar and Other Transducer Bins** | None | |

| Surface Warfare | |
|---|---|
| **Air-to-Surface Missile Test** | |
| **Explosive Bins** | E10 |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Non-explosive missiles and rockets<br>**Explosive Stressors:** *(Section 5.3.3)*<br>Explosive missiles and rockets |
| **Assumptions Used for Analysis** | This activity would typically occur greater than 50 NM from shore. |

## A.2.2 Naval Sea Systems Command Testing Activities

### A.2.2.1 Anti-Submarine Warfare

#### A.2.2.1.1 Anti-Submarine Warfare Mission Package Testing

| **Anti-Submarine Warfare** | | |
|---|---|---|
| **Anti-Submarine Warfare Mission Package Testing** | | |
| **Short Description** | Ships and their supporting platforms (e.g., helicopters and unmanned aerial systems) detect, localize, and prosecute submarines. | **Typical Duration**<br>1–2 weeks, with 4–8 hours of active sonar use with intervals of non-activity in between. |
| **Long Description** | Littoral combat ships 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, culminating in the deployment of lightweight torpedoes to engage the threat. | |
| **Typical Components** | **Platforms:** Rotary-wing aircraft, surface combatant<br>**Targets:** Sub-surface targets<br>**Systems being Trained/Tested:** Sonar systems, countermeasure systems, torpedo systems, sonobuoys | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Vessel safety<br>Aircraft safety<br>Towed in-water device safety<br>Target deployment and retrieval safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:** Mariana Islands Range Complex<br>**Inland Waters/Pierside:** None |
| **Stressors to Biological Resources** | **Acoustic:** Sonar and other transducers; Aircraft noise; Vessel noise<br>**Explosive:** None<br>**Physical Disturbance and Strike:** Aircraft and aerial targets; Vessels and in-water devices; Military expended materials<br>**Ingestion:** Military expended materials – other than munitions | **Energy:** In-air electromagnetic devices<br>**Entanglement:** Decelerators/parachutes; Wires and cables |
| **Stressors to Physical Resources** | **Air Quality:** Criteria air pollutants | **Sediments and Water Quality:** Metals; Chemicals; Other materials |
| **Stressors to Human Resources** | **Cultural Resources:** Physical disturbance and strike<br>**Socioeconomic Resources:** Accessibility; Airborne acoustics; Physical disturbance and strike | **Public Health and Safety:** Underwater energy; In-air energy; Physical interactions |
| **Military Expended Material** | **Ingestible Material:** Decelerators/parachutes - small<br>**Non-Ingestible Material:** Acoustic countermeasures, expended bathythermograph, expended bathythermograph wire, lightweight torpedo accessories, sonobuoy (non-explosive), sonobuoy wires | **Military Recoverable Material:** Sub-surface target (mobile) – recovered, lightweight torpedo (non-explosive) |
| **Sonar and Other Transducer Bins** | **Anti-Submarine Warfare:** ASW1, ASW2, ASW3, ASW5<br>**Mid-Frequency:** MF4, MF5, MF12 | **Torpedoes:** TORP1 |

| Anti-Submarine Warfare | |
|---|---|
| **Anti-Submarine Warfare Mission Package Testing** | |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Towed in-water devices |
| **Assumptions Used for Analysis** | All sonobuoys have parachutes unless otherwise noted. Sub-surface targets are submarines. |

#### A.2.2.1.2 At-Sea Sonar Testing

<table>
<tr><th colspan="2">Anti-Submarine Warfare</th></tr>
<tr><th colspan="2">At-Sea Sonar Testing</th></tr>
<tr><td>Short Description</td><td>At-sea testing to ensure systems are fully functional in an open ocean environment.<br>Typical Duration: From 4 hours to 11 days</td></tr>
<tr><td>Long Description</td><td>At-sea sonar testing is required to calibrate or document the functionality of sonar and torpedo systems while the ship or submarine is in an open ocean environment. At-sea sonar testing is conducted to verify the ship meets design acoustic specifications, define the underwater characteristics of the ship, determine effects of systems and equipment on ship's acoustic characteristics, and provide technical background necessary to initiate development of design improvements to reduce noise. Tests also 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.</td></tr>
<tr><td>Typical Components</td><td>Platforms: Fixed platform, submarines<br>Targets: None<br>Systems being Trained/Tested: High and mid-frequency sonar, acoustic modems</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Typical Locations<br>Range Complexes/Testing Ranges: Mariana Islands Training and Testing Study Area<br>Inland Waters/Pierside: None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic: Sonar and other transducers<br>Explosive: None<br>Physical Disturbance and Strike: Military expended materials<br>Ingestion: None<br>Energy: In-water electromagnetic devices; In-air electromagnetic devices<br>Entanglement: Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality: Criteria air pollutants<br>Sediments and Water Quality: Metals; Other materials</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources: None<br>Socioeconomic Resources: Accessibility; Airborne acoustics; Physical disturbance and strike<br>Public Health and Safety: Underwater energy; In-air energy; Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material: None<br>Non-Ingestible Material: Expended bathythermograph, expended bathythermograph wire<br>Military Recoverable Material: None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td>High-Frequency: HF1, HF6<br>Acoustic Modems: M3<br>Mid-Frequency: MF3, MF9</td></tr>
<tr><td>Explosive Bins</td><td>None</td></tr>
</table>

| Anti-Submarine Warfare | | |
|---|---|---|
| **At-Sea Sonar Testing** | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | Active sonar is intermittent throughout the duration of this event. | |

### A.2.2.1.3 Torpedo (Explosive) Testing

| Anti-Submarine Warfare | | | |
|---|---|---|---|
| **Torpedo (Explosive) Testing** | | | |
| **Short Description** | Air, surface, or submarine crews employ explosive and non-explosive torpedoes against artificial targets. | **Typical Duration** | 1–2 days during daylight hours |
| **Long Description** | Non-explosive and explosive torpedoes (carrying a warhead) will be launched at a suspended target by a submarine and fixed- or rotary-wing aircraft or surface combatants. Event duration is one to two days during daylight hours. | | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, rotary-wing aircraft, moored platform, submarines, support craft, surface combatant<br>**Targets:** Sub-surface targets; surface targets<br>**Systems being Trained/Tested:** Sonar systems, acoustic countermeasures, sonobuoys, torpedo systems | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Vessel safety<br>Aircraft safety<br>Weapons firing safety<br>Target deployment and retrieval safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Range Complex | **Inland Waters/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Sonar and other transducers<br>Aircraft noise<br>Vessel noise<br>**Explosive:**<br>In-water explosions | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Military expended materials<br>**Ingestion:**<br>Military expended materials – munitions<br>Military expended materials – other than munitions | **Energy:**<br>In-air electromagnetic devices<br>**Entanglement:**<br>Decelerators/parachutes<br>Wires and cables |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Explosives<br>Metals | Chemicals<br>Other materials |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Explosives<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>In-air energy<br>Underwater energy<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>Lightweight torpedo (explosive) fragments, heavyweight torpedo (explosive) fragments, decelerators/parachutes - small, target fragments<br>**Non-Ingestible Material:**<br>Buoy (non-explosive), expended bathythermograph, expended bathythermograph wire, guidance wire, heavyweight torpedo accessories, lightweight torpedo accessories, sonobuoy (non-explosive), sonobuoy wires | **Military Recoverable Material** | Heavyweight (non-explosive) torpedo, lightweight torpedo (non-explosive), sub-surface target (stationary), surface target (stationary) |

| Anti-Submarine Warfare | | | |
|---|---|---|---|
| **Torpedo (Explosive) Testing** | | | |
| **Sonar and Other Transducer Bins** | **Anti-Submarine Warfare:**<br>ASW3<br><br>**Torpedoes:**<br>TORP1 TORP2 | **High-Frequency:**<br>HF1 HF6 | **Mid-Frequency:**<br>MF1 MF3<br>MF4 MF5<br>MF6 |
| **Explosive Bins** | E8 E11 | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar<br><br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement | **Explosive Stressors:** *(Section 5.3.3)*<br>Explosive torpedoes | |
| **Assumptions Used for Analysis** | Only one heavyweight torpedo test could occur on a single day; two heavyweight torpedo tests could occur on consecutive days. Two lightweight torpedo tests could occur in a single day.<br>All non-explosive torpedoes are recovered. | | |

#### A.2.2.1.4 Torpedo (Non-Explosive) Testing

| Anti-Submarine Warfare | | | |
|---|---|---|---|
| **Torpedo (Non- Explosive) Testing** | | | |
| **Short Description** | Air, surface, or submarine crews employ non-explosive torpedoes against submarines or surface vessels. | **Typical Duration** | Up to 2 weeks |
| **Long Description** | Aerial, surface, and subsurface assets fire exercise torpedoes against surface or subsurface targets or at no target and programmed with a particular run geometry. Torpedo testing evaluates the performance and the effectiveness of hardware and software upgrades of heavyweight or lightweight torpedoes. It also includes testing of experimental torpedoes. Not all torpedo tests involve acoustics. Exercise torpedoes are recovered, typically from surface ships and helicopters that are specifically crewed and outfitted for torpedo recovery. Event duration is dependent on number of torpedoes fired. | | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, rotary-wing aircraft, moored platform, submarines, support craft, surface combatant<br>**Targets:** Sub-surface targets; surface targets<br>**Systems being Trained/Tested:** Sonar systems, acoustic countermeasures, sonobuoys, torpedo systems | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Vessel safety<br>Aircraft safety<br>Weapons firing safety<br>Target deployment and retrieval safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Range Complex | **Inland Waters/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Sonar and other transducers<br>Aircraft noise<br>Vessel noise<br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Military expended materials<br>**Ingestion:**<br>Military expended materials – other than munitions | **Energy:**<br>In-air electromagnetic devices<br>**Entanglement:**<br>Decelerators/parachutes<br>Wires and cables |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Chemicals<br>Metals | Other materials |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Physical disturbance and strike | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>Underwater energy<br>In-air energy<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>Decelerators/parachutes - small<br>**Non-Ingestible Material:**<br>Acoustic countermeasures, buoy (non-explosive), expended bathythermograph, expended bathythermograph wire, guidance wire, heavyweight torpedo accessories, lightweight torpedo accessories, anti-torpedo torpedo, anti-torpedo torpedo accessories, sonobuoy (non-explosive), sonobuoy wires | **Military Recoverable Material** | Heavyweight (non-explosive) torpedo, lightweight torpedo (non-explosive), sub-surface target (mobile), sub-surface target (stationary) |

| Anti-Submarine Warfare | |
|---|---|
| **Torpedo (Non- Explosive) Testing** | |
| **Sonar and Other Transducer Bins** | **Anti-Submarine Warfare:** ASW3, ASW4<br>**High-Frequency:** HF1, HF6<br>**Low-Frequency:** LF4<br>**Mid-Frequency:** MF1, MF3, MF4, MF5, MF6<br>**Torpedoes:** TORP1, TORP2, TORP3 |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | All torpedoes are recovered.<br>Events can last up to two weeks and use up to 40 torpedoes. Typically, no more than eight torpedoes are fired per day during daylight hours. |

### A.2.2.2 Electronic Warfare

#### A.2.2.2.1 Radar and Other System Testing

<table>
<tr><th colspan="4">Electronic Warfare</th></tr>
<tr><th colspan="4">Radar and Other System Testing</th></tr>
<tr><td>Short Description</td><td>Test may include radiation of military or commercial radar, communication systems (or simulators), or high-energy lasers. Testing may occur aboard a ship against drones, small boats, rockets, missiles, or other targets.</td><td colspan="2">Typical Duration<br>12 hours per day over a 7-day period</td></tr>
<tr><td>Long Description</td><td colspan="3">At-sea and docked testing may use radiation of military or commercial radar, communication systems (or simulators), or high-energy lasers. No subsurface transmission will occur during this testing. Testing of various air and surface targets may include unmanned aerial systems, or small craft (floating cardboard triwalls, towed, anchored, or self-propelled vessels). High-energy laser testing may include tracking, scoring, and neutralization runs with single or multiple targets.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Surface combatant<br>Targets: Air targets; surface targets<br>Systems being Trained/Tested: Radar, high-energy lasers</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Laser Procedures<br>Unmanned aerial and underwater vehicle procedures<br>High-energy laser safety<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area<br>Inland Waters/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Vessel noise<br>Aircraft noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Military expended materials<br>Ingestion:<br>None</td><td>Energy:<br>In-air electromagnetic devices<br>In-water electromagnetic devices<br>Lasers<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Other materials</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>In-air energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>None<br>Non-Ingestible Material:<br>Decelerators/parachutes – large, air target (drone)</td><td>Military Recoverable Material</td><td>Surface target (mobile and stationary), air targets</td></tr>
</table>

| Electronic Warfare | |
|---|---|
| **Radar and Other System Testing** | |
| **Sonar and Other Transducer Bins** | None |
| **Explosive Bins** | None |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | High-energy lasers will not be tested pierside.<br>Any sources used during this activity would be *de minimis* and not quantitatively analyzed and therefore are not included under munitions. |

### A.2.2.3 Mine Warfare

#### A.2.2.3.1 Mine Countermeasure and Neutralization Testing

| Mine Warfare | | |
|---|---|---|
| **Mine Countermeasure and Neutralization Testing** | | |
| **Short Description** | Air, surface, and subsurface vessels neutralize threat mines and mine-like objects. | **Typical Duration**<br>1–10 days, with intermittent use of countermeasure/neutralization systems during this period |
| **Long Description** | Mine countermeasure-neutralization and mine system testing is required to ensure systems can effectively neutralize threat (live or inert) mines that will otherwise restrict passage through an area and to ensure U.S. Navy mines remain effective against enemy ships. These systems may be deployed with a variety of ships, aircraft, submarines, or unmanned autonomous vehicles and operate in water depths up to 6,000 feet. Mines are neutralized by cutting mooring cables of buoyant mines, producing acoustic energy that fires acoustic-influence mines, employing radar or laser fields, producing electrical energy to replicate the magnetic signatures of surface ships in order to detonate threat mines, detonation of mines using remotely-operated vehicles, and using explosive charges to destroy threat mines. | |
| **Typical Components** | **Platforms:** Amphibious warfare ship, mine warfare ship, unmanned aerial system – rotary-wing, rotary-wing aircraft, surface combatant, unmanned underwater vehicle<br>**Targets:** Mine shapes<br>**Systems being Trained/Tested:** Electromagnetic devices, high-frequency sonar, radar, low energy lasers | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Vessel safety<br>Aircraft safety<br>Unmanned aerial and underwater vehicle procedures<br>Towed in-water device safety<br>Laser Procedures<br>Target deployment and retrieval safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:** Mariana Islands Range Complex, nearshore, and littorals<br>**Inland Waters/Pierside:** None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Sonar and other transducers<br>Aircraft noise<br>Vessel noise<br>**Explosive:**<br>In-water explosions<br>**Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Military expended materials<br>Seafloor devices<br>**Ingestion:**<br>Military expended materials – munitions | **Energy:**<br>In-water electromagnetic devices<br>In-air electromagnetic devices<br>**Entanglement:**<br>Wires and cables |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Explosives<br>Metals<br>Chemicals<br>Other materials |
| **Stressors to Human Resources** | **Cultural Resources:**<br>Explosives<br>**Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>Underwater energy<br>In-air energy<br>Physical interactions |

| Mine Warfare | | | |
|---|---|---|---|
| **Mine Countermeasure and Neutralization Testing** | | | |
| **Military Expended Material** | **Ingestible Material:**<br>Neutralizer (explosive) fragments<br>**Non-Ingestible Material:**<br>Fiber optic cable, fiber optic can, mine shape (non-explosive) | **Military Recoverable Material** | Anchor - mine |
| **Sonar and Other Transducer Bins** | **High-Frequency:**<br>HF4 | | |
| **Explosive Bins** | E4 | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar<br>**Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement<br>Towed in-water devices | **Explosive Stressors: (***Section 5.3.3***)**<br>Explosive mine countermeasure and neutralization activities | |
| **Assumptions Used for Analysis** | Agat Bay underwater detonation site, 20 lb. net explosive weight (NEW) maximum charge. Piti and Outer Apra Harbor underwater detonation sites, 10 lb. NEW maximum. | | |

### A.2.2.4 Surface Warfare Testing

#### A.2.2.4.1 Kinetic Energy Weapon Testing

<table>
<tr><th colspan="4">Surface Warfare</th></tr>
<tr><th colspan="4">Kinetic Energy Weapon Testing</th></tr>
<tr><td>Short Description</td><td colspan="2">A kinetic energy weapon uses stored energy released in a burst to accelerate a projectile.</td><td>Typical Duration<br>1 day</td></tr>
<tr><td>Long Description</td><td colspan="3">A kinetic energy weapon uses stored energy released in a burst to accelerate a projectile to more than seven times the speed of sound to a range of up to 200 miles.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Surface combatant<br>Targets: Air targets, surface targets<br>Systems being Trained/Tested: Kinetic energy weapon</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Weapons firing safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges:<br>Mariana Islands Training and Testing Study Area, Primary areas: Special Use Airspace<br>Inland Waters/Pierside:<br>None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Vessel noise<br>Weapons noise<br>Explosive:<br>In-air explosions</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Military expended materials<br>Ingestion:<br>Military expended materials – munitions<br>Military expended materials – other than munitions</td><td>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>None</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Metals</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>In-air energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Large caliber (explosive) fragments, target fragments<br>Non-Ingestible Material:<br>Air target (drone), decelerator/parachute – large, kinetic energy round, large caliber projectile (non-explosive), large caliber casings, sabot - kinetic energy round, surface target (stationary)</td><td>Military Recoverable Material</td><td>None</td></tr>
<tr><td>Sonar and Other Transducer Bins</td><td colspan="3">None</td></tr>
<tr><td>Explosive Bins</td><td colspan="3">None</td></tr>
</table>

| Surface Warfare | |
|---|---|
| **Kinetic Energy Weapon Testing** | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement |
| **Assumptions Used for Analysis** | Assume one target per event.<br>Explosive rounds are designed to detonate above the surface target. |

### A.2.2.5 Vessel Evaluation

#### A.2.2.5.1 Undersea Warfare Testing

<table>
<tr><th colspan="4">Vessel Evaluation</th></tr>
<tr><th colspan="4">Undersea Warfare Testing</th></tr>
<tr><td>Short Description</td><td>Ships demonstrate capability of countermeasure systems and underwater surveillance, weapons engagement and communications systems. This tests ships ability to detect, track, and engage undersea targets.</td><td colspan="2">Typical Duration<br>Up to 10 days</td></tr>
<tr><td>Long Description</td><td colspan="3">Undersea warfare events may be comprised of tracking and firing events or tests of hull-mounted sonar system capabilities to detect and avoid torpedo type targets. Tracking and firing events ensure the operability of the undersea warfare suite and its interface with the rotary-wing helicopter. Tests include demonstrating the ability of the ship to search, detect, and track a target; and conduct attacks with exercise torpedoes. Detection and avoidance events may use surface craft and underwater platforms to test the capability of mid- and high-frequency acoustic sources. Subsurface moving targets, rocket and air-dropped weapons, sonobuoys, towed arrays and sub-surface torpedo-like devices may be used. Approximately one week of in-port training may precede the event.</td></tr>
<tr><td>Typical Components</td><td colspan="3">Platforms: Rotary-wing aircraft, surface combatant<br>Targets: Sub-surface targets<br>Systems being Trained/Tested: Acoustic countermeasures, sonar systems, sonobuoys, torpedo sonar</td></tr>
<tr><td>Standard Operating Procedures (Section 2.3.3)</td><td>Vessel safety<br>Aircraft safety<br>Target deployment and retrieval safety</td><td colspan="2">Typical Locations<br>Range Complexes/Testing Ranges: Mariana Islands Range Complex<br>Inland Waters/Pierside: None</td></tr>
<tr><td>Stressors to Biological Resources</td><td>Acoustic:<br>Sonar and other transducers<br>Aircraft noise<br>Vessel noise<br>Explosive:<br>None</td><td>Physical Disturbance and Strike:<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>Military expended materials<br>Ingestion:<br>Military expended materials – other than munitions</td><td>Energy:<br>In-air electromagnetic devices<br>Entanglement:<br>Decelerators/parachutes<br>Wires and cables</td></tr>
<tr><td>Stressors to Physical Resources</td><td>Air Quality:<br>Criteria air pollutants</td><td colspan="2">Sediments and Water Quality:<br>Metals<br>Other materials</td></tr>
<tr><td>Stressors to Human Resources</td><td>Cultural Resources:<br>Physical disturbance and strike</td><td>Socioeconomic Resources:<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike</td><td>Public Health and Safety:<br>Underwater energy<br>In-air energy<br>Physical interactions</td></tr>
<tr><td>Military Expended Material</td><td>Ingestible Material:<br>Decelerators/parachutes - small<br>Non-Ingestible Material:<br>Expended bathythermograph, expended bathythermograph wire, lightweight torpedo accessories, sonobuoy (non-explosive), sonobuoy wires</td><td>Military Recoverable Material</td><td>Lightweight torpedo (non-explosive), sub-surface target (mobile)</td></tr>
</table>

| Vessel Evaluation | | | |
|---|---|---|---|
| **Undersea Warfare Testing** | | | |
| **Sonar and Other Transducer Bins** | **High-Frequency:**<br>HF4 | **Mid-Frequency:**<br>MF1 MF4<br>MF5 | **Torpedoes:**<br>TORP1 |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Acoustic Stressors:** *(Section 5.3.2)*<br>Active sonar | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement | |
| **Assumptions Used for Analysis** | Five targets per event.<br>Sonobuoys from surface ships do not have an associated parachute.<br>Ships will not be conducting test constantly during the entire duration. | | |

### A.2.2.6 Other Testing

#### A.2.2.6.1 Simulant Testing

| Other Testing Activities | | | |
|---|---|---|---|
| **Simulant Testing** | | | |
| **Short Description** | The capability of surface ship defense systems to detect and protect against chemical and biological attacks are tested. | **Typical Duration** | 3 days |
| **Long Description** | The capabilities of surface ship defense systems to detect and protect in the event of chemical and biological attacks are tested. Testing involves the deployment of harmless compounds (i.e., simulants) as substitutes for chemical and biological warfare agents. Methods of simulant delivery include aerial dispersal and hand-held spray. | | |
| **Typical Components** | **Platforms:** Fixed-wing aircraft, rotary-wing aircraft, surface combatant<br>**Targets:** None<br>**Systems being Trained/Tested:** None | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Vessel safety<br>Aircraft safety | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Marianas Islands Training and Testing Study Area | **Inland Waters/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Aircraft noise<br>Vessel noise<br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Aircraft and aerial targets<br>Vessels and in-water devices<br>**Ingestion:**<br>None | **Energy:**<br>In-air electromagnetic devices<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>Chemicals | Other materials |
| **Stressors to Human Resources** | **Cultural Resources:**<br>None | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement | | |
| **Assumptions Used for Analysis** | All chemical simulants have low toxicity to humans and the environment. Examples of chemical simulants include glacial acetic acid and triethyl phosphate. All biological simulants are considered to be Biosafety Level 1 organisms. Examples of biological simulants are spore- | | |

| Other Testing Activities | |
|---|---|
| **Simulant Testing** | |
| | forming bacteria, non-spore-forming bacteria, the protein ovalbumin, MS2 bacteriophages, and the fungus Aspergillus niger. |

## A.2.3 Office of Naval Research Testing Activities

### A.2.3.1 Acoustic and Oceanographic Research

| | | | |
|---|---|---|---|
| **Acoustic and Oceanographic Science and Technology** | | | |
| **Acoustic and Oceanographic Research** | | | |
| **Short Description** | Research of oceanographic processes using active transmissions, typically high-frequency (38 kHz and above) oceanographic measurement devices, deployed from ships, unmanned underwater vehicles and on moored platform | **Typical Duration** | 1–2 weeks |
| **Long Description** | ONR performs research on oceanographic processes in U.S. territorial waters and international waters using passive measurement devices and active acoustic systems such as acoustic Doppler current profilers and echosounders. Measurement systems may be deployed by ship, unmanned underwater vehicle, or on standard oceanographic moorings. Moorings may be left in place for more than 1 year. | | |
| **Typical Components** | **Platforms:** Research vessels, unmanned vehicles, oceanographic moorings<br>**Targets:** None<br>**Systems being Trained/Tested:** None | | |
| **Standard Operating Procedures** *(Section 2.3.3)* | Vessel safety<br>Unmanned aerial and underwater vehicle procedures | **Typical Locations**<br>**Range Complexes/Testing Ranges:**<br>Mariana Islands Training and Testing Study Area | **Inland Waters/Pierside:**<br>None |
| **Stressors to Biological Resources** | **Acoustic:**<br>Vessel noise<br>**Explosive:**<br>None | **Physical Disturbance and Strike:**<br>Vessel and in-water devices<br>Seafloor devices<br>**Ingestion:**<br>None | **Energy:**<br>None<br>**Entanglement:**<br>None |
| **Stressors to Physical Resources** | **Air Quality:**<br>Criteria air pollutants | **Sediments and Water Quality:**<br>None | |
| **Stressors to Human Resources** | **Cultural Resources:**<br>None | **Socioeconomic Resources:**<br>Accessibility<br>Airborne acoustics<br>Physical disturbance and strike | **Public Health and Safety:**<br>Underwater energy<br>In-air energy<br>Physical interactions |
| **Military Expended Material** | **Ingestible Material:**<br>None<br>**Non-Ingestible Material:**<br>None | **Military Recoverable Material** | None |
| **Sonar and Other Transducer Bins** | None | | |
| **Explosive Bins** | None | | |
| **Procedural Mitigation Measures** | **Physical Disturbance and Strike Stressors:** *(Section 5.3.4)*<br>Vessel movement | | |

| Acoustic and Oceanographic Science and Technology | |
|---|---|
| **Acoustic and Oceanographic Research** | |
| **Assumptions Used for Analysis** | Approximately 12 non-recoverable bottom moorings may be used.<br><br>Any sonar transducers used would be *de minimis*. |

# Appendix B: Federal Register Notices

# Supplemental Environmental Impact Statement/

# Overseas Environmental Impact Statement

# Mariana Islands Training and Testing

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## List of Figures

There are no figures in this appendix.

## List of Tables

There are no tables in this appendix.

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# APPENDIX B FEDERAL REGISTER NOTICES

Appendix B contains the following Federal Register Notice:

1. Notice of Intent to Prepare a Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement for Mariana Islands Training and Testing

Federal Register / Vol. 82, No. 146 / Tuesday, August 1, 2017 / Notices 35767

SIDCO/SUBPART C DCO REGULATIONS—RECORDKEEPING COLLECTION—Continued

| | Estimated number of recordkeepers per year | Records to be kept annually by each | Total annual responses | Estimated average number of hours per record | Estimated total number of hours of annual burden in fiscal year |
|---|---|---|---|---|---|
| Liquidity Resource Due Diligence and Testing | 7 | 4 | 28 | 10 | 280 |
| Financial and Liquidity Resources, Excluding Due Diligence | 7 | 4 | 28 | 10 | 280 |
| Generally | 7 | 28 | 196 | 10 | 1960 |
| Totals | | 118 | 662 | 31 | 4570 |

[FR Doc. 2017–16019 Filed 7–31–17; 8:45 am]

BILLING CODE 6351–01–P

## DEPARTMENT OF DEFENSE

### Department of the Navy

### Meeting of the Board of Visitors of Marine Corps University

**AGENCY:** Department of the Navy, DOD.

**ACTION:** Notice of open meeting.

**SUMMARY:** The Board of Visitors of the Marine Corps University (BOV MCU) will meet to review, develop and provide recommendations on all aspects of the academic and administrative policies of the University; examine all aspects of professional military education operations; and provide such oversight and advice, as is necessary, to facilitate high educational standards and cost effective operations. The Board will be focusing primarily on the internal procedures of Marine Corps University. All sessions of the meeting will be open to the public.

**DATES:** The meeting will be held on Thursday, September 14, 2017, from 9:00 a.m. to 4:30 p.m. and Friday, September 15, 2017, from 8:00 a.m. to 2:30 p.m. Eastern Time Zone.

**ADDRESSES:** The meeting will be held at Marine Corps University in Quantico, Virginia. The address is: 2076 South St., Quantico, VA.

**FOR FURTHER INFORMATION CONTACT:** Dr. Kim Florich, Director of Faculty Development and Outreach, Marine Corps University Board of Visitors, 2076 South Street, Quantico, Virginia 22134, telephone number 703–432–4682.

Dated: July 24, 2017.

A.M. Nichols,

*Lieutenant Commander, Judge Advocate General's Corps, U.S. Navy, Federal Register Liaison Officer.*

[FR Doc. 2017–16150 Filed 7–31–17; 8:45 am]

BILLING CODE 3810–FF–P

## DEPARTMENT OF DEFENSE

### Department of the Navy

### Notice of Intent To Prepare a Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement for Mariana Islands Training and Testing

**AGENCY:** Department of the Navy, DOD.

**ACTION:** Notice.

**SUMMARY:** Pursuant to the National Environmental Policy Act (NEPA) of 1969 and regulations implemented by the Council on Environmental Quality, the Department of the Navy (DoN) announces its intent to prepare a supplement to the 2015 Final Mariana Islands Training and Testing (MITT) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS).

**DATES:** Public scoping meetings will not be held, but public comments will be accepted during the scoping period from August 1, 2017 to September 15, 2017.

**ADDRESSES:** The DoN invites scoping comments on the MITT Supplemental EIS/OEIS from all interested parties. Substantive comments may be provided by mail to the address below and through the project Web site at *http://mitt-eis.com/*. Comments must be postmarked or received by September 15, 2017, for consideration during the development of the Draft Supplemental EIS/OEIS.

**FOR FURTHER INFORMATION CONTACT:** Naval Facilities Engineering Command Pacific, Attention: MITT Supplemental EIS/OEIS Project Manager, 258 Makalapa Drive, Suite 100, Pearl Harbor, HI 96860–3134.

**SUPPLEMENTARY INFORMATION:** The Navy will assess the potential environmental impacts associated with ongoing and proposed military readiness activities conducted within the MITT EIS/OEIS Study Area (hereafter known as the "Study Area"). The Supplement to the 2015 Final EIS/OEIS is being prepared to support ongoing and future activities conducted at sea and on Farallon de Medinilla (FDM) within the Study Area beyond 2020. Military readiness activities include training and research, development, testing, and evaluation (hereafter known as "testing"). The Supplemental EIS/OEIS will include an analysis of training and testing activities using new information available after the release of the 2015 Final MITT EIS/OEIS. New information includes an updated acoustic effects model, updated marine mammal density data, and other best available science. Proposed activities are generally consistent with those analyzed in the 2015 Final MITT EIS/OEIS and are representative of training and testing activities the DoN has been conducting in the Study Area for decades.

The Study Area remains unchanged since the 2015 Final MITT EIS/OEIS. The Study Area includes the existing Mariana Islands Range Complex (MIRC); areas on the high seas to the north and west of the MIRC; a transit corridor between the MIRC and the Hawaii Range Complex, starting at the International Date Line; and Apra Harbor and select DoN pierside and harbor locations. The Study Area includes only the in-water components of the range complex and FDM; land components associated with the range complex are not included in the Study Area.

As part of this process the DoN will seek the issuance of regulatory permits and authorizations under the Marine Mammal Protection Act and Endangered Species Act to support training and testing requirements within the Study Area, beyond 2020, thereby ensuring critical Department of Defense requirements are met.

Pursuant to 40 CFR 1501.6, the DoN will invite the National Marine Fisheries Service to be a cooperating agency in preparation of the Supplemental EIS/OEIS.

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The DoN's lead action proponent is Commander, U.S. Pacific Fleet. Additional action proponents include Naval Sea Systems Command, Naval Air Systems Command, and the Office of Naval Research.

The DoN's Proposed Action is to conduct military training and testing activities within the Study Area. Activities include the use of active sonar and explosives while employing appropriate marine species protective mitigation measures. The Proposed Action does not alter the DoN's original purpose and need as presented in the 2015 MITT Final EIS/OEIS.

The purpose of the Proposed Action is to maintain a ready force, which is needed to ensure the military can accomplish its mission to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas, consistent with Congressional direction in section 5062 of Title 10 of the U.S. Code. A Supplemental EIS/OEIS is considered the appropriate document, as there is recent scientific information including revised acoustic criteria to consider, in furtherance of NEPA, relevant to the environmental effects of the DoN's Proposed Action, and the analysis will support Marine Mammal Protection Act authorization requests.

Proposed training and testing activities are generally consistent to those analyzed in the 2015 MITT Final EIS/OEIS. The Supplemental EIS/OEIS will propose changes to the tempo and types of training and testing activities, accounting for the introduction of new technologies, the evolving nature of international events, advances in war fighting doctrine and procedures, and changes in the organization of vessels, aircraft, weapon systems, and military personnel. The MITT Supplemental EIS/OEIS will reflect the compilation of training and testing activities required to fulfill the DoN's military readiness requirements beyond 2020, and therefore includes the analysis of newly proposed activities and changes to previously analyzed activities.

In the Supplemental EIS/OEIS, the DoN will evaluate the potential environmental impacts of a No Action Alternative and action alternatives. Resources to be evaluated include, but are not limited to, marine mammals, sea turtles, essential fish habitat, and threatened and endangered species.

The scoping process is used to identify public concerns and local issues to be considered during the development of the Draft Supplemental EIS/OEIS. Federal agencies, local agencies, the public, and interested persons are encouraged to provide substantive comments to the DoN on environmental resources and issue areas of concern the commenter believes the DoN should consider.

Comments must be postmarked or received online by September 15, 2017, for consideration during the development of the Draft Supplemental EIS/OEIS. Comments can be mailed to: Naval Facilities Engineering Command Pacific, Attention: MITT Supplemental EIS/OEIS Project Manager, 258 Makalapa Drive, Suite 100, Pearl Harbor, HI, 96869–3134. Comments can be submitted online via the project Web site at *http://mitt-eis.com/*.

Dated: July 20, 2017.

**A.M. Nichols,**

*Lieutenant Commander, Judge Advocate General's Corps, U.S. Navy, Federal Register Liaison Officer.*

[FR Doc. 2017–15939 Filed 7–31–17; 8:45 am]

BILLING CODE 3810–FF–P

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## DEPARTMENT OF EDUCATION

## Final Waiver and Extension of the Project Period for the Native American Career and Technical Education Program

[Catalog of Federal Domestic Assistance (CFDA) Number: 84.101A]

**AGENCY:** Office of Career, Technical, and Adult Education, Department of Education.

**ACTION:** Final waiver and extension of the project period.

**SUMMARY:** For the 24-month projects originally funded in fiscal year (FY) 2013 and extended for an additional 24-months in FY 2015 under the Native American Career and Technical Education Program (NACTEP), the Secretary: Waives the requirements in Education Department regulations that generally prohibit project extensions involving the obligation of additional Federal funds; and extends the project period for the current 30 NACTEP grantees for an additional 12 months under the existing program authority. This waiver and extension will allow the 30 current NACTEP grantees to seek FY 2017 continuation awards for the project period through FY 2018.

**DATES:** As of August 1, 2017, the waiver and extension of the project period are finalized.

**FOR FURTHER INFORMATION CONTACT:** Gwen Washington by telephone at (202) 245–7790 or by email at *gwen.washington@ed.gov*. You may also contact Linda Mayo by telephone at (202) 245–7792 or by email at *linda.mayo@ed.gov*. If you use a telecommunications device for the deaf (TDD) or a text telephone (TTY), call the Federal Relay Service, toll free, at 1–800–877–8339.

**SUPPLEMENTARY INFORMATION:** On April 26, 2017, we published a notice in the **Federal Register** (82 FR 19240) proposing to waive the requirements of 34 CFR 75.261(a) and (c)(2) that generally prohibit project period extensions involving the obligation of additional Federal funds. In that notice, the Secretary also proposed to extend the NACTEP project period for up to an additional 12 months. The proposed waiver and extension of project period would enable the Secretary to provide continuation awards to the current NACTEP grantees through FY 2018 under the existing program authority.

That notice contained background information and our reasons for proposing the waiver and extension of the project period. This notice makes the waiver and extension of the project period final. Any activities carried out during the period of a NACTEP continuation award must be consistent with, or a logical extension of, the scope, goals, and objectives of the grantee's application as approved in the FY 2013 NACTEP competition. The requirements applicable to continuation awards for this competition set forth in the 2013 notice inviting applications and the requirements in 34 CFR 75.253 will apply to any continuation awards sought by the current NACTEP grantees.

We will make decisions regarding the continuation awards based on grantee program narratives, budgets and budget narratives, program performance reports, and the requirements in 34 CFR 75.253. We will not announce a new competition or make new awards in FY 2017.

The final waiver and project period extension will not exempt the current NACTEP grantees from the appropriation account closing provisions of 31 U.S.C. 1552(a), nor will it extend the availability of funds previously awarded to current NACTEP grantees. As a result of 31 U.S.C. 1552(a), appropriations available for a limited period may be used for payment of valid obligations for only five years after the expiration of their period of availability for Federal obligation. After that time, the unexpended balance of those funds is canceled and returned to the U.S. Department of the Treasury and is unavailable for restoration for any purpose (31 U.S.C. 1552(b)).

*Public Comment:* In response to our invitation in the proposed waiver and extension, we received 85 comments.

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# Appendix C: Agency Correspondence

# Supplemental Environmental Impact Statement/

# Overseas Environmental Impact Statement

# Mariana Islands Training and Testing

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## List of Figures

There are no figures in this appendix.

## List of Tables

There are no tables in this appendix.

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# APPENDIX C AGENCY CORRESPONDENCE

This appendix contains correspondence between the Navy and relevant government agencies with respect to cooperating agency status and the National Historic Preservation Act.

# C.1 COOPERATING AGENCY STATUS

## C.1.1 NATIONAL MARINE FISHERIES SERVICE

**DEPARTMENT OF THE NAVY**
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON DC 20350-2000

5090
Ser N45/17U132422
September 27, 2017

Ms. Donna S. Wieting
Director, Office of Protected Resources
National Marine Fisheries Service
1315 East West Highway
Silver Spring, MD 20910

SUBJECT: MARIANA ISLANDS TRAINING AND TESTING SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT - COOPERATING AGENCY REQUEST

Dear Ms. Wieting:

In accordance with the National Environmental Policy Act (NEPA) of 1969 and Executive Order (EO) 12114, the United States (U.S.) Department of the Navy (Navy) is preparing a Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) to assess the potential environmental impacts associated with the continuation of military readiness activities, which consist of training as well as research, development, testing, and evaluation (RDT&E, hereinafter referred to as "testing") activities that include the use of active sonar and explosives in the Mariana Islands Training and Testing (MITT) Study Area. The proposed training and testing activities within the MITT Study Area supports the Navy's Title 10 of the U.S. Code requirements to achieve and maintain military readiness by ensuring the Navy can provide trained and equipped combat-ready forces capable of winning wars, deterring aggression, and maintaining freedom of the seas.

This MITT Supplemental EIS/OEIS represents the third phase (Phase III) of ongoing NEPA and EO 12114 compliance for continuation of at-sea training and testing. It will evaluate the conduct of military readiness activities from 2020 into the reasonably foreseeable future and accommodate evolving mission requirements associated with force structure changes, including those resulting from the development, testing, and ultimate introduction of new platforms (vessels, aircraft, and weapon systems) into the Fleet.

The Phase III MITT Study Area remains consistent with the area studied in the Phase II MITT EIS/OEIS completed in 2015 and consists of the established at sea ranges, operating areas, and special use airspace in the region of the Mariana Islands that are part of the Mariana Islands Range Complex (MIRC) and its surrounding seas, and includes a transit corridor. The transit corridor is outside the geographic boundaries of the MIRC and is a direct route across the high seas for Navy ships in transit between the MIRC and the Hawaii Range Complex. The Proposed Action also includes pierside sonar maintenance and testing alongside Navy piers located in Inner Apra Harbor.

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Ser N45/17U132422
September 27, 2017

The MITT Phase III Supplemental EIS/OEIS is intended to serve as a basis for the renewal of current regulatory permits and authorizations and the analysis of emerging and future force structure changes and training and testing requirements. An important aspect of the MITT Supplemental EIS/OEIS will be the analysis of the potential effects to marine species protected under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA) and habitats protected under the Magnuson-Stevens Fishery Conservation and Management Act. The existing MMPA Final Rule and Letters of Authorization for Phase II MITT activities will expire in August 2020.

To complete the analysis required by the permitting and consultation process pursuant to MMPA and ESA in an efficient and effective way, the Navy believes that participation by the National Marine Fisheries Service (NMFS) is needed. Therefore, in accordance with the Council on Environmental Quality's (CEQ) regulations implementing NEPA (specifically 40 CFR Part 1501) and CEQ's 2002 guidance on cooperating agencies, the Navy requests that the NMFS serve as a cooperating agency for the development of the Phase III MITT Supplemental EIS/OEIS.

Consistent with 40 CFR 1501.6, the Navy is requesting NMFS' participation as early in the planning process as possible. As the lead agency, the Navy will:

a. Gather all necessary background information and prepare the Phase III Supplemental EIS/OEIS and all necessary permit applications associated with acoustic issues within the Study Area;

b. Work with NMFS personnel to determine the method of estimating potential effects to protected marine species, including threatened and endangered species;

c. Determine the scope of the Phase III MITT Supplemental EIS/OEIS, including the alternatives evaluated;

d. Circulate the NEPA document to the general public and any other interested parties;

e. Schedule and supervise meetings held in support of the NEPA process and compile comments received; and

f. Maintain an administrative record and respond to Freedom of Information Act (FOIA) requests relating to the Phase III Supplemental EIS/OEIS.

Navy respectfully requests that NMFS, in its role as a cooperating agency, provide the following support:

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September 27, 2017

a. Participate in the NEPA process, to include public participation efforts pertaining to the Phase III Supplemental EIS/OEIS, and fund such support through its own sources to the maximum extent possible;

b. Provide timely comments on working drafts of the Phase III Supplemental EIS/OEIS in accordance with the approved project schedule and commenting protocols, and provide minutes of any agency information meeting that have been adjudicated within the agency;

c. Adhere to the overall schedule as set forth by the Navy in coordination with NMFS;

d. Respond to Navy requests for information, in particular, those related to review of the acoustic effects analysis and evaluation of the effectiveness of protection and mitigation measures;

e. Coordinate, to the maximum extent practicable, any public comment periods that are necessary in the MMPA permitting process with the Navy's NEPA public comment periods;

f. Make available staff support at Navy's request to enhance the Navy's interdisciplinary capability;

g. Participate, as necessary, in meetings hosted by the Navy for discussion of issues related to the Phase III Supplemental EIS/OEIS;

h. Utilize NMFS resources, including funding where appropriate, in support of executing its cooperating agency responsibilities.;

i. Prepare any NMFS-specific documents required to support the NMFS decision-making process;

j. Maintain an administrative record and respond to FOIA requests relating to the Phase III Supplemental EIS/OEIS; and

k. 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 Phase III MITT Supplemental EIS/OEIS. It is the Navy's goal to complete the analysis as expeditiously as possible, while using the best scientific information available. NMFS assistance is invaluable to this endeavor.

3

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Ser N45/17U132422
September 27, 2017

We appreciate your consideration of our request and look forward to your response. The point of contact for this action is Ms. Dawn Schroeder, (703) 695-5219, email: dawn.schroeder@navy.mil.

Sincerely,

C. A. LAHTI
Director, Energy and Environmental
Readiness Division

Copy to:
ASN (EI&E)
DASN (E)
OAGC (EI&E)
OPNAV (N9I, N83)
Commander, U.S. Fleet Forces Command (N46)
Commander, U.S. Pacific Fleet (N465)
Commander, Navy Installations Command (N45)
Commander, Naval Sea Systems Command
Commander, Naval Air Systems Command
Commander, Joint Region Marianas
Commander, Naval Facilities Engineering Command, (N45)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

Captain C.A. Lahti
Director, Energy and
Environmental and Readiness Division
Department of the Navy
2000 Navy Pentagon
Washington, DC 20350-2000

Dear Captain Lahti:

Thank you for your letter requesting the National Marine Fisheries Service (NOAA Fisheries) be a cooperating agency in the preparation of a Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) to evaluate potential environmental effects in the Department of the Navy's (Navy) Mariana Islands Training and Testing (MITT) Study Area. Activities conducted in the MITT Study Area will achieve and maintain military readiness and include current, emerging, and future training activities and research, development, test and evaluation events (Phase III). We support the Navy's decision to prepare a Supplemental EIS/OEIS on this activity 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 and under section 7 of the Endangered Species Act. NOAA Fisheries will make every effort to support the Navy in the development of a Supplemental EIS/OEIS, including:

- Participating, as necessary, in meetings hosted by the Navy for the discussion of issues related to the Phase III Supplemental EIS/OEIS;
- Providing timely comments on working drafts of the Phase III Supplemental EIS/OEIS in accordance with the approved project schedule and commenting protocols;
- Responding to Navy requests for information, in particular, those related to review of the acoustic effects analysis and evaluation of the effectiveness of protection and mitigation measures; and
- Adhering to the overall schedule as set forth by the Navy in coordination with NMFS.

If you need any additional information, please contact Jolie Harrison at (301) 427-8420.

Sincerely,

Samuel D. Rauch III
Deputy Assistant Administrator for
Regulatory Programs
National Marine Fisheries Service

cc: Michael Tosatto, NMFS PIRO
Vicki Wedell, NMFS HQ NMS
Steve Leathery, NMFS HQ NEPA
Dawn Schroeder, Navy

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# C.2 NATIONAL HISTORIC PRESERVATION ACT

## C.2.1 GUAM

**DEPARTMENT OF THE NAVY**
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N465/0005
January 4, 2019

Ms. Lynda Bordallo Aguon
State Historic Preservation Officer
Department of Parks & Recreation
490 Chalan Palasyo
Agaña Heights, Guam 96910

Dear Ms. Aguon:

SUBJECT: NATIONAL HISTORIC PRESERVATION ACT, SECTION 106 CONSULTATION FOR PROPOSED MARIANA ISLANDS TRAINING AND TESTING ACTIVITIES

In accordance with Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, the United States Department of the Navy (Navy) is initiating consultation on the Guam portion of the proposed continuation of Mariana Islands Training and Testing (MITT) activities. A supplemental analysis of the activities included in the 2015 MITT Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) is being prepared to support ongoing and future activities conducted at sea beyond 2020. The proposed continuation of MITT activities is generally consistent with those analyzed in the 2015 Final EIS/OEIS and are representative of training and testing the military has conducted for decades. However, reanalysis of the activities is being completed using new information available after the release of the 2015 Final EIS/OEIS. In part, this supplemental document will support the renewal of regulatory permits and authorizations under the Marine Mammal Protection Act and Endangered Species Act for training and testing activities. As defined by 36 CFR §800.16(y), the Navy has determined that the proposed activities represent an undertaking requiring consultation.

The current 2009 Programmatic Agreement (PA) among the Department of Defense Representative Guam, Commonwealth of the Northern Marianas Islands (CNMI), Federated States of Micronesia and Republic of Palau, Commander Joint Region Marianas (JRM), Commander 36th Wing Andersen Air Force Base, the Guam Historic Preservation Officer, and the CNMI Preservation Officer expires on December 11, 2019. The PA as written provides NHPA compliance for military activities associated with the Mariana Islands Range Complex (MIRC), including at-sea training and testing, as well as a myriad of land-based activities, most of which are associated with JRM installation actions. The Navy's undertaking for this consultation will be limited to the activities described in our 2015 MITT EIS/OEIS and as proposed in our MITT supplemental EIS/OEIS. The JRM installation-type activities are independent of the MITT and thus, will not be covered under this consultation.

5090
Ser N465/0005
January 4, 2019

The Navy will hold its initial Section 106 consultation meetings from January 22-25, 2019. We welcome your attendance and participation. Ms. Carly Antone of the Naval Facilities Engineering Command, Pacific's Environmental Business Line will be my point of contact for coordination of location, dates, and times. Ms. Antone may be reached by telephone at (808) 472-1464 or by email at carly.antone@navy.mil.

Sincerely,

Timothy C. Liberatore
Captain, Civil Engineer Corps, U.S. Navy
By direction of the Commander

Copy to:
Katharine Kerr, Advisory Council on Historic Preservation
John Salas, Commander, Joint Region Marianas

2

**DEPARTMENT OF THE NAVY**
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N465/0025
January 10, 2019

Dear Sir/Madam:

SUBJECT: NATIONAL HISTORIC PRESERVATION ACT, SECTION 106 CONSULTATION MEETING FOR PROPOSED CONTINUATION OF MARIANA ISLANDS TRAINING AND TESTING ACTIVITIES

In accordance with Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, the United States Department of the Navy (Navy) is initiating consultation on the Guam portion of the proposed continuation of Mariana Islands Training and Testing (MITT) activities. A supplemental analysis of the activities included in the 2015 MITT Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) is being prepared to support ongoing and future activities conducted at sea and on beyond 2020. The proposed continuation of MITT activities is generally consistent with those analyzed in the 2015 Final EIS/OEIS and are representative of training and testing the military has conducted for decades. However, reanalysis of the activities is being completed using new information available after the release of the 2015 Final EIS/OEIS. In part, this supplemental document will support the renewal of regulatory permits and authorizations under the Marine Mammal Protection Act and Endangered Species Act for training and testing activities. As defined by 36 CFR §800.16(y), the Navy has determined that the proposed activities represent an undertaking requiring consultation.

The current 2009 Programmatic Agreement (PA) among the Department of Defense Representative Guam, Commonwealth of the Northern Marianas Islands (CNMI), Federated States of Micronesia and Republic of Palau, Commander Joint Region Marianas (JRM), Commander 36th Wing Andersen Air Force Base, the Guam Historic Preservation Officer, and the CNMI Preservation Officer expires on December 11, 2019. The PA as written provides NHPA compliance for military activities associated with the Mariana Islands Range Complex (MIRC), including at-sea training and testing, as well as a myriad of land-based activities, most of which are associated with JRM installation actions. The Navy's undertaking for this consultation will be limited to the activities described in our 2015 MITT EIS/OEIS and as proposed in our MITT supplemental EIS/OEIS. The JRM installation-type activities are independent of the MITT and thus, will not be covered under this consultation.

The current list of consulting parties for this undertaking includes the State Historic Preservation Officer, National Park Service, and other interested parties identified through previous consultations. We invite you to attend and participate in the Navy's initial Section 106 consultation meetings in Guam being held on January 22 and 23, 2019. Should you be aware of an interested entity/individual not included in the "Copy to" section of this letter, please forward the invitation accordingly.

On January 22, we will meet at the Daniel L. Perez Elementary School cafeteria from 3:30-6:00 pm. On January 23, we will meet at the Guam Museum multi-purpose room, from 4:00-7:00 pm.

The meetings will focus on the following:

1) Explanation of the NHPA Section 106 process;
2) Details about the Undertaking;
3) Development of the Area of Potential Effects;
4) Identification of Historic Properties
5) Potential effects of the Undertaking on Historic Properties

5090
Ser N465/0025
January 10, 2019

To attend, please respond no later than January 18, 2019 to give us an opportunity to ensure accommodations for all attendees at the meeting venues. Ms. Carly Antone of the Naval Facilities Engineering Command, Pacific's Environmental Business Line will be my point of contact for coordination. Ms. Antone may be reached by telephone at (808) 472-1464 or by email at carly.antone@navy.mil.

Sincerely,

Timothy C. Liberatore
Captain, Civil Engineer Corps, U.S. Navy
By direction of the Commander

Copy to:
Julian Aguon
Stanley Austin, Pacific West Region, National Park Service
Michael Lujan Bevacqua, Famoksaiyan
Chamorro Land Trust Commission
Hope A. Cristobal, Guahan Coalition for Peace and Justice
Jose Ulloa Garrido, Commission on Decolonization
Galaide Group
Guam Ancestral Lands Commission
Victoria-Lola Leon Guerrero, Reclaim Guahan Collective
Leonard Iriarte, I Fanlalai'an Oral History Project
Danny Jackson, Nasion Chamoru
Ramona Jones, Jones and Guerrero, Inc.
Katharine Kerr, Advisory Council on Historic Preservation

Dave Lotz, Guam Boonie Stompers
Rufo Lujan, Organization of People for Indigenous Rights
Mayor's Council of Guam
Lisalinda Natividad
Prutehi Litekyan - Save Ritidian
Joseph Quinata, Guam Preservation Trust
Frank Rabon, På'å Taotao Tåno
Johnny Sablan, Department of Chamorro Affairs
John F. Salas, Regional Environmental Director (J45), Joint Region Marianas
Frank J. Schacher, Chamorro Tribe
Rlene Santos Steffy, Micronesia Publishing
Dianne Strong
Trini Torres, Chamorro Cultural Development and Research Institute

2

## C.2.2 COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

**DEPARTMENT OF THE NAVY**
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N465/0006
January 4, 2019

Ms. Rita Chong
CNMI Historic Preservation Office
Department of Community and Cultural Affairs
P.O. Box 10007
Saipan, MP 96950

Dear Ms. Chong:

SUBJECT: NATIONAL HISTORIC PRESERVATION ACT, SECTION 106 CONSULTATION FOR PROPOSED MARIANA ISLANDS TRAINING AND TESTING ACTIVITIES

In accordance with Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, the United States Department of the Navy (Navy) is initiating consultation on the CNMI portion of the proposed continuation of Mariana Islands Training and Testing (MITT) activities. A supplemental analysis of the activities included in the 2015 MITT Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) is being prepared to support ongoing and future activities conducted at sea and on Farallon de Medinilla beyond 2020. The proposed continuation of MITT activities is generally consistent with those analyzed in the 2015 Final EIS/OEIS and are representative of training and testing the military has conducted for decades. However, reanalysis of the activities is being completed using new information available after the release of the 2015 Final EIS/OEIS. In part, this supplemental document will support the renewal of regulatory permits and authorizations under the Marine Mammal Protection Act and Endangered Species Act for training and testing activities. As defined by 36 CFR §800.16(y), the Navy has determined that the proposed activities represent an undertaking requiring consultation.

The current 2009 Programmatic Agreement (PA) among the Department of Defense Representative Guam, Commonwealth of the Northern Marianas Islands (CNMI), Federated States of Micronesia and Republic of Palau, Commander Joint Region Marianas (JRM), Commander 36th Wing Andersen Air Force Base, the Guam Historic Preservation Officer, and the CNMI Preservation Officer expires on December 11, 2019. The PA as written provides NHPA compliance for military activities associated with the Mariana Islands Range Complex (MIRC), including at-sea training and testing, as well as a myriad of land-based activities, most of which are associated with JRM installation actions. The Navy's undertaking for this consultation will be limited to the activities described in our 2015 MITT EIS/OEIS and as proposed in our MITT supplemental EIS/OEIS. The JRM installation-type activities are independent of the MITT and thus, will not be covered under this consultation.

5090
Ser N465/0006
January 4, 2019

The Navy will hold its initial Section 106 consultation meetings from January 22-25, 2019. We welcome your attendance and participation. Ms. Carly Antone of the Naval Facilities Engineering Command, Pacific's Environmental Business Line will be my point of contact for coordination of location, dates, and times. Ms. Antone may be reached by telephone at (808) 472-1464 or by email at carly.antone@navy.mil.

Sincerely,

Timothy C. Liberatore
Captain, Civil Engineer Corps, U.S. Navy
By direction of the Commander

Copy to:
Katharine Kerr, Advisory Council on Historic Preservation
John Salas, Commander, Joint Region Marianas

2

**DEPARTMENT OF THE NAVY**
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N465/0024
January 9, 2019

Dear Sir/Madam:

SUBJECT: NATIONAL HISTORIC PRESERVATION ACT, SECTION 106 CONSULTATION MEETING FOR PROPOSED CONTINUATION OF MARIANA ISLANDS TRAINING AND TESTING ACTIVITIES

In accordance with Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, the United States Department of the Navy (Navy) is initiating consultation on the CNMI portion of the proposed continuation of Mariana Islands Training and Testing (MITT) activities. A supplemental analysis of the activities included in the 2015 MITT Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) is being prepared to support ongoing and future activities conducted at sea and on Farallon de Medinilla beyond 2020. The proposed continuation of MITT activities is generally consistent with those analyzed in the 2015 Final EIS/OEIS and are representative of training and testing the military has conducted for decades. However, reanalysis of the activities is being completed using new information available after the release of the 2015 Final EIS/OEIS. In part, this supplemental document will support the renewal of regulatory permits and authorizations under the Marine Mammal Protection Act and Endangered Species Act for training and testing activities. As defined by 36 CFR §800.16(y), the Navy has determined that the proposed activities represent an undertaking requiring consultation.

The current 2009 Programmatic Agreement (PA) among the Department of Defense Representative Guam, Commonwealth of the Northern Marianas Islands (CNMI), Federated States of Micronesia and Republic of Palau, Commander Joint Region Marianas (JRM), Commander 36th Wing Andersen Air Force Base, the Guam Historic Preservation Officer, and the CNMI Preservation Officer expires on December 11, 2019. The PA as written provides NHPA compliance for military activities associated with the Mariana Islands Range Complex (MIRC), including at-sea training and testing, as well as a myriad of land-based activities, most of which are associated with JRM installation actions. The Navy's undertaking for this consultation will be limited to the activities described in our 2015 MITT EIS/OEIS and as proposed in our MITT supplemental EIS/OEIS. The JRM installation-type activities are independent of the MITT and thus, will not be covered under this consultation.

The current list of consulting parties for this undertaking includes the State Historic Preservation Officer, National Park Service, and other interested parties identified through previous consultations. We invite you to attend and participate in the Navy's initial Section 106 consultation meetings in Saipan and Tinian being held on January 24 and 25, 2019, respectively.

5090
Ser N465/0024
January 9, 2019

Should you be aware of an interested entity/individual not included in the "Copy to" section of this letter, please forward the invitation accordingly.

On Saipan, we will meet at the Kanoa Resort, Latte Stone Room, from 4:00-7:00 pm. On Tinian, we will meet at the Mayor's Offices, from 10:00 am – to 1230 pm.

The meetings will focus on the following:

1) Explanation of the NHPA Section 106 process;
2) Details about the Undertaking;
3) Development of the Area of Potential Effects;
4) Identification of Historic Properties
5) Potential effects of the Undertaking on Historic Properties

To attend, please respond no later than January 18, 2019 to give us an opportunity to ensure accommodations for all attendees at the meeting venues. Ms. Carly Antone of the Naval Facilities Engineering Command, Pacific's Environmental Business Line will be my point of contact for coordination. Ms. Antone may be reached by telephone at (808) 472-1464 or by email at carly.antone@navy.mil.

Sincerely,

Timothy C. Liberatore
Captain, Civil Engineer Corps, U.S. Navy
By direction of the Commander

Copy to:
David M. Apatang, Mayor of Saipan
Stanley Austin, Pacific West Region, National Park Service
Bonnie Borja, Department of Community and Cultural Affairs, Office of the Mayor, Tinian
John Castro
Don Farrell
Walt Goodridge
Robert Hunter, CNMI Department of Community and Cultural Affairs
Stanley Iakopo, Civil Military Liaison Office, Office of the Governor, CNMI
Katharine Kerr, Advisory Council on Historic Preservation
Gregorio Kilili Camacho Sablan, Congressman, CNMI
Polly DLG Masga, Northern Marianas Humanities Council
Randel Sablan, Joint Region Marianas (Saipan)
John F. Salas, Regional Environmental Director (J45), Joint Region Marianas
Joey Patrick San Nicholas, Mayor of Tinian
Oscar C. Torres, Military Liaison and Veterans Affairs, Office of the Governor, CNMI

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# Appendix D: Air Quality Emissions Calculations

# Supplemental Environmental Impact Statement/

# Overseas Environmental Impact Statement

# Mariana Islands Training and Testing

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There are no figures in this appendix.

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# APPENDIX D AIR QUALITY EMISSIONS CALCULATIONS

This appendix discusses emission factor development, 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 ACTIVITIES EMISSIONS

Surface activities are associated with vessel movements. Fleet training activities use a variety of marine vessels, including cruisers, destroyers, frigates, carriers, submarines, amphibious vessels, and small boats. Testing activities use a variety of marine vessels, including various testing support vessels, work boats, torpedo recovery vessels, unmanned surface vehicles, and small boats. These vessels use a variety of propulsion methods, including marine outboard engines, diesel engines, and gas turbines.

**Marine Outboard Engines:**

Emission factors for small surface craft involved in amphibious training and testing activities were obtained from the Navy and Military Sealift Command (MSC) Marine Engine Fuel Consumption & Emission Calculator database. Emissions for surface craft using outboard engines were calculated using Navy and MSC emission factors which are provided in terms of emissions per hour, and multiplied by the hours of operation.

$$Emissions = HR/YR \times EF \times ENG$$

*Where:*

*Emissions = surface craft emissions*
*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:**

Emission factors for small surface craft involved in amphibious training and testing activities were obtained from the Navy and MSC Marine Engine Fuel Consumption & Emission Calculator database. 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.

$$Emissions = HR/YR \times EF \times ENG$$

*Where:*

*Emissions = surface craft emissions*
*HR/YR = hours per year*
*EF = emission factor for specific engine type*
*ENG = number of engines*

Diesel engine emission factors were multiplied by the annual hours of operation to calculate the pollutant emissions per year.

## D.2 Air Activities Emissions

Fleet training and Naval Air Systems Command testing consists of the activities of various aircraft, including the F/A-18, P-8, SH-60B, MH-53, MH-60S, and Lear jet. Research Development Testing & Evaluation air activities consist of various aircraft, including the 1UH-1N, SH-60B, MH-53, MH-60S, and Cessna-172. Aircraft activities of concern are those that occur from ground level up to 3,000 feet (ft.) above ground level (AGL). The 3,000 ft. 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 criteria pollutant emissions from aircraft generated above 3,000 ft. AGL are excluded from analysis of 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 Supplemental Environmental Impact Statement (SEIS)/Overseas EIS (OEIS), emission factors for most military engines were obtained from Navy's Aircraft Environmental Support Office memoranda and previous Navy EIS/OEIS documentation (primarily citing the Federal Aviation Administration's Emissions and Dispersion Modeling System model). For those aircraft for which engine data were unavailable, an applicable surrogate was used. Pollutant emissions for each aircraft/organization were calculated by applying the equation below.

$$Emissions = TIM \times FF \times EF \times ENG \times CF$$

*Where:*

*Emissions = aircraft emissions (pounds [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)*

## 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 Estimates Spreadsheets

The following spreadsheets show the emissions calculations for ships, aircraft, and ordnance involved in training and testing activities. These spreadsheets were developed for each range complex and testing area. The spreadsheets show the calculations developed for each alternative analyzed in this SEIS/OEIS.

## Table D-1: Summary of Emissions Released within 3 NM of the Coast

| *Source* | *Emissions by Air Pollutant (TPY)* | | | | | |
|---|---|---|---|---|---|---|
| | *CO* | *$NO_X$* | *VOC* | *$SO_X$* | *$PM_{10}$* | *$PM_{2.5}$* |
| Baseline Emissions | 211 | 482 | 121 | 296 | 103 | 92 |
| Alternative 1 Emissions | 476 | 554 | 169 | 312 | 131 | 119 |
| Alternative 2 Emissions | 479 | 555 | 169 | 312 | 132 | 120 |

[1] Table includes criteria pollutant precursors (e.g., volatile organic compounds). Individual values may not add exactly to total values due to rounding.

Notes: NM = nautical miles, CO = carbon monoxide, $NO_X$ = nitrogen oxides, $PM_{2.5}$ = particulate matter ≤ 2.5 microns in diameter, $PM_{10}$ = particulate matter≤ 10 microns in diameter, $SO_X$ = sulfur oxides, TPY = tons per year, VOC = volatile organic compounds

## Table D-2: Vessel Emissions Factors

| Vessel Mode | Emissions Factors (lb/hr) Propulsion Engines + Generators | | | | |
|---|---|---|---|---|---|
| | CO | NOx | HC | SOx | PM10 |
| CG-3 | 61.51 | 79.58 | 4.32 | 77.63 | 2.79 |
| DDG-3 | 60.16 | 114.52 | 4.01 | 88.53 | 3.64 |
| FFG-3 | 32.94 | 47.16 | 3 | 34.92 | 2.31 |
| TRB-3 | 6.47 | 56.22 | 1.55 | 7.40 | 1.18 |
| AOE-2 | 109.76 | 311.31 | 10.6 | 119.99 | 10.41 |
| USCG | 5.74 | 57.91 | 0.88 | 11.55 | 0.21 |
| LHA-1 | 7.38 | 43.53 | 5.53 | 130.97 | 26.29 |
| LHD-2 | 8.08 | 47.83 | 5.77 | 135.50 | 28.58 |
| LPD-2 | 3.48 | 21.00 | 2.58 | 60.82 | 12.85 |
| LCAC | 18.32 | 114.53 | 3.49 | 54.61 | 5.14 |
| LCU | 5.06 | 15.7 | 1.27 | 2.91 | 0.75 |
| AAV-2 | 0.76 | 6.22 | 0.82 | 1.25 | 0.26 |
| AAAV | | | | | |
| PC-2 | 37.36 | 74.17 | 6.02 | 23.42 | 2.6 |
| MK V-2 | 3.86 | 29.49 | 0.99 | 4.73 | 0.40 |
| RIB-4 | 0.34 | 9.14 | 0.06 | 1.44 | 0.15 |
| CRRC-5 | | 0.15 | 12.90 | | |
| AE-2 | 2.61 | 15.84 | 1.94 | 45.83 | 9.67 |
| BW-3 | 111.75 | 1.60 | 45.89 | 0.31 | 0.08 |
| SSN | 0 | 0.00 | 0.00 | 0 | 0 |
| SSGN | 0 | 0.00 | 0.00 | 0 | 0 |
| T-AGO(LFA) | 6.67 | 39.37 | 5.00 | 119.43 | 23.77 |
| CG-PARTNER | 107.79 | 47.10 | 9.90 | 21 | 2.6 |
| DDG-PARTNER | 103.99 | 49.90 | 9.00 | 17.9 | 2.5 |
| SS-PARTNER | 2.94 | 17.32 | 2.20 | 52.11 | 10.46 |
| LCS | 727.98 | 171.04 | 2.82 | 67.28 | 6.94 |
| LSD | 21.25 | 334.51 | 10.84 | 35.04 | 2.71 |

## Table D-3: Aircraft Emissions Factors

| Aircraft | Emission Indices, lb/1,000 lb fuel | | | | | Emissions Factors (lb/hr) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CO | NOx | VOC | SOx | PM | CO | NOx | VOC | SOx | PM |
| AH-1W | 11.21 | 5.44 | 0.57 | 0.40 | 4.20 | 9.10 | 4.42 | 0.46 | 0.32 | 3.41 |
| AV-8B | 7.70 | 8.60 | 0.54 | 0.40 | 3.80 | 46.20 | 51.60 | 3.24 | 2.40 | 22.80 |
| C-130 F/R/T | 2.07 | 8.16 | 0.47 | 0.40 | 3.97 | 9.32 | 36.72 | 2.12 | 1.80 | 17.87 |
| CH-46 | 17.04 | 4.12 | 2.64 | 0.40 | 1.78 | 20.45 | 4.94 | 3.17 | 0.48 | 2.14 |
| CH-53 | 2.13 | 8.08 | 0.15 | 0.40 | 2.21 | 9.51 | 36.07 | 0.67 | 1.79 | 9.87 |
| E-2 / E-2C | 2.54 | 10.04 | 0.36 | 0.40 | 0.94 | 5.59 | 22.09 | 0.79 | 0.88 | 2.07 |
| EA-18G | 0.72 | 14.75 | 0.12 | 0.40 | 6.56 | 7.44 | 152.49 | 1.24 | 4.14 | 67.82 |
| EA-6B | 7.99 | 5.71 | 1.09 | 0.40 | 12.12 | 51.06 | 36.49 | 6.97 | 2.56 | 77.45 |
| EP-3 | 2.51 | 7.73 | 0.58 | 0.40 | 3.97 | 10.57 | 32.56 | 2.44 | 1.68 | 16.72 |
| F-15 | 3.62 | 46.72 | 0.65 | 0.40 | 8.15 | 22.43 | 289.48 | 4.03 | 2.48 | 50.50 |
| FA-18A/C | 2.44 | 6.74 | 0.44 | 0.40 | 6.36 | 16.19 | 44.73 | 2.92 | 2.65 | 42.20 |
| FA-18E/F | 0.72 | 14.75 | 0.12 | 0.40 | 6.56 | 7.44 | 152.49 | 1.24 | 4.14 | 67.82 |
| HH-60 | 6.25 | 6.40 | 0.55 | 0.40 | 4.20 | 7.50 | 7.68 | 0.66 | 0.48 | 5.04 |
| Learjet | 22.38 | 5.90 | 4.26 | 0.40 | 1.27 | 23.81 | 6.28 | 4.53 | 0.43 | 1.35 |
| MH-60R/S | 6.25 | 6.40 | 0.55 | 0.40 | 4.20 | 7.50 | 7.68 | 0.66 | 0.48 | 5.04 |
| P-3C | 2.51 | 7.73 | 0.58 | 0.40 | 3.97 | 12.05 | 37.10 | 2.78 | 1.92 | 19.06 |
| P-8 MMA | 1.24 | 9.26 | 0.28 | 0.40 | 0.56 | 4.05 | 30.21 | 0.91 | 1.31 | 1.83 |
| S-3 | 14.10 | 4.07 | 1.86 | 0.40 | 3.62 | 32.29 | 9.32 | 4.26 | 0.92 | 8.29 |
| S-3B | 14.10 | 4.07 | 1.86 | 0.40 | 3.62 | 32.29 | 9.32 | 4.26 | 0.92 | 8.29 |
| SH-60 | 6.25 | 6.40 | 0.55 | 0.40 | 4.20 | 7.50 | 7.68 | 0.66 | 0.48 | 5.04 |
| SH-60B | 6.25 | 6.40 | 0.55 | 0.40 | 4.20 | 7.50 | 7.68 | 0.66 | 0.48 | 5.04 |
| SH-60B/F | 6.25 | 6.40 | 0.55 | 0.40 | 4.20 | 7.50 | 7.68 | 0.66 | 0.48 | 5.04 |
| SH-60F | 6.25 | 6.40 | 0.55 | 0.40 | 4.20 | 7.50 | 7.68 | 0.66 | 0.48 | 5.04 |
| UH-1N | 3.34 | 4.72 | 0.17 | 0.40 | 4.20 | 1.80 | 2.55 | 0.09 | 0.22 | 2.27 |
| A-10 | 4 | 8.83 | 0.4 | 0.4 | 2.67 | 12.104 | 26.71958 | 1.2104 | 1.2104 | 8.07942 |
| B-1B | 0.84 | 13.12 | 0.11 | 0.4 | 0.14 | 5.5776 | 87.1168 | 0.7304 | 2.656 | 0.9296 |
| E-2 | 0.65 | 10.45 | 0.16 | 0.4 | 3.97 | 2.8847 | 46.3771 | 0.71008 | 1.7752 | 17.61886 |
| E-3 | 2.07 | 8.45 | 0.31 | 0.4 | 0.26 | 67.65588 | 276.1798 | 10.13204 | 13.0736 | 8.49784 |
| KC-135 | 1.34 | 13.5 | 0.03 | 0.4 | 0.13 | 30.66992 | 308.988 | 0.68664 | 9.1552 | 2.97544 |
| MQ-4C | | | | | | 2.1 | 38.84 | 0.66 | 3.54 | 0.61 |
| MV-22 | 19.74 | 3.94 | 3.43 | 0.40 | 1.78 | 22.1088 | 4.4128 | 3.8416 | 0.448 | 1.9936 |

## Table D-4: Ordnance Emissions Factors

| Ordnance Type | Ordnance | Emission Factor (lb per lb) | | | | | | | Emission Factor (lb/item) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $CO_2$ | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | Lead | $CO_2$ | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | Lead |
| BOMB | CBU MK20 ROCKEYE | | | | | | | | | 0.00 | | | | | |
| | GBU32I JDAM | | 0.1482 | | | | | | | 57.06 | | | | | |
| | LGTR | | | | | | | | | 0.00 | | | | | |
| | MK76 | | 0.085 | | | | | | | 0.26 | | | | | |
| | BDU 48 | | 0.085 | | | | | | | 0.26 | | | | | |
| | MK82 HE | | 0.3184 | | | | | | | 61 | | | | | |
| | GBU12 - Paveway II | | 0.3184 | | | | | | | 61 | | | | | |
| | MK82 INERT | | 0.085 | | | | | | | 0.26 | | | | | |
| | BDU 45 | | 0.085 | | | | | | | 0.26 | | | | | |
| | MK83 HE | | 0.1482 | | | | | | | 62 | | | | | |
| | GBU 16 | | 0.1482 | | | | | | | 66 | | | | | |
| | MK84 | | 0.1482 | | | | | | | 140 | | | | | |
| | MK83 INERT | | 0.085 | | | | | | | 0.26 | | | | | |
| OTHER ORD | Type | | | | | | | | | | | | | | |
| | EER/IEER AN/SQQ-110 | 1.2 | 0.0044 | 0.011 | | | | 0.00004 | | 0.02 | | | | | |
| | BLASTING CAP MK11 | | | | | | | | 1.80E-03 | 3.10E-04 | 4.50E-05 | 4.60E-04 | 2.90E-04 | | 1.30E-04 |
| | Detonator | | | | | | | | | | | | | | |
| | FIRING DEVICE | | | | | | | | | | | | | | |
| | FUSE | | | | | | | | | | | | | | |
| | GRENADE SIMULATOR | | | | | | | | 4.10E-03 | 0.0004 | 5.60E-03 | 0.12 | | 4.70E-04 | 1.40E-06 |
| | Grenades | 6.30E-01 | 0.021 | 6.30E-03 | 2.10E-02 | 1.50E-02 | 1.20E-04 | 1.40E-04 | | 0.00 | | | | | |
| | Haversacks | 6.30E-01 | 0.021 | 6.30E-03 | 2.10E-02 | 1.50E-02 | 1.20E-04 | 1.40E-04 | | 0.42 | | | | | |
| | K143 Antipersonnel Mine | 6.30E-01 | 0.021 | 6.30E-03 | 2.10E-02 | 1.50E-02 | 1.20E-04 | 1.40E-04 | | 0.03 | | | | | |
| | M1A2 BANGALORE TORP | 6.30E-01 | 0.021 | 6.30E-03 | 2.10E-02 | 1.50E-02 | 1.20E-04 | 1.40E-04 | | 0.21 | | | | | |
| | M7 BANDOLEER MK57 (Claymore mine) | | 0.15108 | | | | | | | | | | | | |

## Table D-4: Ordnance Emissions Factors (continued)

| Ordnance Type | Ordnance | Emission Factor (lb per lb) | | | | | | | Emission Factor (lb/item) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $CO_2$ | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | Lead | $CO_2$ | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | Lead |
| | M112 DEMO CHARGE | | | | | | | | 7.90E-01 | 2.60E-02 | 7.90E-03 | 2.60E-02 | 1.90E-02 | | 1.70E-04 |
| | M700 BLASTING FUSE | | 0.149 | | | | | | 0.0008 | 0.0003 | 0.0002 | 0.00009 | 0.00009 | 0.000002 | 0 |
| | Flare, Aircraft Parachute | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | 0.039 | 0.021 | 0.054 | 0.1 | 0.092 | 0.00018 | | | 5.91E-05 | 0.000152 | 0.000282 | 0.000259 | 5.07E-07 | |
| | Chaff | 0.039 | 0.021 | 0.054 | 0.1 | 0.092 | 0.00018 | | | 5.91E-05 | 0.000152 | 0.000282 | 0.000259 | 5.07E-07 | |
| | MK36 M0 DEMO CHARGE | | | | | | | | | | | | | | |
| | MK75 CHARGE | | | | | | | | | | | | | | |
| | MK84 [86] EOD Shaped Charge | | | | | | | | | | | | | | |
| | MK120 NONELEC DET (ft) | | | | | | | | | | | | | | |
| | MK123 NONELEC DET (ft) | | | | | | | | | | | | | | |
| | MK138 DEMO CHG ASSEMBLY | 6.30E-01 | 0.021 | 6.30E-03 | 2.10E-02 | 1.50E-02 | 1.20E-04 | 1.40E-04 | | | | | | | |
| | MK140 FLEXIBLE CHARGE | | | | | | | | | | | | | | |
| | PBXN-109 TEST Det Cord | | | | | | | | | | | | | | |
| | SIGNAL MK 18(G950) SMOKE | | | | | | | | | | | | | | |
| | C4 1.25 LB | 6.30E-01 | 0.021 | 6.30E-03 | 2.10E-02 | 1.50E-02 | 1.20E-04 | 1.40E-04 | | 0.02625 | 0.007875 | 0.02625 | 0.01875 | 0.00015 | |
| | C4 5 LB | 6.30E-01 | 0.021 | 6.30E-03 | 2.10E-02 | 1.50E-02 | 1.20E-04 | 1.40E-04 | | 0.105 | 0.0315 | 0.105 | 0.075 | 0.0006 | |
| | C4 15 LB | 6.30E-01 | 0.021 | 6.30E-03 | 2.10E-02 | 1.50E-02 | 1.20E-04 | 1.40E-04 | | 0.315 | 0.0945 | 0.315 | 0.225 | 0.0018 | |
| | C4 40 LB | 6.30E-01 | 0.021 | 6.30E-03 | 2.10E-02 | 1.50E-02 | 1.20E-04 | 1.40E-04 | | 0.84 | 0.252 | 0.84 | 0.6 | 0.0048 | 0.0056 |
| | C4 100 LB | 6.30E-01 | 0.021 | 6.30E-03 | 2.10E-02 | 1.50E-02 | 1.20E-04 | 1.40E-04 | | 2.1 | 0.63 | 2.1 | 1.5 | 0.012 | 0.014 |

## Table D-4: Ordnance Emissions Factors (continued)

| Ordnance Type | Ordnance | Emission Factor (lb per lb) | | | | | | | Emission Factor (lb/item) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $CO_2$ | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | Lead | $CO_2$ | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | Lead |
| | C4 300 LB | 6.30E-01 | 0.021 | 6.30E-03 | 2.10E-02 | 1.50E-02 | 1.20E-04 | 1.40E-04 | | 0.021 | 0.0063 | 0.021 | 0.015 | 0.00012 | 0.00014 |
| | C4 500 LB | 6.30E-01 | 0.021 | 6.30E-03 | 2.10E-02 | 1.50E-02 | 1.20E-04 | 1.40E-04 | | 0.021 | 0.0063 | 0.021 | 0.015 | 0.00012 | 0.00014 |
| | TNT Blocks 0.5 lbd | | 0.398 | | | | | | | | | | | | |
| | DEMO SHEET | | | | | | | | | | | | | | |
| | DETONATING CORD | | | | | | | | | | | | | | |
| | DEMO CHARGE | | | | | | | | | | | | | | |
| | SIMULATED ARTILLERY | 6.30E-01 | 0.021 | 6.30E-03 | 2.10E-02 | 1.50E-02 | 1.20E-04 | 1.40E-04 | | 0.002888 | 0.000866 | 0.002888 | 0.002063 | 1.65E-05 | |
| PROJECTILE (LARGE) | 155MM HE | 6.51 | 2.35E+01 | 1.43E+00 | 0.496 | 0.2418 | | 2.26E-03 | | | | | | | |
| | 155MM ILL | | | | | | | | 6.00 | 8.63 | 0.087 | 3.44 | 0.13 | 0.0027 | 0.029 |
| | 5"/54 Inert | 2.60E-04 | 3.50E-04 | 3.60E-05 | 2.60E-05 | 2.30E-05 | | 6.70E-04 | | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 5"/54 | 5"/54 BLP | 1.60E-02 | 2.00E-02 | | 1.20E-03 | 9.30E-04 | | 6.00E-06 | | | | | | | |
| | 5"/54 HCVT+32 (EOD) | 1.60E-02 | 2.00E-02 | | 1.20E-03 | 9.30E-04 | | 6.00E-06 | | 0.16 | 0 | 0.0096 | 0.00744 | 0 | 0.000048 |
| | 5"/54 HECVT | 1.60E-02 | 2.00E-02 | | 1.20E-03 | 9.30E-04 | | 6.00E-06 | | 0.1280 | 0.1600 | 0.0096 | 0.0074 | | |
| | 5"/54 HEPD | 1.60E-02 | 2.00E-02 | | 1.20E-03 | 9.30E-04 | | 6.00E-06 | | 0.16 | 0 | 0.0096 | 0.00744 | 0 | 0.000048 |
| | 5"/54 HEVT | 1.60E-02 | 2.00E-02 | | 1.20E-03 | 9.30E-04 | | 6.00E-06 | | 1.60E-01 | 0.00E+00 | 9.60E-03 | 7.44E-03 | 0.00E+00 | 4.80E-05 |
| | 5"/54 ILL | 1.50E-02 | 1.40E-02 | 3.60E-04 | 9.20E-04 | 7.60E-04 | | 1.30E-06 | | 1.12E-01 | 2.88E-03 | 7.36E-03 | 6.08E-03 | 0.00E+00 | 1.04E-05 |
| | 5"54/54 VTNF | 1.60E-02 | 2.00E-02 | | 1.20E-03 | 9.30E-04 | | 6.00E-06 | | 1.60E-01 | 0.00E+00 | 9.60E-03 | 7.44E-03 | 0.00E+00 | 4.80E-05 |
| 5"/62 | 5"/62 | 1.60E-02 | 2.00E-02 | | 1.20E-03 | 9.30E-04 | | 6.00E-06 | | 1.60E-01 | 0.00E+00 | 9.60E-03 | 7.44E-03 | 0.00E+00 | 4.80E-05 |
| | 5"/62 HE-MFF | 1.60E-02 | 2.00E-02 | | 1.20E-03 | 9.30E-04 | | 6.00E-06 | | 1.60E-01 | 0.00E+00 | 9.60E-03 | 7.44E-03 | 0.00E+00 | 4.80E-05 |
| | 5"/62 HECVT | 1.60E-02 | 2.00E-02 | | 1.20E-03 | 9.30E-04 | | 6.00E-06 | | 1.60E-01 | 0.00E+00 | 9.60E-03 | 7.44E-03 | 0.00E+00 | 4.80E-05 |
| | 5"/62 HEET | 1.60E-02 | 2.00E-02 | | 1.20E-03 | 9.30E-04 | | 6.00E-06 | | 1.60E-01 | 0.00E+00 | 9.60E-03 | 7.44E-03 | 0.00E+00 | 4.80E-05 |
| | 5"/62 KEET | 1.60E-02 | 2.00E-02 | | 1.20E-03 | 9.30E-04 | | 6.00E-06 | | 1.60E-01 | 0.00E+00 | 9.60E-03 | 7.44E-03 | 0.00E+00 | 4.80E-05 |
| 60mm | 60MM | | | | | | | | 0.4 | 0.06 | 0.005 | 0.062 | 0.03 | | 0.0004 |
| | 60MM WP | | | | | | | | 0.13 | 0.154 | 0.0124 | 0.221 | 0.494 | 0.00014 | 0.001 |
| 76mm | 76MM BLP | 1.44E-02 | 1.80E-02 | | 1.08E-03 | 8.37E-04 | | 5.40E-06 | | | | | | | |
| | 81MM HE | | | | | | | | 1.48 | 0.14 | 0.016 | 0.173 | 0.096 | | 0.0007 |
| | 81MM ILL | | | | | | | | 1.48 | 0.14 | 0.016 | 0.173 | 0.096 | | 0.0007 |
| CAS | GAU-17 30mm | | | | | | | | | | | | | | |
| PROJECTILE (SMALL) | 20MM | 0.19 | 0.38 | 0.0049 | 0.0075 | 0.0053 | | 0.00026 | 0.016 | 0.033 | 0.00043 | 0.00066 | 0.00046 | | 0.000023 |

## Table D-4: Ordnance Emissions Factors (continued)

| Ordnance Type | Ordnance | Emission Factor (lb per lb) | | | | | | | Emission Factor (lb/item) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $CO_2$ | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | Lead | $CO_2$ | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | Lead |
| | 25MM | | | | | | | | 0.11 | 0.019 | 0.00067 | 0.0027 | 0.0017 | | 0.000055 |
| | 30MM EFV Main Gun | 0.14 | 0.028 | 0.0063 | 0.13 | 0.08 | | 0.00037 | | 7.28E-03 | 1.64E-03 | 3.38E-02 | 2.08E-02 | 0.00E+00 | 9.62E-05 |
| | 40MM | 5.70E-01 | 6.00E-02 | 1.30E-02 | 1.10E-01 | 5.60E-02 | | 6.20E-04 | 4.90E-02 | 4.00E-03 | 1.30E-03 | 9.50E-03 | 5.10E-03 | 0.00E+00 | 8.00E-05 |
| | 40MM HE | 5.70E-01 | 6.00E-02 | 1.30E-02 | 1.10E-01 | 5.60E-02 | | 6.20E-04 | 4.90E-02 | 4.00E-03 | 1.30E-03 | 9.50E-03 | 5.10E-03 | 0.00E+00 | 8.00E-05 |
| | 40MM ILL | 7.20E-02 | 2.40E-02 | 6.50E-03 | 1.40E-01 | 1.20E-01 | 0.00019 | 7.90E-04 | 0.015 | 0.005 | 0.0014 | 0.029 | 0.025 | 0.00004 | 1.60E-04 |
| | 40MM PRACTICE | 2.60E-01 | 2.50E-01 | 9.50E-03 | 1.40E-02 | 1.10E-02 | | 1.10E-03 | 2.70E-03 | 2.60E-03 | 9.70E-05 | 1.40E-04 | 1.20E-04 | 0.00E+00 | 1.10E-05 |
| | .45 CAL | 2.80E-01 | 3.40E-01 | 1.00E-02 | 4.70E-02 | 4.00E-02 | | 1.60E-02 | 2.20E-04 | 2.60E-04 | 8.10E-06 | 3.70E-05 | 3.10E-05 | | 1.20E-05 |
| | 5.56 | 2.40E-01 | 4.40E-01 | 1.30E-02 | 9.20E-03 | 7.60E-03 | | 3.20E-03 | 8.70E-04 | 1.60E-03 | 8.50E-05 | 3.90E-05 | 2.80E-05 | | 5.10E-06 |
| | 5.56 BLANK | 2.60E-01 | 3.20E-01 | 2.30E-02 | 7.80E-03 | 6.80E-03 | 0.00011 | 1.10E-03 | 2.30E-04 | 2.80E-04 | 2.00E-05 | 6.90E-06 | 6.00E-06 | 9.80E-09 | 9.70E-07 |
| | .50CAL | 1.50E-01 | 3.30E-01 | 3.60E-02 | 9.60E-03 | 5.60E-03 | | 4.00E-04 | 5.10E-03 | 1.10E-02 | 1.20E-03 | 3.10E-04 | 1.90E-04 | | 1.30E-05 |
| | .50CAL | 1.50E-01 | 3.30E-01 | 3.60E-02 | 9.60E-03 | 5.60E-03 | | 4.00E-04 | 5.10E-03 | 1.10E-02 | 1.20E-03 | 3.10E-04 | 1.90E-04 | | 1.30E-05 |
| | .50CAL BLANK | 3.10E-01 | 2.70E-01 | 4.10E-03 | 1.40E-02 | 1.30E-02 | | 1.70E-03 | 5.10E-03 | 1.10E-02 | 1.20E-03 | 3.10E-04 | 1.90E-04 | | 1.30E-05 |
| | 7.62 | 3.50E-01 | 2.50E-01 | 1.60E-02 | 6.10E-03 | 5.60E-03 | 0.00013 | 9.70E-04 | 1.20E-03 | 2.30E-03 | 9.70E-05 | 5.10E-05 | 3.80E-05 | | 4.90E-06 |
| | 7.62 | 3.50E-01 | 2.50E-01 | 1.60E-02 | 6.10E-03 | 5.60E-03 | 0.00013 | 9.70E-04 | 1.20E-03 | 2.30E-03 | 9.70E-05 | 5.10E-05 | 3.80E-05 | | 4.90E-06 |
| | 9MM | | | | | | | | 2.00E-04 | 3.10E-04 | 1.50E-05 | 2.40E-05 | 2.00E-05 | 8.20E-08 | 6.80E-06 |
| | .300 WIN MAG | | | | | | | | 1.90E-03 | 3.00E-03 | 1.50E-05 | 9.40E-05 | 7.30E-05 | | 1.80E-05 |
| | .223 Rifle Rounds | | | | | | | | 7.50E-05 | 8.00E-05 | 5.00E-06 | 3.40E-06 | 2.60E-06 | | 1.90E-06 |
| | .22 Magnum | | | | | | | | 7.50E-05 | 8.00E-05 | 5.00E-06 | 3.40E-06 | 2.60E-06 | | 1.90E-06 |
| | .22 Long Rifle | | | | | | | | 7.50E-05 | 8.00E-05 | 5.00E-06 | 3.40E-06 | 2.60E-06 | | 1.90E-06 |
| | 12 Guage Shotgun | 5.10E-03 | 1.10E-02 | 1.20E-03 | 3.10E-04 | 1.90E-04 | | 1.30E-05 | | | | | | | |
| **MINE SHAPE** | M18A1 | 1.6 | 2.00E-02 | 1.80E-02 | 4.90E-02 | 2.60E-02 | | 5.70E-05 | | | | | | | |
| | MK76 | | | | | | | | | | | | | | |
| **MISSILE** | AGM-114B | | | | | | | | | | | | | | |
| | AGM-65 Maverick | | | | | | | | | | | | | | |
| | AGM-84 | 0.4 | | 0.06 | 0.1025 | 0.1025 | | | 140 | 30.62356 | 35.574 | 61.795 | 61.795 | | |
| | AIM-120 | | | | | | | | | | | | | | |
| | AIM-7 | | | | | | | | | | | | | | |
| | AIM-9 | | | | | | | | | | | | | | |
| | BGM-71E TOW-A | | | | | | | | | | | | | | |
| | GBU-9 | | | | | | | | | | | | | | |

## Table D-4: Ordnance Emissions Factors (continued)

| Ordnance Type | Ordnance | Emission Factor (lb per lb) | | | | | | | Emission Factor (lb/item) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $CO_2$ | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | Lead | $CO_2$ | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | Lead |
| | AGM-88 HARM | | | | | | | | | | | | | | |
| | NSM | | | | | | | | | | | | | | |
| | JSOW | | | | | | | | | | | | | | |
| | Japanese Missile Tests | | | | | | | | | | | | | | |
| | Tactical Tomahawk | | | | | | | | | | | | | | |
| | Seasparrow Missile | | | | | | | | | | | | | | |
| | SLAM ER | | | | | | | | | | | | | | |
| | SM2 or equivalent | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| ROCKET | 2.75" RKT | 4.50E-01 | 5.60E-02 | 7.10E-03 | 6.10E-02 | 3.80E-02 | | 1.20E-03 | | | | | | | |
| | 2.75" RKT HE | 3.00E-01 | 1.70E-01 | 2.40E-03 | 1.00E-01 | 5.30E-02 | | 2.60E-04 | 5.5 | 0.93 | 0.0056 | 0.4 | 0.29 | | 0.07 |
| | 2.75" RKT I | 4.50E-01 | 5.60E-02 | 7.10E-03 | 6.10E-02 | 3.80E-02 | | 1.20E-03 | | | | | | | |
| PYROTECHNICS | MK58 Marine Location Marker | 1 | 1.30E-02 | 1.20E-02 | 3.20E-02 | 1.70E-02 | 6.10E-05 | 3.80E-05 | | | | | | | |
| | Smoke Grenade AN-M8 | | | | | | | | 3.30E-02 | 4.60E-02 | 1.00E-03 | 6.80E-01 | 1.10E-01 | 1.20E-04 | 4.70E-04 |

## Table D-5: Vessel Emissions – No Action Alternative

**OPERATIONAL INFORMATION – VESSELS**

| Type Training | Training Ops (#) | Ship / Vessel / Boat: Number | Ship Type | Type | Participation | Range Time (hr): Per Ship | Time at Each Power Level (%) | Total | Distribution (hr): 0-3 nm from shore | 3-12 nm from shore | >12 nm from shore |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-AIR WARFARE** | | | | | | | | | | | |
| Air Combat Maneuver | 4800 | | | | | | | | | | |
| Air Defense Exercise | 100 | | | | | | | | | | |
| Air Intercept Control | 4800 | | | | | | | | | | |
| Gunnery Exercise, A-A (Medium Caliber) | 36 | | | | | | | | | | |
| Missile Exercise, A-A | 18 | | | | | | | | | | |
| Gunnery Exercise, S-A (Large Caliber) | 5 | 10 | FFG | Guided Missile Frigate | 2.00 | 2.0 | 100% | 20.0 | 0.0 | 0.0 | 20.0 |
| Gunnery Exercise, S-A (Medium Caliber) | 12 | 24 | FFG | Guided Missile Frigate | 2.00 | 2.0 | 100% | 48.0 | 0.0 | 0.0 | 48.0 |
| Missile Exercise, S-A | 15 | 30 | FFG | Guided Missile Frigate | 2.00 | 2.0 | 100% | 60.0 | 0.0 | 0.0 | 0.0 |
| **STRIKE WARFARE** | | | | | | | | | | | |
| Bombing Exercise, A-G | 2300 | | | | | | | | | | |
| Missile Exercise, A-G | 85 | | | | | | | | | | |
| Gunnery Exercise, A-G | 36 | | | | | | | | | | |
| **AMPHIBIOUS WARFARE** | | | | | | | | | | | |
| Fire Support Exercise - Land-Based target | 10 | 10 | CG | Cruiser | 1 | 8.0 | 100% | 80.00 | 80.0 | 0.0 | 0.0 |
| Amphibious Rehearsal, No Landing - Marine Air Ground Task Force | 12 | 48 | LSD | Cruiser | 4 | 24.0 | 100% | 1152.0 | 1152.0 | 0.0 | 0.0 |
| | | 48 | LHA/LHD | Amphib. Assault Ship - T | 4 | 24.0 | 100% | 1152.0 | 1152.0 | 0.0 | 0.0 |
| | | 48 | LPD | Amphibious Transport D | 4 | 24.0 | 100% | 1152.0 | 1152.0 | 0.0 | 0.0 |
| Amphibious Assault - Marine Air Ground Task Force | 6 | 6 | CG | Cruiser | 1 | 8.0 | 100% | 48.0 | 48.0 | 0.0 | 0.0 |
| | | 6 | LHA | Amphib. Assault Ship - T | 1 | 8.0 | 100% | 48.0 | 48.0 | 0.0 | 0.0 |
| | | 12 | LPD | Amphibious Transport D | 2 | 8.0 | 100% | 96.0 | 96.0 | 0.0 | 0.0 |
| | | 12 | FFG | Guided Missile Frigate | 2 | 8.0 | 100% | 96.0 | 96.0 | 0.0 | 0.0 |
| Amphibious Raid - Special Purpose Marine Air Ground Task Force | 6 | 6 | LHA | Amphib. Assault Ship - T | 1 | 6.0 | 100% | 36.0 | 36.0 | 0.0 | 0.0 |
| | | 12 | LPD | Amphibious Transport D | 2 | 2.5 | 100% | 30.0 | 30.0 | 0.0 | 0.0 |
| Non-Combatant Evacuation Operation | 5 | 5 | LHA | Amphib. Assault Ship - T | 1 | 80.0 | 100% | 400.0 | 400.0 | 0.0 | 0.0 |
| | | 10 | LPD | Amphibious Transport D | 2 | 80.0 | 100% | 800.0 | 800.0 | 0.0 | 0.0 |
| | | 5 | LCU | Landing Craft Utility | 1 | 80.0 | 100% | 400.0 | 400.0 | 0.0 | 0.0 |
| Humanitarian Assistance/ Disaster Relief Operations | 5 | 5 | LHA | Amphib. Assault Ship - T | 1 | 8.0 | 100% | 40.0 | 40.0 | 0.0 | 0.0 |
| | | 10 | LPD | Amphibious Transport D | 2 | 8.0 | 100% | 80.0 | 80.0 | 0.0 | 0.0 |
| | | 5 | LCAC | Landing Craft Air Cushic | 1 | 8.0 | 100% | 40.0 | 40.0 | 0.0 | 0.0 |
| Unmanned Aerial Vehicle - Intelligence, Surveillance, and Reconaissance | 100 | | | | | | | | | | |

**EMISSIONS/YEAR (lb) BY JURISDICTION**

| Type Training | State (0-3 nm offshore): CO | $NO_x$ | HC | $SO_x$ | $PM_{10}$ | PM2.5 | Waters of U S (3-12 nm): CO | $NO_x$ | HC | $SO_x$ | $PM_{10}$ | PM2.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-AIR WARFARE** | | | | | | | | | | | | |
| Air Combat Maneuver | | | | | | | | | | | | |
| Air Defense Exercise | | | | | | | | | | | | |
| Air Intercept Control | | | | | | | | | | | | |
| Gunnery Exercise, A-A (Medium Caliber) | | | | | | | | | | | | |
| Missile Exercise, A-A | | | | | | | | | | | | |
| Gunnery Exercise, S-A (Large Caliber) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gunnery Exercise, S-A (Medium Caliber) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Missile Exercise, S-A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **STRIKE WARFARE** | | | | | | | | | | | | |
| Bombing Exercise, A-G | | | | | | | | | | | | |
| Missile Exercise, A-G | | | | | | | | | | | | |
| Gunnery Exercise, A-G | | | | | | | | | | | | |
| **AMPHIBIOUS WARFARE** | | | | | | | | | | | | |
| Fire Support Exercise - Land-Based target | 4,921 | 6,366 | 346 | 6,210 | 223 | 201 | 0 | 0 | 0 | 0 | 0 | 0 |
| Amphibious Rehearsal, No Landing - Marine Air Ground Task Force | 24,480 | 385,356 | 12,488 | 40,366 | 3,122 | 2,810 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 3,308 | 55,100 | 6,647 | 156,036 | 32,924 | 29,632 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 4,009 | 24,192 | 2,972 | 70,065 | 14,803 | 13,323 | 0 | 0 | 0 | 0 | 0 | 0 |
| Amphibious Assault - Marine Air Ground Task Force | 2,952 | 3,820 | 207 | 3,726 | 134 | 121 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 354 | 2,089 | 265 | 6,287 | 1,262 | 1,136 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 334 | 2,016 | 248 | 5,839 | 1,234 | 1,110 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 3,162 | 4,527 | 288 | 3,352 | 222 | 200 | 0 | 0 | 0 | 0 | 0 | 0 |
| Amphibious Raid - Special Purpose Marine Air Ground Task Force | 266 | 1,567 | 199 | 4,715 | 946 | 852 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 104 | 630 | 77 | 1,825 | 386 | 347 | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Combatant Evacuation Operation | 2,952 | 17,412 | 2,212 | 52,388 | 10,516 | 9,464 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2,784 | 16,800 | 2,064 | 48,656 | 10,280 | 9,252 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 7,328 | 45,812 | 1,396 | 21,844 | 2,056 | 1,850 | 0 | 0 | 0 | 0 | 0 | 0 |
| Humanitarian Assistance/ Disaster Relief Operations | 295 | 1,741 | 221 | 5,239 | 1,052 | 946 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 278 | 1,680 | 206 | 4,866 | 1,028 | 925 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 733 | 4,581 | 140 | 2,184 | 206 | 185 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unmanned Aerial Vehicle - Intelligence, Surveillance, and Reconaissance | | | | | | | | | | | | |

**EMISSIONS/YEAR (lb) BY JURISDICTION**

| Type Training | Int Waters (> 12 nm): CO | $NO_x$ | HC | $SO_x$ | $PM_{10}$ | PM2.5 | Total Emissions: CO | $NO_x$ | HC | $SO_x$ | $PM_{10}$ | PM2.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-AIR WARFARE** | | | | | | | | | | | | |
| Air Combat Maneuver | | | | | | | | | | | | |
| Air Defense Exercise | | | | | | | | | | | | |
| Air Intercept Control | | | | | | | | | | | | |
| Gunnery Exercise, A-A (Medium Caliber) | | | | | | | | | | | | |
| Missile Exercise, A-A | | | | | | | | | | | | |
| Gunnery Exercise, S-A (Large Caliber) | 659 | 943 | 60 | 698 | 46 | 42 | 659 | 943 | 60 | 698 | 46 | 42 |
| Gunnery Exercise, S-A (Medium Caliber) | 1,581 | 2,264 | 144 | 1,676 | 111 | 100 | 1,581 | 2,264 | 144 | 1,676 | 111 | 100 |
| Missile Exercise, S-A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **STRIKE WARFARE** | | | | | | | | | | | | |
| Bombing Exercise, A-G | | | | | | | | | | | | |
| Missile Exercise, A-G | | | | | | | | | | | | |
| Gunnery Exercise, A-G | | | | | | | | | | | | |
| **AMPHIBIOUS WARFARE** | | | | | | | | | | | | |
| Fire Support Exercise - Land-Based target | 0 | 0 | 0 | 0 | 0 | 0 | 4,921 | 6,366 | 346 | 6,210 | 223 | 201 |
| Amphibious Rehearsal, No Landing - Marine Air Ground Task Force | 0 | 0 | 0 | 0 | 0 | 0 | 24,480 | 385,356 | 12,488 | 40,366 | 3,122 | 2,810 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 3,308 | 55,100 | 6,647 | 156,036 | 32,924 | 29,632 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 4,009 | 24,192 | 2,972 | 70,065 | 14,803 | 13,323 |
| Amphibious Assault - Marine Air Ground Task Force | 0 | 0 | 0 | 0 | 0 | 0 | 2,952 | 3,820 | 207 | 3,726 | 134 | 121 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 354 | 2,089 | 265 | 6,287 | 1,262 | 1,136 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 334 | 2,016 | 248 | 5,839 | 1,234 | 1,110 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 3,162 | 4,527 | 288 | 3,352 | 222 | 200 |
| Amphibious Raid - Special Purpose Marine Air Ground Task Force | 0 | 0 | 0 | 0 | 0 | 0 | 266 | 1,567 | 199 | 4,715 | 946 | 852 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 104 | 630 | 77 | 1,825 | 386 | 347 |
| Non-Combatant Evacuation Operation | 0 | 0 | 0 | 0 | 0 | 0 | 2,952 | 17,412 | 2,212 | 52,388 | 10,516 | 9,464 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 2,784 | 16,800 | 2,064 | 48,656 | 10,280 | 9,252 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 7,328 | 45,812 | 1,396 | 21,844 | 2,056 | 1,850 |
| Humanitarian Assistance/ Disaster Relief Operations | 0 | 0 | 0 | 0 | 0 | 0 | 295 | 1,741 | 221 | 5,239 | 1,052 | 946 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 278 | 1,680 | 206 | 4,866 | 1,028 | 925 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 733 | 4,581 | 140 | 2,184 | 206 | 185 |
| Unmanned Aerial Vehicle - Intelligence, Surveillance, and Reconaissance | | | | | | | | | | | | |

**GHG Emissions (lb)**

| Type Training | Fuel Flow (GPH) | Annual Fuel Consumption (gal) | $CO_2$ | $N_2O$ | $CH_4$ | $CO_{2-e}$ |
|---|---|---|---|---|---|---|
| **ANTI-AIR WARFARE** | | | | | | |
| Air Combat Maneuver | | | | | | |
| Air Defense Exercise | | | | | | |
| Air Intercept Control | | | | | | |
| Gunnery Exercise, A-A (Medium Caliber) | | | | | | |
| Missile Exercise, A-A | | | | | | |
| Gunnery Exercise, S-A (Large Caliber) | 79 | 1,580 | 33,265 | 1 | 1 | 33,620 |
| Gunnery Exercise, S-A (Medium Caliber) | 79 | 3,792 | 79,837 | 3 | 2 | 80,687 |
| Missile Exercise, S-A | 79 | 0 | 0 | 0 | 0 | 0 |
| **STRIKE WARFARE** | | | | | | |
| Bombing Exercise, A-G | | | | | | |
| Missile Exercise, A-G | | | | | | |
| Gunnery Exercise, A-G | | | | | | |
| **AMPHIBIOUS WARFARE** | | | | | | |
| Fire Support Exercise - Land-Based target | 184 | 14,720 | 309,915 | 10 | 9 | 313,215 |
| Amphibious Rehearsal, No Landing - Marine Air Ground Task Force | 184 | 1,461,888 | 30,778,590 | 998 | 870 | 31,106,382 |
| | 373 | 1,461,888 | 30,778,590 | 998 | 870 | 31,106,382 |
| | 373 | 1,461,888 | 30,778,590 | 998 | 870 | 31,106,382 |
| Amphibious Assault - Marine Air Ground Task Force | 184 | 60,912 | 1,282,441 | 42 | 36 | 1,296,099 |
| | 373 | 60,912 | 1,282,441 | 42 | 36 | 1,296,099 |
| | 373 | 121,824 | 2,564,882 | 83 | 72 | 2,592,198 |
| | 79 | 121,824 | 2,564,882 | 83 | 72 | 2,592,198 |
| Amphibious Raid - Special Purpose Marine Air Ground Task Force | 373 | 45,684 | 961,831 | 31 | 27 | 972,074 |
| | 373 | 38,070 | 801,526 | 26 | 23 | 810,062 |
| Non-Combatant Evacuation Operation | 373 | 149,200 | 3,141,257 | 102 | 89 | 3,174,711 |
| | 373 | 298,400 | 6,282,514 | 204 | 178 | 6,349,422 |
| | 611 | 244,400 | 5,145,598 | 167 | 145 | 5,200,398 |
| Humanitarian Assistance/ Disaster Relief Operations | 373 | 50,760 | 1,068,701 | 35 | 30 | 1,080,083 |
| | 373 | 101,520 | 2,137,402 | 69 | 60 | 2,160,165 |
| | 611 | 50,760 | 1,068,701 | 35 | 30 | 1,080,083 |
| Unmanned Aerial Vehicle - Intelligence, Surveillance, and Reconaissance | | | | | | |

## Table D-5: Vessel Emissions – No Action Alternative (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-SURFACE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-S (Small Caliber) - Ship | 242 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-S (Medium Caliber) - Ship | 295 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise (A-S) - Rocket | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise (A-S) | 20 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Laser Targeting | 600 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bombing Exercise (A-S) | 37 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise (Submarine to Surface) | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise (S-S) | 12 | 24 | FFG | Guided Missile Frigate | 2.00 | 2.0 | 100% | 48.0 | 0.0 | 0.0 | 48.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,581 | 2,264 | 144 | 1,676 | 111 | 100 | 1,581 | 2,264 | 144 | 1,676 | 111 | 100 | 79 | 3,792 | 79,837 | 3 | 2 | 80,687 |
| Gunner Exercise (Surface-to-Surface) Ship - Large-caliber | 140 | 30.8 | CG | Cruiser | 0.22 | 2.5 | 100% | 77.00 | 0.0 | 21.6 | 55.4 | 0 | 0 | 0 | 0 | 0 | 0 | 1,326 | 1,716 | 93 | 1,674 | 60 | 54 | 3,410 | 4,412 | 240 | 4,304 | 155 | 139 | 4,736 | 6,128 | 333 | 5,978 | 215 | 193 | 184 | 14,168 | 298,293 | 10 | 8 | 301,470 |
| | | 63 | DDG | | 0.45 | 2.5 | 100% | 157.5 | 0.0 | 44.1 | 113.4 | 0 | 0 | 0 | 0 | 0 | 0 | 2,653 | 5,050 | 177 | 3,904 | 161 | 144 | 6,822 | 12,987 | 455 | 10,039 | 413 | 371 | 9,475 | 18,037 | 632 | 13,943 | 573 | 516 | 187 | 29,453 | 620,093 | 20 | 18 | 626,697 |
| | | 21 | FFG | Guided Missile Frigate | 0.15 | 2.5 | 100% | 52.5 | 0.0 | 14.7 | 37.8 | 0 | 0 | 0 | 0 | 0 | 0 | 484 | 693 | 44 | 513 | 34 | 31 | 1,245 | 1,783 | 113 | 1,320 | 87 | 79 | 1,729 | 2,476 | 158 | 1,833 | 121 | 109 | 79 | 4,148 | 87,321 | 3 | 2 | 88,251 |
| | | 16.8 | USCG | US Coast Guard | 0.12 | 2.5 | 100% | 42.0 | 0.0 | 11.8 | 30.2 | 0 | 0 | 0 | 0 | 0 | 0 | 68 | 681 | 10 | 136 | 2 | 2 | 174 | 1,751 | 27 | 349 | 6 | 6 | 241 | 2,432 | 37 | 485 | 9 | 8 | 66 | 2,772 | 58,362 | 2 | 2 | 58,983 |
| Gunner Exercise (Surface-to-Surface) Ship - Medium-caliber | 100 | 22 | CG | Cruiser | 0.22 | 2.5 | 100% | 55.00 | 0.0 | 15.4 | 39.6 | 0 | 0 | 0 | 0 | 0 | 0 | 947 | 1,226 | 67 | 1,196 | 43 | 39 | 2,436 | 3,151 | 171 | 3,074 | 110 | 99 | 3,383 | 4,377 | 238 | 4,270 | 153 | 138 | 184 | 10,120 | 213,066 | 7 | 6 | 215,336 |
| | | 45 | DDG | | 0.45 | 2.5 | 100% | 112.5 | 0.0 | 31.5 | 81.0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,895 | 3,607 | 126 | 2,789 | 115 | 103 | 4,873 | 9,276 | 325 | 7,171 | 295 | 265 | 6,768 | 12,884 | 451 | 9,960 | 410 | 369 | 187 | 21,038 | 442,924 | 14 | 13 | 447,641 |
| | | 15 | FFG | Guided Missile Frigate | 0.15 | 2.5 | 100% | 37.5 | 0.0 | 10.5 | 27.0 | 0 | 0 | 0 | 0 | 0 | 0 | 346 | 495 | 32 | 367 | 24 | 22 | 889 | 1,273 | 81 | 943 | 62 | 56 | 1,235 | 1,769 | 113 | 1,310 | 87 | 78 | 79 | 2,963 | 62,372 | 2 | 2 | 63,037 |
| | | 1 | LPD | Amphibious Transport D | 0.01 | 2.5 | 100% | 2.5 | 0.0 | 0.7 | 1.8 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 15 | 2 | 43 | 9 | 8 | 6 | 38 | 5 | 109 | 23 | 21 | 9 | 53 | 6 | 152 | 32 | 29 | 373 | 933 | 19,633 | 1 | 1 | 19,842 |
| | | 12 | USCG | US Coast Guard | 0.12 | 2.5 | 100% | 30.0 | 0.0 | 8.4 | 21.6 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 486 | 7 | 37 | 2 | 2 | 124 | 1,251 | 19 | 249 | 5 | 4 | 172 | 1,737 | 26 | 347 | 6 | 6 | 66 | 1,980 | 41,687 | 1 | 1 | 42,131 |
| Sinking Exercise (SINKEX) | 2 | 10 | FFG | Guided Missile Frigate | 5.00 | 16.0 | 100% | 160.0 | 0.0 | 0.0 | 160.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,270 | 7,546 | 480 | 5,587 | 370 | 333 | 5,270 | 7,546 | 480 | 5,587 | 370 | 333 | 79 | 12,640 | 266,123 | 9 | 8 | 268,957 |
| Gunnery Exercise (S-S) Boat - Medium-caliber | 10 | 50 | FFG | Guided Missile Frigate | 5.00 | 3.0 | 100% | 150.0 | 0.0 | 0.0 | 150.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4,941 | 7,074 | 450 | 5,238 | 347 | 312 | 4,941 | 7,074 | 450 | 5,238 | 347 | 312 | 79 | 11,850 | 249,490 | 8 | 7 | 252,147 |
| Gunnery Exercise (S-S) Small-caliber | 40 | 80 | CRRC | Combat Rubber Raiding | 2 | 3.0 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 3,096 | 0 | 0 | 0 | 0 | 36 | 3,096 | 0 | 0 | 0 | 3 | 720 | 15,159 | 0 | 0 | 15,320 |
| Maritime Security Operations (MSO) | 40 | 40 | FFG | Guided Missile Frigate | 1 | 8.0 | 100% | 320.0 | 0.0 | 0.0 | 320.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10,541 | 15,091 | 960 | 11,174 | 739 | 665 | 10,541 | 15,091 | 960 | 11,174 | 739 | 665 | 79 | 25,280 | 532,245 | 17 | 15 | 537,914 |
| | | 40 | RHIB | Rigid Hulled Inflatable B | 1 | 8.0 | 100% | 320.0 | 0.0 | 0.0 | 320.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 108.8 | 2324.8 | 13.2 | 460.8 | 48.0 | 43 | 109 | 2,325 | 19 | 461 | 48 | 43 | 14 | 4,480 | 94,322 | 3 | 3 | 95,326 |
| | | 40 | CRRC | Combat Rubber Raiding | 1 | 8.0 | 100% | 320.0 | 0.0 | 0.0 | 320.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 4,128 | 0 | 0 | 0 | 0 | 48 | 4,128 | 0 | 0 | 0 | 3 | 960 | 20,212 | 1 | 1 | 20,427 |
| **ANTI-SUBMARINE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise-Helo | 62 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise-Helo | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise-Maritime Patrol Advanced Extended Echo Ranging Sonobuoys | 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise -Maritime Patrol Aircraft | 34 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise-Maritime Patrol Aircraft | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise -Surface | 132 | 30 | FFG | Guided Missile Frigate | 0.23 | 2.0 | 100% | 60.7 | 0.0 | 30.4 | 30.4 | 0 | 0 | 0 | 0 | 0 | 0 | 1,000 | 1,432 | 91 | 1,060 | 70 | 63 | 1,000 | 1,432 | 91 | 1,060 | 70 | 63 | 2,000 | 2,864 | 182 | 2,120 | 140 | 126 | 79 | 4,797 | 100,994 | 3 | 3 | 102,069 |
| | | 92 | DDG | | 0.7 | 2.0 | 100% | 184.8 | 0.0 | 92.4 | 92.4 | 0 | 0 | 0 | 0 | 0 | 0 | 5,559 | 10,582 | 371 | 8,180 | 336 | 303 | 5,559 | 10,582 | 371 | 8,180 | 336 | 0 | 11,118 | 21,163 | 741 | 16,360 | 673 | 303 | 187 | 34,558 | 727,576 | 24 | 21 | 735,324 |
| | | 10 | LCS | | 0.075 | 2.0 | 100% | 19.8 | 0.0 | 9.9 | 9.9 | 0 | 0 | 0 | 0 | 0 | 0 | 7,207 | 1,693 | 28 | 666 | 69 | 62 | 7,207 | 1,693 | 28 | 666 | 69 | 0 | 14,414 | 3,387 | 56 | 1,332 | 137 | 62 | 66 | 1,307 | 27,513 | 1 | 1 | 27,806 |
| Torpedo Exercise-Surface | 3 | 3 | FFG | Guided Missile Frigate | 1 | 2.0 | 100% | 6.0 | 0.0 | 3.0 | 3.0 | 0 | 0 | 0 | 0 | 0 | 0 | 99 | 141 | 9 | 105 | 7 | 6 | 99 | 141 | 9 | 105 | 7 | 6 | 198 | 283 | 18 | 210 | 14 | 12 | 79 | 474 | 9,980 | 0 | 0 | 10,086 |
| Tracking Exercise- Submarine | 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise - Submarine | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

## Table D-5: Vessel Emissions – No Action Alternative (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MAJOR TRAINING EVENTS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Joint Expeditionary Exercise | 1 | 1.0 | CVN | Nuclear Carrier (No emis | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1.0 | CG | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 4,321 | 6,366 | 346 | 6,210 | 223 | 201 | 0 | 0 | 0 | 0 | 0 | 0 | 4,321 | 6,366 | 346 | 6,210 | 223 | 201 | 184 | 14,720 | 309,915 | 10 | 9 | 313,215 |
| | | 2.0 | FFG | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,270 | 7,546 | 480 | 5,587 | 370 | 333 | 0 | 0 | 0 | 0 | 0 | 0 | 5,270 | 7,546 | 480 | 5,587 | 370 | 333 | 79 | 12,640 | 266,123 | 9 | 8 | 268,957 |
| | | 5.0 | DDG | | 5 | 80.0 | 100% | 400.0 | 0.0 | 400.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 24,064 | 45,808 | 1,604 | 35,412 | 1,456 | 1,310 | 0 | 0 | 0 | 0 | 0 | 0 | 24,064 | 45,808 | 1,604 | 35,412 | 1,456 | 1,310 | 187 | 74,800 | 1,574,839 | 51 | 45 | 1,591,611 |
| | | 1.0 | LHD/LHA | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 590 | 3,482 | 442 | 10,478 | 2,103 | 1,893 | 0 | 0 | 0 | 0 | 0 | 0 | 590 | 3,482 | 442 | 10,478 | 2,103 | 1,893 | 373 | 29,840 | 628,251 | 20 | 18 | 634,942 |
| | | 2.0 | LSD | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,400 | 53,522 | 1,734 | 5,606 | 434 | 390 | 0 | 0 | 0 | 0 | 0 | 0 | 3,400 | 53,522 | 1,734 | 5,606 | 434 | 390 | 373 | 59,680 | 1,256,503 | 41 | 36 | 1,269,884 |
| | | 1.0 | LPD | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 278 | 1,680 | 206 | 4,866 | 1,028 | 925 | 0 | 0 | 0 | 0 | 0 | 0 | 278 | 1,680 | 206 | 4,866 | 1,028 | 925 | 373 | 29,840 | 628,251 | 20 | 18 | 634,942 |
| | | 1.0 | TAOE | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 8,781 | 24,305 | 848 | 3,539 | 833 | 750 | 0 | 0 | 0 | 0 | 0 | 0 | 8,781 | 24,305 | 848 | 3,539 | 833 | 750 | 1,865 | 149,200 | 3,141,257 | 102 | 89 | 3,174,711 |
| | | 1.0 | SSN | Nuclear Carrier (No emis | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1.0 | SSGN | Nuclear Carrier (No emis | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 2.0 | T-AGO(LFA) | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,067 | 6,299 | 800 | 19,109 | 3,803 | 3,423 | 0 | 0 | 0 | 0 | 0 | 0 | 1,067 | 6,299 | 800 | 19,109 | 3,803 | 3,423 | 1,865 | 298,400 | 6,282,514 | 204 | 178 | 6,349,422 |
| | | 1.0 | CG-PARTNER | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 8,623 | 3,768 | 792 | 1,680 | 208 | 187 | 0 | 0 | 0 | 0 | 0 | 0 | 8,623 | 3,768 | 792 | 1,680 | 208 | 187 | 184 | 14,720 | 309,915 | 10 | 9 | 313,215 |
| | | 2.0 | DDG-PARTNER | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 16,638 | 7,984 | 1,440 | 2,864 | 400 | 360 | 0 | 0 | 0 | 0 | 0 | 0 | 16,638 | 7,984 | 1,440 | 2,864 | 400 | 360 | 187 | 29,920 | 629,936 | 20 | 18 | 636,644 |
| | | 1.0 | SS-PARTNER | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 235 | 1,386 | 176 | 4,169 | 837 | 753 | 0 | 0 | 0 | 0 | 0 | 0 | 235 | 1,386 | 176 | 4,169 | 837 | 753 | 373 | 29,840 | 628,251 | 20 | 18 | 634,942 |
| | | 5.0 | LCAC | | 5 | 80.0 | 100% | 400.0 | 0.0 | 400.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,328 | 45,812 | 1,396 | 21,844 | 2,056 | 1,850 | 0 | 0 | 0 | 0 | 0 | 0 | 7,328 | 45,812 | 1,396 | 21,844 | 2,056 | 1,850 | 611 | 507,600 | 10,687,010 | 347 | 302 | 10,800,827 |
| | | 2.0 | LCU | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,931 | 18,325 | 558 | 8,738 | 822 | 740 | 0 | 0 | 0 | 0 | 0 | 0 | 2,931 | 18,325 | 558 | 8,738 | 822 | 740 | 611 | 97,760 | 2,058,239 | 67 | 58 | 2,080,159 |
| | | 19.0 | CRRC | | 19 | 80.0 | 100% | 1520.0 | 0.0 | 1520.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 226 | 19,610 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 226 | 19,610 | 0 | 0 | 0 | 3 | 4,560 | 96,006 | 3 | 3 | 97,029 |
| | | 2.0 | RHIB | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 1,462 | 10 | 230 | 24 | 22 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 1,462 | 10 | 230 | 24 | 22 | 373 | 59,680 | 1,256,503 | 41 | 36 | 1,269,884 |
| | | 14.0 | AAV | | 14 | 80.0 | 100% | 1120.0 | 0.0 | 1120.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 851 | 6,366 | 318 | 1,400 | 291 | 262 | 0 | 0 | 0 | 0 | 0 | 0 | 851 | 6,366 | 318 | 1,400 | 291 | 262 | 3 | 3,360 | 70,741 | 2 | 2 | 71,495 |
| Joint Multi-Strike Group Exercise | 1 | 3.0 | CVN | | 3 | 80.0 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 3.0 | CG | | 3 | 80.0 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14,762 | 19,099 | 1,037 | 18,631 | 670 | 603 | 14,762 | 19,099 | 1,037 | 18,631 | 670 | 603 | 184 | 44,160 | 929,745 | 30 | 26 | 939,646 |
| | | 3.0 | FFG | | 3 | 80.0 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,906 | 11,318 | 720 | 8,381 | 554 | 499 | 7,906 | 11,318 | 720 | 8,381 | 554 | 499 | 79 | 18,960 | 399,184 | 13 | 11 | 403,435 |
| | | 12.0 | DDG | | 12 | 80.0 | 100% | 960.0 | 0.0 | 0.0 | 960.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 57,754 | 109,939 | 3,850 | 84,989 | 3,494 | 3,145 | 57,754 | 109,939 | 3,850 | 84,989 | 3,494 | 3,145 | 187 | 179,520 | 3,779,614 | 123 | 107 | 3,819,867 |
| | | 3.0 | TAOE | | 3 | 80.0 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26,342 | 74,714 | 2,544 | 28,798 | 2,498 | 2,249 | 26,342 | 74,714 | 2,544 | 28,798 | 2,498 | 2,249 | 1,865 | 447,600 | 9,423,770 | 306 | 266 | 9,524,134 |
| | | 5.0 | SSN | | 5 | 80.0 | 100% | 400.0 | 0.0 | 0.0 | 400.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 2.0 | T-AGO(LFA) | | 2 | 80.0 | 100% | 160.0 | 0.0 | 0.0 | 160.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,067 | 6,299 | 800 | 19,109 | 3,803 | 3,423 | 1,067 | 6,299 | 800 | 19,109 | 3,803 | 3,423 | 1,865 | 298,400 | 6,282,514 | 204 | 178 | 6,349,422 |
| | | 1.0 | SS-PARTNER | | 1 | 80.0 | 100% | 80.0 | 0.0 | 0.0 | 80.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 235 | 1,386 | 176 | 4,169 | 837 | 753 | 235 | 1,386 | 176 | 4,169 | 837 | 753 | 373 | 29,840 | 628,251 | 20 | 18 | 634,942 |
| Marine Air Ground Task Force Exercise (Amphibious) | 4 | 4.0 | LHD/LHA | | 1 | 80.0 | 100% | 320.0 | 320.0 | 0.0 | 0.0 | 2,362 | 13,930 | 1,770 | 41,910 | 8,413 | 7,572 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,362 | 13,930 | 1,770 | 41,910 | 8,413 | 7,572 | 373 | 119,360 | 2,513,005 | 82 | 71 | 2,539,769 |
| | | 4.0 | LSD | | 1 | 80.0 | 100% | 320.0 | 320.0 | 0.0 | 0.0 | 2,586 | 15,306 | 1,846 | 43,360 | 9,146 | 8,231 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,586 | 15,306 | 1,846 | 43,360 | 9,146 | 8,231 | 373 | 119,360 | 2,513,005 | 82 | 71 | 2,539,769 |
| | | 4.0 | LPD | | 1 | 80.0 | 100% | 320.0 | 320.0 | 0.0 | 0.0 | 1,114 | 6,720 | 826 | 19,462 | 4,112 | 3,701 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,114 | 6,720 | 826 | 19,462 | 4,112 | 3,701 | 373 | 119,360 | 2,513,005 | 82 | 71 | 2,539,769 |
| Special Purpose Marine Air Ground Task Force Exercise | 2 | 2.0 | LHA | Amphib. Assault Ship - T | 1 | 80.0 | 100% | 160.0 | 52.8 | 52.8 | 54.4 | 390 | 2,298 | 292 | 6,915 | 1,388 | 1,249 | 390 | 2,298 | 292 | 6,915 | 1,388 | 1,249 | 401 | 2,368 | 301 | 7,125 | 1,430 | 1,287 | 1,181 | 6,965 | 885 | 20,955 | 4,206 | 3,786 | 373 | 59,680 | 1,256,503 | 41 | 36 | 1,269,884 |
| | | 4.0 | LPD | Amphibious Transport D | 2 | 80.0 | 100% | 320.0 | 105.6 | 105.6 | 108.8 | 367 | 2,218 | 272 | 6,423 | 1,357 | 1,221 | 367 | 2,218 | 272 | 6,423 | 1,357 | 1,221 | 379 | 2,285 | 281 | 6,617 | 1,398 | 1,258 | 1,114 | 6,720 | 826 | 19,462 | 4,112 | 3,701 | 373 | 119,360 | 2,513,005 | 82 | 71 | 2,539,769 |
| **ELECTRONIC WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Electronic Warfare Operations | 480 | 480 | FFG | Guided Missile Frigate | 1 | 4 | 100% | 1920.0 | 0.0 | 0.0 | 1920.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 63,245 | 90,547 | 5,760 | 67,046 | 4,435 | 3,992 | 63,245 | 90,547 | 5,760 | 67,046 | 4,435 | 3,992 | 79 | 151,680 | 3,193,471 | 104 | 90 | 3,227,481 |
| Flare Exercise | 3200 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chaff Exercise - Ship | 40 | 40 | FFG | Guided Missile Frigate | 1 | 4 | 100% | 160.0 | 0.0 | 0.0 | 160.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,270 | 7,546 | 480 | 5,587 | 370 | 333 | 5,270 | 7,546 | 480 | 5,587 | 370 | 333 | 79 | 12,640 | 266,123 | 9 | 8 | 268,957 |
| Chaff Exercise - Aircraft | 3200 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# Table D-5: Vessel Emissions – No Action Alternative (continued)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **MINE WARFARE** | | | | | | | | | | |
| Civilian Port Defense | 1 | 1 | RHIB | 1 | 24.0 | 100% | 24.0 | 24.0 | 0.0 | 0.0 |
| Mine Laying - Aircraft | 4 | | | | | | | | | |
| Mine Neutralization - Explosive Ordnance Disposal | 20 | 60 | RHIB | 3 | 12.0 | 100% | 720.0 | 720.0 | 0.0 | 0.0 |
| Limpet Mine Neutralization System/Shock Wave Generator | 40 | 40 | RHIB | 1 | 4.0 | 100% | 160.0 | 160.0 | 0.0 | 0.0 |
| Airborne Mine Countermeasure - Mine Detection | 4 | | | | | | | | | |
| Mine Countermeasure Exercise - Towed Sonar (AQS-20,LCS) | 4 | | | | | | | | | |
| Mine Countermeasure Exercise - Surface (SMCMEX) Sonar (SQQ-32, MCM) | 4 | | | | | | | | | |
| Mine Neutralization - Remotely Operated Vehicle Soanr (ASQ-235 [AQS-20], SLQ-48) | 4 | | | | | | | | | |
| Mine Countermeasure - Towed Mine Detection | 4 | | | | | | | | | |
| Underwater Demolition Qualification/Certification | 30 | 30 | CRRC | 1 | 8.0 | 100% | 240.0 | 0.0 | 240.0 | 0.0 |
| Submarine Mine Exercise | 16 | | | | | | | | | |
| **NAVAL SPECIAL WARFARE** | | | | | | | | | | |
| Personnel I&E | 240 | 1200 | RHIB | 5 | 8.0 | 100% | ##### | 3600.0 | 0.0 | 0.0 |
| | | 1440 | CRRC | 6 | 8.0 | 100% | ##### | 11520.0 | 0.0 | 0.0 |
| Parachute Insertion | 20 | | | | | | | | | |
| **OTHER** | | | | | | | | | | |
| Direct Action (Tactical Air Control Party) | 18 | | | | | | | | | |
| Intelligence, Surveillance, Reconnaissance | 16 | | | | | | | | | |
| Search and Rescue At Sea | 0 | | | | | | | | | |
| Surface Ship Sonar Maintenance | 42 | 42 | FFG | 1 | 4.0 | 100% | 168.0 | 168.0 | 0.0 | 0.0 |
| Submarine Sonar Maintenance | 48 | | | | | | | | | |
| Small Boat Attack | 18 | 18 | CRRC | 1 | 4.0 | 100% | 72.0 | 0.0 | 72.0 | 0.0 |
| Sub Navigation / Sub Nav Under Ice | 8 | | | | | | | | | |
| Precision Anchoring | 18 | 18 | FFG | 1 | 4.0 | 100% | 72.0 | 72.0 | 0.0 | 0.0 |
| Underwater Survey | 32 | 96 | RHIB | 3 | 8.0 | 100% | 768.0 | 768.0 | 0.0 | 0.0 |
| | | 96 | CRRC | 3 | 8.0 | 100% | 768.0 | 768.0 | 0.0 | 0.0 |
| Unmanned Aerial Vehicle Operation | 1000 | | | | | | | | | |
| Training | 0 | | | | | | | | | |
| **TOTAL TRAINING (lbs per year)** | | | | | | | | 30,568 | 5,885 | 6,973 |
| **TOTAL TRAINING (tons per year)** | | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MINE WARFARE** | | | | | | | | | | | | |
| Civilian Port Defense | 8.2 | 219.4 | 1.4 | 34.6 | 3.6 | 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 |
| Mine Laying - Aircraft | | | | | | | | | | | | |
| Mine Neutralization - Explosive Ordnance Disposal | 244.8 | 6580.8 | 43.2 | 1036.8 | 108.0 | 37 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 |
| Limpet Mine Neutralization System/Shock Wave Generator | 54.4 | 1462.4 | 9.6 | 230.4 | 24.0 | 22 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 |
| Airborne Mine Countermeasure - Mine Detection | | | | | | | | | | | | |
| Mine Countermeasure Exercise - Towed Sonar (AQS-20,LCS) | | | | | | | | | | | | |
| Mine Countermeasure Exercise - Surface (SMCMEX) Sonar (SQQ-32, MCM) | | | | | | | | | | | | |
| Mine Neutralization - Remotely Operated Vehicle Soanr (ASQ-235 [AQS-20], SLQ-48) | | | | | | | | | | | | |
| Mine Countermeasure - Towed Mine Detection | | | | | | | | | | | | |
| Underwater Demolition Qualification/Certification | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 3,096 | 0 | 0 | 0 |
| Submarine Mine Exercise | | | | | | | | | | | | |
| **NAVAL SPECIAL WARFARE** | | | | | | | | | | | | |
| Personnel I&E | 3264.0 | 87744.0 | 576.0 | 13824.0 | 1440.0 | 1,296 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 |
| | 0 | 1,711 | 148,625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parachute Insertion | | | | | | | | | | | | |
| **OTHER** | | | | | | | | | | | | |
| Direct Action (Tactical Air Control Party) | | | | | | | | | | | | |
| Intelligence, Surveillance, Reconnaissance | | | | | | | | | | | | |
| Search and Rescue At Sea | | | | | | | | | | | | |
| Surface Ship Sonar Maintenance | 5,534 | 7,923 | 504 | 5,867 | 388 | 349 | 0 | 0 | 0 | 0 | 0 | 0 |
| Submarine Sonar Maintenance | | | | | | | | | | | | |
| Small Boat Attack | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 329 | 0 | 0 | 0 |
| Sub Navigation / Sub Nav Under Ice | | | | | | | | | | | | |
| Precision Anchoring | 2,372 | 3,396 | 216 | 2,514 | 166 | 150 | 0 | 0 | 0 | 0 | 0 | 0 |
| Underwater Survey | 261.1 | 7019.5 | 46.1 | 1105.9 | 115.2 | 104 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 |
| | 0 | 114 | 9,908 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unmanned Aerial Vehicle Operation | | | | | | | | | | | | |
| Training | | | | | | | | | | | | |
| **TOTAL TRAINING (lbs per year)** | 82,817 | 730,331 | 194,912 | 576,340 | 107,053 | 96,348 | 107,425 | 267,917 | 37,008 | 171,858 | 18,565 | 16,708 |
| **TOTAL TRAINING (tons per year)** | 41 | 365 | 97 | 288 | 54 | 48 | 54 | 134 | 19 | 86 | 9 | 8 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MINE WARFARE** | | | | | | | | | | | | |
| Civilian Port Defense | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 8 | 219 | 1 | 35 | 4 | 3 |
| Mine Laying - Aircraft | | | | | | | | | | | | |
| Mine Neutralization - Explosive Ordnance Disposal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 245 | 6,581 | 43 | 1,037 | 108 | 37 |
| Limpet Mine Neutralization System/Shock Wave Generator | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 54 | 1,462 | 10 | 230 | 24 | 22 |
| Airborne Mine Countermeasure - Mine Detection | | | | | | | | | | | | |
| Mine Countermeasure Exercise - Towed Sonar (AQS-20,LCS) | | | | | | | | | | | | |
| Mine Countermeasure Exercise - Surface (SMCMEX) Sonar (SQQ-32, MCM) | | | | | | | | | | | | |
| Mine Neutralization - Remotely Operated Vehicle Soanr (ASQ-235 [AQS-20], SLQ-48) | | | | | | | | | | | | |
| Mine Countermeasure - Towed Mine Detection | | | | | | | | | | | | |
| Underwater Demolition Qualification/Certification | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 3,096 | 0 | 0 | 0 |
| Submarine Mine Exercise | | | | | | | | | | | | |
| **NAVAL SPECIAL WARFARE** | | | | | | | | | | | | |
| Personnel I&E | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 3,264 | 87,744 | 576 | 13,824 | 1,440 | 1,296 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,711 | 148,625 | 0 | 0 | 0 |
| Parachute Insertion | | | | | | | | | | | | |
| **OTHER** | | | | | | | | | | | | |
| Direct Action (Tactical Air Control Party) | | | | | | | | | | | | |
| Intelligence, Surveillance, Reconnaissance | | | | | | | | | | | | |
| Search and Rescue At Sea | | | | | | | | | | | | |
| Surface Ship Sonar Maintenance | 0 | 0 | 0 | 0 | 0 | 0 | 5,534 | 7,923 | 504 | 5,867 | 388 | 349 |
| Submarine Sonar Maintenance | | | | | | | | | | | | |
| Small Boat Attack | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 329 | 0 | 0 | 0 |
| Sub Navigation / Sub Nav Under Ice | | | | | | | | | | | | |
| Precision Anchoring | 0 | 0 | 0 | 0 | 0 | 0 | 2,372 | 3,396 | 216 | 2,514 | 166 | 150 |
| Underwater Survey | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 261 | 7,020 | 46 | 1,106 | 115 | 104 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 114 | 9,908 | 0 | 0 | 0 |
| Unmanned Aerial Vehicle Operation | | | | | | | | | | | | |
| Training | | | | | | | | | | | | |
| **TOTAL TRAINING (lbs per year)** | 235,888 | 413,461 | 27,363 | 314,533 | 22,900 | 20,245 | 426,130 | 1,411,709 | 259,283 | 1,062,732 | 148,518 | 133,302 |
| **TOTAL TRAINING (tons per year)** | 118 | 207 | 14 | 157 | 11 | 10 | 213 | 706 | 130 | 531 | 74 | 67 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **MINE WARFARE** | | | | | | |
| Civilian Port Defense | 14 | 336 | 7,074 | 0 | 0 | 7,143 |
| Mine Laying - Aircraft | | | | | | |
| Mine Neutralization - Explosive Ordnance Disposal | 14 | 10,080 | 212,224 | 7 | 6 | 214,485 |
| Limpet Mine Neutralization System/Shock Wave Generator | 14 | 2,240 | 47,161 | 2 | 1 | 47,663 |
| Airborne Mine Countermeasure - Mine Detection | | | | | | |
| Mine Countermeasure Exercise - Towed Sonar (AQS-20,LCS) | | | | | | |
| Mine Countermeasure Exercise - Surface (SMCMEX) Sonar (SQQ-32, MCM) | | | | | | |
| Mine Neutralization - Remotely Operated Vehicle Soanr (ASQ-235 [AQS-20], SLQ-48) | | | | | | |
| Mine Countermeasure - Towed Mine Detection | | | | | | |
| Underwater Demolition Qualification/Certification | 3 | 720 | 15,159 | 0 | 0 | 15,320 |
| Submarine Mine Exercise | | | | | | |
| **NAVAL SPECIAL WARFARE** | | | | | | |
| Personnel I&E | 48 | 460,800 | 9,701,683 | 315 | 274 | 9,805,006 |
| | 3 | 34,560 | 727,626 | 24 | 21 | 735,375 |
| Parachute Insertion | | | | | | |
| **OTHER** | | | | | | |
| Direct Action (Tactical Air Control Party) | | | | | | |
| Intelligence, Surveillance, Reconnaissance | | | | | | |
| Search and Rescue At Sea | | | | | | |
| Surface Ship Sonar Maintenance | 79 | 13,272 | 279,429 | 9 | 8 | 282,405 |
| Submarine Sonar Maintenance | | | | | | |
| Small Boat Attack | 3 | 216 | 4,548 | 0 | 0 | 4,596 |
| Sub Navigation / Sub Nav Under Ice | | | | | | |
| Precision Anchoring | 79 | 5,688 | 119,755 | 4 | 3 | 121,031 |
| Underwater Survey | 48 | 36,864 | 776,135 | 25 | 22 | 784,400 |
| | 3 | 2,304 | 48,508 | 2 | 1 | 49,025 |
| Unmanned Aerial Vehicle Operation | | | | | | |
| Training | | | | | | |
| **TOTAL TRAINING (lbs per year)** | | 9,642,012 | 203,002,916 | 6,585 | 5,737 | 205,164,896 |
| **TOTAL TRAINING (tons per year)** | | | 101,501 | 3 | 3 | 102,582 |

## Table D-6: Aircraft Emissions – No Action Alternative

**OPERATIONAL INFORMATION - AIRCRAFT**

| Type Training | Training Ops (#) | Aircraft: Distribution | Aircraft: A/C Sorties (#) | Aircraft: Type | Time: Ave Time on Range (hr) | Time: Total Time on Range (hr) | Altitude: Time < 3,000 ft (%) | Altitude: Time < 3,000 ft (hr) | Distribution (%): 0-3 nm from shore | Distribution (%): 3-12 nm from Shore | Distribution (%): > 12 nm from Shore | Distribution (hr): Total Time 0-3 nm from shore | Distribution (hr): Total Time 3-12 nm from shore | Distribution (hr): Total Time > 12 nm from shore |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-AIR WARFARE** | | | | | | | | | | | | | | |
| Air Combat Maneuv | 4800 | 1 | 4800 | FA-18E/F | 1.0 | 4800.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| | | 1 | 4800 | AV-8B | 1.0 | 4800.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| Air Defense Exercis | 100 | 2 | 200 | FA-18E/F | 1.0 | 200.0 | 50% | 100.0 | 0% | 0% | 100% | 0.00 | 0.00 | 100.00 |
| Air Intercept Contr | 4800 | 2 | 9600 | FA-18E/F | 1.0 | 9600.0 | 50% | 4800.0 | 0% | 0% | 100% | 0.00 | 0.00 | 4800.00 |
| Gunnery Exercise, A-A(Medium | 36 | 1 | 36 | AV-8B | 1.0 | 36.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| | | 1 | 36 | FA-18E/F | 1.0 | 36.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| Missile Exercise, A- | 18 | 1 | 18 | AV-8B | 1.0 | 18.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| | | 1 | 18 | FA-18E/F | 1.0 | 18.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| Gunnery Exercise, S-A(Large Caliber) | 5 | | | | | | | | | | | | | |
| Gunnery Exercise, S-A(Medium | 12 | | | | | | | | | | | | | |
| Missile Exercise, S-A | 15 | | | | | | | | | | | | | |
| **STRIKE WARFARE** | | | | | | | | | | | | | | |
| Bombing Exercise, A-G | 2300 | 1 | 2300 | FA-18E/F | 1.0 | 2300.0 | 10% | 230.0 | 0% | 0% | 100% | 0.00 | 0.00 | 230.00 |
| Missile Exercise, A-G | 85 | 0.5 | 43 | FA-18E/F | 2.0 | 85.0 | 10% | 8.5 | 0% | 0% | 100% | 0.00 | 0.00 | 8.50 |
| | | 0.5 | 43 | SH-60B | 2.0 | 85.0 | 100% | 85.0 | 0% | 0% | 100% | 0.00 | 0.00 | 85.00 |
| Gunnery Exercise, A-G | 96 | 0.5 | 48 | FA-18E/F | 2.0 | 96.0 | 10% | 9.6 | 0% | 0% | 100% | 0.00 | 0.00 | 9.60 |
| | | 0.5 | 48 | SH-60B | 2.0 | 96.0 | 100% | 96.0 | 0% | 0% | 100% | 0.00 | 0.00 | 96.00 |

**EMISSIONS/YEAR (lb) BY JURISDICTION**

| Type Training | Type | State (0-3 nm offshore) CO | $NO_x$ | HC | $SO_x$ | PM | $PM_{2.5}$ | Waters of U S (3-12 nm) CO | $NO_x$ | HC | $SO_x$ | PM | $PM_{2.5}$ | Int Waters (> 12 nm) CO | $NO_x$ | HC | $SO_x$ | PM | $PM_{2.5}$ | Total Emissions CO | $NO_x$ | HC | $SO_x$ | PM | $PM_{2.5}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-AIR WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Air Combat Maneuv | FA-18E/F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | AV-8B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Air Defense Exercis | FA-18E/F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 744 | 15249 | 124 | 414 | 6782 | 6104 | 744 | 15249 | 124 | 414 | 6782 | 6104 |
| Air Intercept Contr | FA-18E/F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 35728 | 731930 | 5955 | 19849 | 325523 | 292971 | 35728 | 731930 | 5955 | 19849 | 325523 | 292971 |
| Gunnery Exercise, A-A(Medium | AV-8B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | FA-18E/F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Missile Exercise, A- | AV-8B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | FA-18E/F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gunnery Exercise, S-A(Large Caliber) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, S-A(Medium | | | | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise, S-A | | | | | | | | | | | | | | | | | | | | | | | | | |
| **STRIKE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bombing Exercise, A-G | FA-18E/F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1712 | 35072 | 285 | 951 | 15598 | 14038 | 1712 | 35072 | 285 | 951 | 15598 | 14038 |
| Missile Exercise, A-G | FA-18E/F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 63 | 1296 | 11 | 35 | 576 | 519 | 63 | 1296 | 11 | 35 | 576 | 519 |
| | SH-60B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 638 | 653 | 56 | 41 | 428 | 386 | 638 | 653 | 56 | 41 | 428 | 386 |
| Gunnery Exercise, A-G | FA-18E/F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 71 | 1464 | 12 | 40 | 651 | 586 | 71 | 1464 | 12 | 40 | 651 | 586 |
| | SH-60B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 720 | 737 | 63 | 46 | 484 | 435 | 720 | 737 | 63 | 46 | 484 | 435 |

**Training Platform Information / Annual Fuel Use (total) / GHG Emissions (lb)**

| Type Training | Type | Engine Model | Engines (#) | Fuel Flow (lb/hr) | Pounds | Gallons | $CO_2$ | $N_2O$ | $CH_4$ | $CO_{2-e}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-AIR WARFARE** | | | | | | | | | | |
| Air Combat Maneuv | FA-18E/F | F414-GE | 2 | 10,338 | 49622400 | 7297412 | 153639707 | 4984 | 4342 | 155,275,969 |
| | AV-8B | F402-RR | 1 | 6,000 | 28800000 | 4235294 | 89169882 | 2893 | 2520 | 90,119,541 |
| Air Defense Exercis | FA-18E/F | F414-GE | 2 | 10,338 | 2067600 | 304059 | 6401654 | 208 | 181 | 6,469,832 |
| Air Intercept Contr | FA-18E/F | F414-GE | 2 | 10,338 | 99244800 | 14594824 | 307279415 | 9968 | 8684 | 310,551,939 |
| Gunnery Exercise, A-A(Medium | AV-8B | F402-RR | 1 | 6,000 | 216000 | 31765 | 668774 | 22 | 19 | 675,897 |
| | FA-18E/F | F414-GE | 2 | 10,338 | 372168 | 54731 | 1152298 | 37 | 33 | 1,164,570 |
| Missile Exercise, A- | AV-8B | F402-RR | 1 | 6,000 | 108000 | 15882 | 334387 | 11 | 9 | 337,948 |
| | FA-18E/F | F414-GE | 2 | 10,338 | 186084 | 27365 | 576149 | 19 | 16 | 582,285 |
| Gunnery Exercise, S-A(Large Caliber) | | | | | | | | | | |
| Gunnery Exercise, S-A(Medium | | | | | | | | | | |
| Missile Exercise, S-A | | | | | | | | | | |
| **STRIKE WARFARE** | | | | | | | | | | |
| Bombing Exercise, A-G | FA-18E/F | F414-GE | 2 | 10,338 | 23777400 | 3496676 | 73619026 | 2388 | 2081 | 74,403,069 |
| Missile Exercise, A-G | FA-18E/F | F414-GE | 2 | 10,338 | 878730 | 129225 | 2720703 | 88 | 77 | 2,749,679 |
| | SH-60B | T700-GE | 2 | 1200 | 102000 | 15000 | 315810 | 10 | 9 | 319,173 |
| Gunnery Exercise, A-G | FA-18E/F | F414-GE | 2 | 10,338 | 992448 | 145948 | 3072794 | 100 | 87 | 3,105,519 |
| | SH-60B | T700-GE | 2 | 1200 | 115200 | 16941 | 356680 | 12 | 10 | 360,478 |

## Table D-6: Aircraft Emissions – No Action Alternative (continued)

| AMPHIBIOUS WARFARE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fire Support Exercise - Land-Based target | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Amphibious Rehearsal, No Landing - Marine Air Ground Task Force | 12 | 4 | 48.0 | CH-53 | 18.0 | 864.0 | 100% | 864.0 | 100% | 0% | 0% | 864.00 | 0.00 | 0.00 | 8215 | 31164 | 579 | 1543 | 8524 | 7671 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8215 | 31164 | 579 | 1543 | 8524 | 7671 | T64-GE- | 3 | 4,464 | 3856896 | 567191 | 11941631 | 387 | 337 | 12,068,809 |
| | | 10 | 120.0 | MV-22 | 18.0 | 2160.0 | 100% | 2160.0 | 100% | 0% | 0% | 2160.00 | 0.00 | 0.00 | 47755 | 9532 | 8298 | 968 | 4306 | 3876 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 47755 | 9532 | 8298 | 968 | 4306 | 3876 | | 2 | 2240 | 4838400 | 711529 | 14980540 | 486 | 423 | 15,140,083 |
| | | 2 | 24.0 | UH-1 | 18.0 | 432.0 | 100% | 432.0 | 100% | 0% | 0% | 432.00 | 0.00 | 0.00 | 779 | 1101 | 40 | 93 | 980 | 882 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 779 | 1101 | 40 | 93 | 980 | 882 | T400-CP | 2 | 540 | 233280 | 34306 | 722276 | 23 | 20 | 729,968 |
| | | 4 | 48.0 | AH-1 | 18.0 | 864.0 | 100% | 864.0 | 100% | 0% | 0% | 864.00 | 0.00 | 0.00 | 7865 | 3817 | 400 | 281 | 2947 | 2652 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7865 | 3817 | 400 | 281 | 2947 | 2652 | T700-GE | 2 | 812 | 701568 | 103172 | 2172178 | 70 | 61 | 2,195,312 |
| | | 4 | 48.0 | AV-8 | 18.0 | 864.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RR | 1 | 6,000 | 5184000 | 762353 | 16050579 | 521 | 454 | 16,221,517 |
| Amphibious Assault - Marine Air Ground Task F | 6 | 4 | 24.0 | CH-53 | 18.0 | 432.0 | 100% | 432.0 | 100% | 0% | 0% | 432.00 | 0.00 | 0.00 | 4108 | 15582 | 289 | 771 | 4262 | 3836 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4108 | 15582 | 289 | 771 | 4262 | 3836 | T64-GE- | 3 | 4,464 | 1928448 | 283595 | 5970815 | 194 | 169 | 6,034,404 |
| | | 10 | 60.0 | MV-22 | 18.0 | 1080.0 | 100% | 1080.0 | 100% | 0% | 0% | 1080.00 | 0.00 | 0.00 | 23878 | 4766 | 4149 | 484 | 2153 | 1938 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 23878 | 4766 | 4149 | 484 | 2153 | 1938 | | 2 | 2240 | 2419200 | 355765 | 7490270 | 243 | 212 | 7,570,041 |
| | | 2 | 12.0 | UH-1 | 18.0 | 216.0 | 100% | 216.0 | 100% | 0% | 0% | 216.00 | 0.00 | 0.00 | 390 | 551 | 20 | 47 | 490 | 441 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 390 | 551 | 20 | 47 | 490 | 441 | T400-CP | 2 | 540 | 116640 | 17153 | 361138 | 12 | 10 | 364,984 |
| | | 4 | 24.0 | AH-1 | 18.0 | 432.0 | 100% | 432.0 | 100% | 0% | 0% | 432.00 | 0.00 | 0.00 | 3932 | 1908 | 200 | 140 | 1473 | 1326 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3932 | 1908 | 200 | 140 | 1473 | 1326 | T700-GE | 2 | 812 | 350784 | 51586 | 1086089 | 35 | 31 | 1,097,656 |
| | | 4 | 24.0 | AV-8 | 18.0 | 432.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RR | 1 | 6,000 | 2592000 | 381176 | 8025289 | 260 | 227 | 8,110,759 |
| Amphibious Raid - Special Purpose Marine Air Ground Task Force | 6 | 4 | 24.0 | H-53 | 12.0 | 288.0 | 100% | 288.0 | 100% | 0% | 0% | 288.00 | 0.00 | 0.00 | 2738 | 10388 | 193 | 514 | 2841 | 2557 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2738 | 10388 | 193 | 514 | 2841 | 2557 | T64-GE- | 3 | 4,464 | 1285632 | 189064 | 3980544 | 129 | 112 | 4,022,936 |
| | | 10 | 60.0 | MV-22 | 12.0 | 720.0 | 100% | 720.0 | 100% | 0% | 0% | 720.00 | 0.00 | 0.00 | 15918 | 3177 | 2766 | 323 | 1435 | 1292 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15918 | 3177 | 2766 | 323 | 1435 | 1292 | | 2 | 2240 | 1612800 | 237176 | 4993513 | 162 | 141 | 5,046,694 |
| | | 2 | 12.0 | UH-1 | 12.0 | 144.0 | 100% | 144.0 | 100% | 0% | 0% | 144.00 | 0.00 | 0.00 | 260 | 367 | 13 | 31 | 327 | 294 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 260 | 367 | 13 | 31 | 327 | 294 | T400-CP | 2 | 540 | 77760 | 11435 | 240759 | 8 | 7 | 243,323 |
| | | 4 | 24.0 | AH-1 | 12.0 | 288.0 | 100% | 288.0 | 100% | 0% | 0% | 288.00 | 0.00 | 0.00 | 2622 | 1272 | 133 | 94 | 982 | 884 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2622 | 1272 | 133 | 94 | 982 | 884 | T700-GE | 2 | 812 | 233856 | 34391 | 724059 | 23 | 20 | 731,771 |
| | | 4 | 24.0 | AV-8 | 12.0 | 288.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RR | 1 | 6,000 | 1728000 | 254118 | 5350193 | 174 | 151 | 5,407,172 |
| Non-Combatant Evacuation Operation | 5 | 10 | 50 | MV-22 | 20.0 | 1000.0 | 100% | 1000.0 | 100% | 0% | 0% | 1000.00 | 0.00 | 0.00 | 22109 | 4413 | 3842 | 448 | 1994 | 1794 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22109 | 4413 | 3842 | 448 | 1994 | 1794 | | 2 | 2240 | 2240000 | 329412 | 6935435 | 225 | 196 | 7,009,298 |
| | | 4 | 20 | H-53 | 20.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 3803 | 14428 | 268 | 714 | 3946 | 3552 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3803 | 14428 | 268 | 714 | 3946 | 3552 | T64-GE- | 3 | 4,464 | 1785600 | 262588 | 5528533 | 179 | 156 | 5,587,412 |
| | | 2 | 10 | UH-1 | 20.0 | 200.0 | 100% | 200.0 | 100% | 0% | 0% | 200.00 | 0.00 | 0.00 | 361 | 510 | 18 | 43 | 454 | 408 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 361 | 510 | 18 | 43 | 454 | 408 | T400-CP | 2 | 540 | 108000 | 15882 | 334387 | 11 | 9 | 337,948 |
| | | 4 | 20 | AH-1 | 20.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 3641 | 1767 | 185 | 130 | 1364 | 1228 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3641 | 1767 | 185 | 130 | 1364 | 1228 | T700-GE | 2 | 812 | 324800 | 47765 | 1005638 | 33 | 28 | 1,016,348 |
| | | 4 | 20 | AV-8 | 20.0 | 400.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RR | 1 | 6,000 | 2400000 | 352941 | 7430824 | 241 | 210 | 7,509,962 |
| Humanitarian Assistance/ Disaster Relief Operations | 5 | 10 | 50 | MV-22 | 20.0 | 1000.0 | 100% | 1000.0 | 100% | 0% | 0% | 1000.00 | 0.00 | 0.00 | 22109 | 4413 | 3842 | 448 | 1994 | 1794 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22109 | 4413 | 3842 | 448 | 1994 | 1794 | | 2 | 2240 | 2240000 | 329412 | 6935435 | 225 | 196 | 7,009,298 |
| | | 4 | 20 | H-53 | 20.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 3803 | 14428 | 268 | 714 | 3946 | 3552 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3803 | 14428 | 268 | 714 | 3946 | 3552 | T64-GE- | 3 | 4,464 | 1785600 | 262588 | 5528533 | 179 | 156 | 5,587,412 |
| | | 2 | 10 | UH-1 | 20.0 | 200.0 | 100% | 200.0 | 100% | 0% | 0% | 200.00 | 0.00 | 0.00 | 361 | 510 | 18 | 43 | 454 | 408 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 361 | 510 | 18 | 43 | 454 | 408 | T400-CP | 2 | 540 | 108000 | 15882 | 334387 | 11 | 9 | 337,948 |
| | | 4 | 20 | AH-1 | 20.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 3641 | 1767 | 185 | 130 | 1364 | 1228 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3641 | 1767 | 185 | 130 | 1364 | 1228 | T700-GE | 2 | 812 | 324800 | 47765 | 1005638 | 33 | 28 | 1,016,348 |
| | | 4 | 20 | AV-8 | 20.0 | 400.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RR | 1 | 6,000 | 2400000 | 352941 | 7430824 | 241 | 210 | 7,509,962 |
| Unmanned Aerial Vehicle - Intelligence, Surveillance, and Reconaissance | 100 | 1 | 100.0 | MQ-4C | 4.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 840 | 15536 | 264 | 1416 | 244 | 220 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 840 | 15536 | 264 | 1416 | 244 | 220 | AE3007I | 1 | 2,532 | 1012800 | 148941 | 3135808 | 102 | 89 | 3,169,204 |

## Table D-6: Aircraft Emissions – No Action Alternative (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-SURFACE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-S (Small Caliber) - Ship | 242 | 0.25 | 60.5 | FA-18E/F | 2.0 | 121.0 | 10% | 12.1 | 0% | 0% | 100% | 0.00 | 0.00 | 12.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 1845 | 15 | 50 | 821 | 739 | 30 | 1845 | 15 | 50 | 821 | 739 | F414-GE | 2 | 10,338 | 1250838 | 183956 | 3873001 | 126 | 109 | 3,314,248 |
| | | 0.75 | 181.5 | SH-60B | 2.0 | 363.0 | 100% | 363.0 | 0% | 0% | 100% | 0.00 | 0.00 | 363.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2723 | 2788 | 240 | 174 | 1830 | 1647 | 2723 | 2788 | 240 | 174 | 1830 | 1647 | T700-GE | 2 | 1200 | 435600 | 64059 | 1348634 | 44 | 38 | 1,363,058 |
| Gunnery Exercise, A-S (Medium Caliber) - Ship | 295 | 0.25 | 73.75 | FA-18E/F | 2.0 | 147.5 | 10% | 14.8 | 0% | 0% | 100% | 0.00 | 0.00 | 14.75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 110 | 2249 | 18 | 61 | 1000 | 900 | 110 | 2249 | 18 | 61 | 1000 | 900 | F414-GE | 2 | 10,338 | 1524855 | 224243 | 4721220 | 153 | 133 | 4,771,501 |
| | | 0.75 | 221.3 | SH-60B | 2.0 | 442.5 | 100% | 442.5 | 0% | 0% | 100% | 0.00 | 0.00 | 442.50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3319 | 3398 | 292 | 212 | 2230 | 2007 | 3319 | 3398 | 292 | 212 | 2230 | 2007 | T700-GE | 2 | 1200 | 531000 | 78088 | 1644070 | 53 | 46 | 1,661,579 |
| Missile Exercise (A-S) - Rocket | 3 | 0.33 | 0.99 | FA-18E/F | 2.0 | 2.0 | 10% | 0.2 | 0% | 0% | 100% | 0.00 | 0.00 | 0.20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 30 | 0 | 1 | 13 | 12 | 1 | 30 | 0 | 1 | 13 | 12 | F414-GE | 2 | 10,338 | 20463.24 | 3010 | 63376 | 2 | 2 | 64,051 |
| | | 0.66 | 1.98 | SH-60B | 2.0 | 4.0 | 100% | 4.0 | 0% | 0% | 100% | 0.00 | 0.00 | 3.96 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 30 | 3 | 2 | 20 | 18 | 30 | 30 | 3 | 2 | 20 | 18 | T700-GE | 2 | 1200 | 4752 | 699 | 14713 | 0 | 0 | 14,870 |
| Missile Exercise (A-S) | 20 | 0.5 | 10 | FA-18E/F | 2.0 | 20.0 | 10% | 2.0 | 0% | 0% | 100% | 0.00 | 0.00 | 2.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 305 | 2 | 8 | 136 | 122 | 15 | 305 | 2 | 8 | 136 | 122 | F414-GE | 2 | 10,338 | 206760 | 30406 | 640165 | 21 | 18 | 646,983 |
| | | 0.5 | 10 | SH-60B | 2.0 | 20.0 | 100% | 20.0 | 0% | 0% | 100% | 0.00 | 0.00 | 20.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 150 | 154 | 13 | 10 | 101 | 91 | 150 | 154 | 13 | 10 | 101 | 91 | T700-GE | 2 | 1200 | 24000 | 3529 | 74308 | 2 | 2 | 75,100 |
| Laser Targeting | 600 | 0.5 | 300 | FA-18E/F | 1.0 | 300.0 | 10% | 30.0 | 0% | 0% | 100% | 0.00 | 0.00 | 30.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 223 | 4575 | 37 | 124 | 2035 | 1831 | 223 | 4575 | 37 | 124 | 2035 | 1831 | F414-GE | 2 | 10,338 | 3101400 | 456088 | 9602482 | 312 | 271 | 9,704,748 |
| | | 0.5 | 300 | SH-60B | 1.0 | 300.0 | 100% | 300.0 | 0% | 0% | 100% | 0.00 | 0.00 | 300.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2250 | 2304 | 198 | 144 | 1512 | 1361 | 2250 | 2304 | 198 | 144 | 1512 | 1361 | T700-GE | 2 | 1200 | 360000 | 52941 | 1114624 | 36 | 32 | 1,126,494 |
| Bombing Exercise (A-S) | 37 | 0.5 | 19 | FA-18E/F | 1.0 | 18.5 | 10% | 1.9 | 0% | 0% | 100% | 0.00 | 0.00 | 1.85 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 282 | 2 | 8 | 125 | 113 | 14 | 282 | 2 | 8 | 125 | 113 | F414-GE | 2 | 10,338 | 191253 | 28125 | 592153 | 19 | 17 | 598,459 |
| | | 0.5 | 19 | P-3 | 1.0 | 18.5 | 10% | 1.9 | 0% | 0% | 100% | 0.00 | 0.00 | 1.85 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 69 | 5 | 4 | 35 | 32 | 22 | 69 | 5 | 4 | 35 | 32 | T56-A-14 | 4 | 4,800 | 88800 | 13059 | 274940 | 9 | 8 | 277,869 |
| Torpedo Exercise (Submarine to Surface) | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise (S-S) | 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sinking Exercise (SINKEX) | 2 | 2 | 4 | FA-18E/F | 8.0 | 32.0 | 10% | 3.2 | 0% | 0% | 100% | 0.00 | 0.00 | 3.20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 488 | 4 | 13 | 217 | 195 | 24 | 488 | 4 | 13 | 217 | 195 | F414-GE | 2 | 10,338 | 330816 | 48649 | 1024265 | 33 | 29 | 1,035,173 |
| | | 1 | 2 | P-3 | 8.0 | 16.0 | 10% | 1.6 | 0% | 0% | 100% | 0.00 | 0.00 | 1.60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 59 | 4 | 3 | 30 | 27 | 19 | 59 | 4 | 3 | 30 | 27 | T56-A-14 | 4 | 4,800 | 76800 | 11294 | 237786 | 8 | 7 | 240,319 |
| | | 1 | 2 | SH-60B | 8.0 | 16.0 | 100% | 16.0 | 0% | 0% | 100% | 0.00 | 0.00 | 16.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 120 | 123 | 11 | 8 | 81 | 73 | 120 | 123 | 11 | 8 | 81 | 73 | T700-GE | 2 | 1200 | 19200 | 2824 | 59447 | 2 | 2 | 60,080 |
| Gunnery Exercise (S-S) Boat - Medium-caliber | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise (S-S) Small-caliber | 40 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Maritime Security Operations (MSO) | 40 | 1 | 40 | SH-60B | 4.0 | 160.0 | 100% | 160.0 | 100% | 0% | 0% | 160.00 | 0.00 | 0.00 | 1200 | 1229 | 106 | 77 | 806 | 726 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1200 | 1229 | 106 | 77 | 806 | 726 | T700-GE | 2 | 1200 | 192000 | 28235 | 594466 | 19 | 17 | 600,797 |
| **ANTI-SUBMARINE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise-Helo | 62 | 3 | 186 | SH-60B | 4.0 | 744.0 | 100% | 744.0 | 0% | 100% | 0% | 0.00 | 744.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 5580 | 5714 | 491 | 357 | 3750 | 3375 | 0 | 0 | 0 | 0 | 0 | 0 | 5580 | 5714 | 491 | 357 | 3750 | 3375 | T700-GE | 2 | 1200 | 892800 | 131294 | 2764266 | 90 | 78 | 2,793,706 |
| Torpedo Exercise-Helo | 4 | 3 | 12 | SH-60B | 4.0 | 48.0 | 100% | 48.0 | 0% | 100% | 0% | 0.00 | 48.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 360 | 369 | 32 | 23 | 242 | 218 | 0 | 0 | 0 | 0 | 0 | 0 | 360 | 369 | 32 | 23 | 242 | 218 | T700-GE | 2 | 1200 | 57600 | 8471 | 178340 | 6 | 5 | 180,239 |
| Tracking Exercise-Maritime Patrol Advanced Extended Echo Ranging | 11 | 1 | 11 | P-3 | 6.0 | 66.0 | 75% | 49.5 | 0% | 100% | 0% | 0.00 | 49.50 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 596 | 1837 | 138 | 95 | 943 | 849 | 0 | 0 | 0 | 0 | 0 | 0 | 596 | 1837 | 138 | 95 | 943 | 849 | T56-A-14 | 4 | 4,800 | 316800 | 46588 | 980869 | 32 | 28 | 991,315 |
| Tracking Exercise - Maritime Patrol Aircraft | 34 | 1 | 34 | P-3 | 6.0 | 204.0 | 75% | 153.0 | 0% | 100% | 0% | 0.00 | 153.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 1843 | 5677 | 426 | 294 | 2916 | 2624 | 0 | 0 | 0 | 0 | 0 | 0 | 1843 | 5677 | 426 | 294 | 2916 | 2624 | T56-A-14 | 4 | 4,800 | 979200 | 144000 | 3031776 | 98 | 86 | 3,064,064 |
| Torpedo Exercise-Maritime Patrol Aircraft | 4 | 1 | 4 | P-3 | 6.0 | 24.0 | 75% | 18.0 | 0% | 100% | 0% | 0.00 | 18.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 217 | 668 | 50 | 35 | 343 | 309 | 0 | 0 | 0 | 0 | 0 | 0 | 217 | 668 | 50 | 35 | 343 | 309 | T56-A-14 | 4 | 4,800 | 115200 | 16941 | 356680 | 12 | 10 | 360,478 |
| Tracking Exercise -Surface | 132 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise-Surface | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise-Submarine | 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise - Submarine | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

## Table D-6: Aircraft Emissions – No Action Alternative (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MAJOR TRAINING EVENTS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Joint Expeditionary | 1 | 48 | 48 | FA-18E/F | 8.0 | 384.0 | 10% | 38.4 | 0% | 100% | 0% | 0.00 | 38.40 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 286 | 5855 | 48 | 159 | 2604 | 2344 | 0 | 0 | 0 | 0 | 0 | 0 | 286 | 5855 | 48 | 159 | 2604 | 2344 | F414-GE | 2 | 10,338 | 3969792 | 583793 | 12291177 | 399 | 347 | 12,422,078 |
| | | 4 | 4 | EA-6B | 8.0 | 32.0 | 10% | 3.2 | 0% | 100% | 0% | 0.00 | 3.20 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 148 | 165 | 10 | 8 | 73 | 66 | 0 | 0 | 0 | 0 | 0 | 0 | 148 | 165 | 10 | 8 | 73 | 66 | F402-RR | 1 | 6,000 | 192000 | 28235 | 594466 | 19 | 17 | 600,797 |
| | | 4 | 4 | E-2 | 8.0 | 32.0 | 10% | 3.2 | 0% | 100% | 0% | 0.00 | 3.20 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 71 | 3 | 3 | 7 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 71 | 3 | 3 | 7 | 6 | T56-A-42 | 1 | 1,100 | 35200 | 5176 | 108985 | 4 | 3 | 110,146 |
| | | 3 | 3 | P-3 | 8.0 | 24.0 | 10% | 2.4 | 0% | 100% | 0% | 0.00 | 2.40 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 89 | 7 | 5 | 46 | 41 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 89 | 7 | 5 | 46 | 41 | T56-A-14 | 4 | 4,800 | 115200 | 16941 | 356680 | 12 | 10 | 360,478 |
| | | 6 | 6 | AV-8B | 8.0 | 48.0 | 10% | 4.8 | 0% | 100% | 0% | 0.00 | 4.80 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 222 | 248 | 16 | 12 | 109 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 222 | 248 | 16 | 12 | 109 | 98 | F402-RR | 1 | 6,000 | 288000 | 42353 | 891699 | 29 | 25 | 901,195 |
| | | 2 | 2 | C-130 | 8.0 | 16.0 | 10% | 1.6 | 0% | 100% | 0% | 0.00 | 1.60 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 59 | 3 | 3 | 29 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 59 | 3 | 3 | 29 | 26 | T56-A-42 | 4 | 4,500 | 72000 | 10588 | 222925 | 7 | 6 | 225,299 |
| | | 4 | 4 | A-10 | 8.0 | 32.0 | 10% | 3.2 | 0% | 100% | 0% | 0.00 | 3.20 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 86 | 4 | 4 | 26 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 86 | 4 | 4 | 26 | 23 | | 2 | 6,052 | 193664 | 28480 | 599618 | 19 | 17 | 606,004 |
| | | 1 | 1 | E-3 | 8.0 | 8.0 | 10% | 0.8 | 0% | 100% | 0% | 0.00 | 0.80 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 221 | 8 | 10 | 7 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 221 | 8 | 10 | 7 | 6 | | 4 | 130,736 | 1045888 | 153807 | 3238254 | 105 | 92 | 3,272,741 |
| | | 1 | 1 | KC-135 | 8.0 | 8.0 | 10% | 0.8 | 0% | 100% | 0% | 0.00 | 0.80 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 247 | 1 | 7 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 247 | 1 | 7 | 2 | 2 | | 4 | 91,552 | 732416 | 107708 | 2267689 | 74 | 64 | 2,291,840 |
| | | 15 | 15 | SH-60B | 8.0 | 120.0 | 100% | 120.0 | 0% | 100% | 0% | 0.00 | 120.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 900 | 922 | 79 | 58 | 605 | 544 | 0 | 0 | 0 | 0 | 0 | 0 | 900 | 922 | 79 | 58 | 605 | 544 | T700-GE | 2 | 1200 | 144000 | 21176 | 445849 | 14 | 13 | 450,598 |
| | | 4 | 4 | CH-53 | 8.0 | 32.0 | 100% | 32.0 | 0% | 100% | 0% | 0.00 | 32.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 304 | 1154 | 21 | 57 | 316 | 284 | 0 | 0 | 0 | 0 | 0 | 0 | 304 | 1154 | 21 | 57 | 316 | 284 | T64-GE- | 3 | 4,464 | 142848 | 21007 | 442283 | 14 | 12 | 446,993 |
| | | 12 | 12 | CH-46 | 8.0 | 96.0 | 100% | 96.0 | 0% | 100% | 0% | 0.00 | 96.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 2454 | 593 | 380 | 58 | 256 | 231 | 0 | 0 | 0 | 0 | 0 | 0 | 2454 | 593 | 380 | 58 | 256 | 231 | T58-GE- | 2 | 1200 | 144000 | 21176 | 445849 | 14 | 13 | 450,598 |
| | | 4 | 4 | AH-1 | 8.0 | 32.0 | 100% | 32.0 | 0% | 100% | 0% | 0.00 | 32.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 291 | 141 | 15 | 10 | 109 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 291 | 141 | 15 | 10 | 109 | 98 | T700-GE | 2 | 812 | 25984 | 3821 | 80451 | 3 | 2 | 81,308 |
| | | 2 | 2 | UH-1 | 8.0 | 16.0 | 100% | 16.0 | 0% | 100% | 0% | 0.00 | 16.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 41 | 1 | 3 | 36 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 41 | 1 | 3 | 36 | 33 | T400-CP | 2 | 540 | 8640 | 1271 | 26751 | 1 | 1 | 27,036 |
| | | 10 | 10 | MV-22 | 8.0 | 80.0 | 100% | 80.0 | 0% | 100% | 0% | 0.00 | 80.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 1769 | 353 | 307 | 36 | 159 | 144 | 0 | 0 | 0 | 0 | 0 | 0 | 1769 | 353 | 307 | 36 | 159 | 144 | | 2 | 2240 | 179200 | 26353 | 554835 | 18 | 16 | 560,744 |
| Joint Multi-Strike Group Exercise | 1 | 144 | 144 | FA-18E/F | 8.0 | 1152.0 | 10% | 115.2 | 0% | 0% | 100% | 0.00 | 0.00 | 115.20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 857 | 17566 | 143 | 476 | 7813 | 7031 | 857 | 17566 | 143 | 476 | 7813 | 7031 | F414-GE | 2 | 10,338 | 11909376 | 1751379 | 36873530 | 1196 | 1042 | 37,266,233 |
| | | 12 | 12 | EA-6B | 8.0 | 96.0 | 10% | 9.6 | 0% | 0% | 100% | 0.00 | 0.00 | 9.60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 444 | 495 | 31 | 23 | 219 | 197 | 444 | 495 | 31 | 23 | 219 | 197 | F402-RR | 1 | 6,000 | 576000 | 84706 | 1783398 | 58 | 50 | 1,802,391 |
| | | 12 | 12 | E-2 | 8.0 | 96.0 | 10% | 9.6 | 0% | 0% | 100% | 0.00 | 0.00 | 9.60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 212 | 8 | 8 | 20 | 18 | 54 | 212 | 8 | 8 | 20 | 18 | T56-A-42 | 1 | 1,100 | 105600 | 15529 | 326956 | 11 | 9 | 330,438 |
| | | 5 | 5 | P-3 | 8.0 | 40.0 | 10% | 4.0 | 0% | 0% | 100% | 0.00 | 0.00 | 4.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 148 | 11 | 8 | 76 | 69 | 48 | 148 | 11 | 8 | 76 | 69 | T56-A-14 | 4 | 4,800 | 192000 | 28235 | 594466 | 19 | 17 | 600,797 |
| | | 1 | 1 | E-3 | 8.0 | 8.0 | 10% | 0.8 | 0% | 0% | 100% | 0.00 | 0.00 | 0.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 221 | 8 | 10 | 7 | 6 | 54 | 221 | 8 | 10 | 7 | 6 | | 4 | 130,736 | 1045888 | 153807 | 3238254 | 105 | 92 | 3,272,741 |
| | | 2 | 2 | KC-135 | 8.0 | 16.0 | 10% | 1.6 | 0% | 0% | 100% | 0.00 | 0.00 | 1.60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 49 | 494 | 1 | 15 | 5 | 4 | 49 | 494 | 1 | 15 | 5 | 4 | | 4 | 91,552 | 1464832 | 215416 | 4535378 | 147 | 128 | 4,583,680 |
| | | 6 | 6 | B-1B | 8.0 | 48.0 | 10% | 4.8 | 0% | 0% | 100% | 0.00 | 0.00 | 4.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 418 | 4 | 13 | 4 | 4 | 27 | 418 | 4 | 13 | 4 | 4 | | 4 | 26,560 | 1274880 | 187482 | 3947253 | 128 | 112 | 3,989,292 |
| | | 24 | 24 | F-15 | 8.0 | 192.0 | 10% | 19.2 | 0% | 0% | 100% | 0.00 | 0.00 | 19.20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 431 | 5558 | 77 | 48 | 970 | 873 | 431 | 5558 | 77 | 48 | 970 | 873 | F100-PW | 2 | 6196 | 1189632 | 174946 | 3683311 | 119 | 104 | 3,722,538 |
| | | 45 | 45 | SH-60B | 8.0 | 360.0 | 100% | 360.0 | 0% | 0% | 100% | 0.00 | 0.00 | 360.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2700 | 2765 | 238 | 173 | 1814 | 1633 | 2700 | 2765 | 238 | 173 | 1814 | 1633 | T700-GE | 2 | 1200 | 432000 | 63529 | 1337548 | 43 | 38 | 1,351,793 |
| Marine Air Ground Task Force Exercise (Amphibious) | 4 | 1 | 4 | C-130 | 8.0 | 32.0 | 10% | 3.2 | 50% | 50% | 0% | 1.60 | 1.60 | 0.00 | 15 | 59 | 3 | 3 | 29 | 26 | 15 | 59 | 3 | 3 | 29 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 118 | 7 | 6 | 57 | 51 | T56-A-42 | 4 | 4,500 | 144000 | 21176 | 445849 | 14 | 13 | 450,598 |
| | | 2 | 8 | SH-60B | 8.0 | 64.0 | 100% | 64.0 | 50% | 50% | 0% | 32.00 | 32.00 | 0.00 | 240 | 246 | 21 | 15 | 161 | 145 | 240 | 246 | 21 | 15 | 161 | 145 | 0 | 0 | 0 | 0 | 0 | 0 | 480 | 492 | 42 | 31 | 323 | 290 | T700-GE | 2 | 1200 | 76800 | 11294 | 237786 | 8 | 7 | 240,319 |
| | | 4 | 16 | CH-53 | 8.0 | 128.0 | 100% | 128.0 | 50% | 50% | 0% | 64.00 | 64.00 | 0.00 | 609 | 2308 | 43 | 114 | 631 | 568 | 609 | 2308 | 43 | 114 | 631 | 568 | 0 | 0 | 0 | 0 | 0 | 0 | 1217 | 4617 | 86 | 229 | 1263 | 1136 | T64-GE- | 3 | 4,464 | 571392 | 84028 | 1769130 | 57 | 50 | 1,787,972 |
| | | 12 | 48 | CH-46 | 8.0 | 384.0 | 100% | 384.0 | 50% | 50% | 0% | 192.00 | 192.00 | 0.00 | 3926 | 3926 | 608 | 92 | 410 | 369 | 3926 | 949 | 608 | 92 | 410 | 369 | 0 | 0 | 0 | 0 | 0 | 0 | 7852 | 4875 | 1217 | 184 | 820 | 738 | T58-GE- | 2 | 1200 | 460800 | 67765 | 1426718 | 46 | 40 | 1,441,913 |
| | | 4 | 16 | AH-1 | 8.0 | 128.0 | 100% | 128.0 | 50% | 50% | 0% | 64.00 | 64.00 | 0.00 | 583 | 283 | 30 | 21 | 218 | 196 | 583 | 283 | 30 | 21 | 218 | 196 | 0 | 0 | 0 | 0 | 0 | 0 | 1165 | 565 | 59 | 42 | 437 | 393 | T700-GE | 2 | 812 | 103936 | 15285 | 321804 | 10 | 9 | 325,231 |
| | | 2 | 8 | UH-1 | 8.0 | 64.0 | 100% | 64.0 | 50% | 50% | 0% | 32.00 | 32.00 | 0.00 | 58 | 82 | 3 | 7 | 73 | 65 | 58 | 82 | 3 | 7 | 73 | 65 | 0 | 0 | 0 | 0 | 0 | 0 | 115 | 163 | 6 | 14 | 145 | 131 | T400-CP | 2 | 540 | 34560 | 5082 | 107004 | 3 | 3 | 108,143 |
| | | 10 | 40 | MV-22 | 8.0 | 320.0 | 100% | 320.0 | 50% | 50% | 0% | 160.00 | 160.00 | 0.00 | 3537 | 706 | 615 | 72 | 319 | 287 | 3537 | 706 | 615 | 72 | 319 | 287 | 0 | 0 | 0 | 0 | 0 | 0 | 7075 | 1412 | 1229 | 143 | 638 | 574 | | 2 | 2240 | 716800 | 105412 | 2219339 | 72 | 63 | 2,242,975 |
| Special Purpose Marine Air Ground Task Force Exercise | 2 | 1 | 2 | C-130 | 8.0 | 16.0 | 10% | 1.6 | 50% | 50% | 0% | 0.80 | 0.80 | 0.00 | 7 | 29 | 2 | 1 | 14 | 13 | 7 | 29 | 2 | 1 | 14 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 59 | 3 | 3 | 29 | 26 | T56-A-42 | 4 | 4,500 | 72000 | 10588 | 222925 | 7 | 6 | 225,299 |
| | | 4 | 8 | CH-53 | 8.0 | 64.0 | 100% | 64.0 | 50% | 50% | 0% | 32.00 | 32.00 | 0.00 | 304 | 1154 | 21 | 57 | 316 | 284 | 304 | 1154 | 21 | 57 | 316 | 284 | 0 | 0 | 0 | 0 | 0 | 0 | 609 | 2308 | 43 | 114 | 631 | 568 | T64-GE- | 3 | 4,464 | 285696 | 42014 | 884565 | 29 | 25 | 893,986 |
| | | 12 | 24 | CH-46 | 8.0 | 192.0 | 100% | 192.0 | 50% | 50% | 0% | 96.00 | 96.00 | 0.00 | 1963 | 1963 | 304 | 46 | 205 | 185 | 1963 | 475 | 304 | 46 | 205 | 185 | 0 | 0 | 0 | 0 | 0 | 0 | 3926 | 2438 | 608 | 92 | 410 | 369 | T58-GE- | 2 | 1200 | 230400 | 33882 | 713359 | 23 | 20 | 720,956 |
| | | 4 | 8 | AH-1 | 8.0 | 64.0 | 100% | 64.0 | 50% | 50% | 0% | 32.00 | 32.00 | 0.00 | 291 | 141 | 15 | 10 | 109 | 98 | 291 | 141 | 15 | 10 | 109 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 583 | 283 | 30 | 21 | 218 | 196 | T700-GE | 2 | 812 | 51968 | 7642 | 160902 | 5 | 5 | 162,616 |
| | | 2 | 4 | UH-1 | 8.0 | 32.0 | 100% | 32.0 | 50% | 50% | 0% | 16.00 | 16.00 | 0.00 | 29 | 41 | 1 | 3 | 36 | 33 | 29 | 41 | 1 | 3 | 36 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 58 | 82 | 3 | 7 | 73 | 65 | T400-CP | 2 | 540 | 17280 | 2541 | 53502 | 2 | 2 | 54,072 |
| | | 10 | 20 | MV-22 | 8.0 | 160.0 | 100% | 160.0 | 50% | 50% | 0% | 80.00 | 80.00 | 0.00 | 1769 | 353 | 307 | 36 | 159 | 144 | 1769 | 353 | 307 | 36 | 159 | 144 | 0 | 0 | 0 | 0 | 0 | 0 | 3537 | 706 | 615 | 72 | 319 | 287 | | 2 | 2240 | 358400 | 52706 | 1109670 | 36 | 31 | 1,121,488 |
| **ELECTRONIC WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Electronic Warfare Operations | 480 | 1 | 480 | FA-18E/F | 2.0 | 960.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F414-GE | 2 | 10,338 | 9924480 | 1459482 | 30727941 | 997 | 868 | 31,055,194 |
| Flare Exercise | 3200 | 0.9 | 2880 | F-15 | 3.0 | 8640.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F100-PW | 2 | 6196 | 53533440 | 7872565 | 165748977 | 5377 | 4684 | 167,514,203 |
| | | 0.06 | 192 | FA-18E/F | 3.0 | 576.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F414-GE | 2 | 10,338 | 5954688 | 875689 | 18436765 | 598 | 521 | 18,633,116 |
| | | 0.04 | 128 | SH-60B | 3.0 | 384.0 | 100% | 384.0 | 0% | 0% | 100% | 0.00 | 0.00 | 384.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2880 | 2949 | 253 | 184 | 1935 | 1742 | 2880 | 2949 | 253 | 184 | 1935 | 1742 | T700-GE | 2 | 1200 | 460800 | 67765 | 1426718 | 46 | 40 | 1,441,913 |
| Chaff Exercise - Shi | 40 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chaff Exercise - Aircraft | 3200 | 0.9 | 2880 | F-15 | 3.0 | 8640.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F100-PW | 2 | 6196 | 53533440 | 7872565 | 165748977 | 5377 | 4684 | 167,514,203 |
| | | 0.06 | 192 | FA-18E/F | 3.0 | 576.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F414-GE | 2 | 10,338 | 5954688 | 875689 | 18436765 | 598 | 521 | 18,633,116 |
| | | 0.04 | 128 | SH-60B | 3.0 | 384.0 | 100% | 384.0 | 0% | 0% | 100% | 0.00 | 0.00 | 384.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2880 | 2949 | 253 | 184 | 1935 | 1742 | 2880 | 2949 | 253 | 184 | 1935 | 1742 | T700-GE | 2 | 1200 | 460800 | 67765 | 1426718 | 46 | 40 | 1,441,913 |

## Table D-6: Aircraft Emissions – No Action Alternative (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MINE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mine Laying - Aircraft | 4 | 0.5 | 2 | FA-18E/ | 0.5 | 1.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 10,338 | 10338 | 1520 | 32008 | 1 | 1 | 32,349 |
| | | 0.5 | 2 | P-3 | 1.0 | 2.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4,800 | 9600 | 1412 | 29723 | 1 | 1 | 30,040 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0.00 | 0.00 | 0 |
| Mine Neutralization - Explosive | 20 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Limpet Mine Neutralization System/Shock Wave Generator | 40 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **NAVAL SPECIAL WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Personnel I&E | 240 | 4 | 360 | H-60 | 8.0 | 7680.0 | 100% | 7680.0 | 100% | 0% | 0% | 7680.00 | 0.00 | 0.00 | 57600 | 58982 | 5063 | 3686 | 38707 | 34836 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 57600 | 58982 | 5063 | 3686 | 38707 | 34836 | 2 | 1200 | 3216000 | 1355294 | 28534362 | 326 | 806 | 28,838,253 |
| | | 2 | 480 | MV-22 | 8.0 | 3840.0 | 100% | 3840.0 | 100% | 0% | 0% | 3840.00 | 0.00 | 0.00 | 84898 | 16945 | 14752 | 1720 | 7655 | 6890 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 84898 | 16945 | 14752 | 1720 | 7655 | 6890 | 2 | 2240 | 8601600 | 1264941 | 26632072 | 864 | 753 | 26,915,703 |
| Parachute Insertion | 20 | 1 | 20 | C-130 | 4.0 | 80.0 | 100% | 80.0 | 100% | 0% | 0% | 80.00 | 0.00 | 0.00 | 745 | 2938 | 169 | 144 | 1429 | 1286 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 745 | 2938 | 169 | 144 | 1429 | 1286 | 4 | 4,500 | 360000 | 52941 | 1114624 | 36 | 32 | 1,126,494 |
| | | 1 | 20 | CH-46 | 4.0 | 80.0 | 100% | 80.0 | 100% | 0% | 0% | 80.00 | 0.00 | 0.00 | 1636 | 0 | 253 | 38 | 171 | 154 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1636 | 0 | 253 | 38 | 171 | 154 | 2 | 1200 | 96000 | 14118 | 297233 | 10 | 8 | 300,398 |
| | | 1 | 20 | H-60 | 4.0 | 80.0 | 100% | 80.0 | 100% | 0% | 0% | 80.00 | 0.00 | 0.00 | 600 | 614 | 53 | 38 | 403 | 363 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 600 | 614 | 53 | 38 | 403 | 363 | 2 | 1200 | 96000 | 14118 | 297233 | 10 | 8 | 300,398 |
| **OTHER** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Surface Ship Sonar | 42 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Submarine Sonar | 48 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Small Boat Attack | 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sub Navigation/ Sub Nav Under | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Precision Anchoring | 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Unmanned Aerial Vehicle | 1000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Direct Action (TAC-P) | 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Intelligence, Surveillance, Reconnaissance | 16 | 1 | 16.0 | MQ-4C | 4.0 | 64.0 | 100% | 64.0 | 0% | 50% | 50% | 0.00 | 32.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 67 | 1243 | 21 | 113 | 20 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 67 | 1243 | 21 | 113 | 20 | 18 | 1 | 2,532 | 162048 | 23831 | 501729 | 16 | 14 | 507,073 |
| Underwater Survey | 16 | 1 | 16 | SH-[illegible] | 2.0 | 32.0 | 100% | 32.0 | 100% | 0% | 0% | 32.00 | 0.00 | 0.00 | 240 | 246 | 21 | 15 | 161 | 145 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 240 | 246 | 21 | 15 | 161 | 145 | 2 | 1200 | 38400 | 5647 | 118893 | 4 | 3 | 120,159 |
| Unmanned Underwater Vehicle Training | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **TOTAL TRAINING (lbs per year)** | | | | | | | | | | | | | | | 339,376 | 233,639 | 48,365 | 15,573 | 98,494 | 88,644 | 28,576 | 32,577 | 4,034 | 1,827 | 15,278 | 13,751 | 59,210 | 838,876 | 8,378 | 23,339 | 375,026 | 337,524 | 426,855 | 1,103,604 | 60,736 | 40,611 | 488,618 | 439,756 | | | 436,107,291 | 64,133,425 | 1,349,644,511 | 43,783 | 38,142 | 1,364,018,219 |
| **TOTAL TRAINING (tons per year)** | | | | | | | | | | | | | | | 170 | 117 | 24 | 8 | 49 | 44 | 14 | 16 | 2 | 1 | 8 | 7 | 30 | 419 | 4 | 12 | 188 | 169 | 213 | 552 | 30 | 20 | 244 | 220 | | | 218,054 | 64,133,425 | 674,822 | 22 | 19 | 682,009 |

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## Table D-7: Emissions from Ordnance – No Action Alternative

| MEM Category | Location | Training MEM | Testing MEM | Emissions (lb/year) Training | | | | | | Emissions (lb/year) Testing | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | #/yr | #/yr | CO | NOx | VOC | SOx | PM10 | PM2.5 | CO | NOx | VOC | SOx | PM10 | PM2.5 |
| **BOMBS** | | | | | | | | | | | | | | | |
| Bombs (H-E) | MITT | 6,454 | 0 | 394,551.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Bombs (N-E) | MITT | 3,038 | 0 | 774.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **PROJECTILES** | | | | | | | | | | | | | | | |
| Small Caliber | MITT | 138,640 | 0 | 318.9 | 13.4 | 0.0 | 0.0 | 7.1 | 5.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Medium Caliber (H-E) | MITT | 25,500 | 2040 | 102.0 | 33.2 | 0.0 | 0.0 | 242.3 | 130.1 | 8.2 | 2.7 | 0.0 | 0.0 | 19.4 | 10.4 |
| Medium Caliber (N-E) | MITT | 179,650 | 2040 | 467.1 | 17.4 | 0.0 | 0.0 | 25.2 | 21.6 | 5.3 | 0.2 | 0.0 | 0.0 | 0.3 | 0.2 |
| Large Caliber (H-E) | MITT | 2,500 | 3290 | 320.0 | 400.0 | 0.0 | 0.0 | 24.0 | 18.6 | 421.1 | 526.4 | 0.0 | 0.0 | 31.6 | 24.5 |
| Large Caliber (N-E) | MITT | 7,038 | 2310 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Missiles (H-E) | MITT | 210 | 12 | 6,430.9 | 7,470.5 | 0.0 | 0.0 | 12,977.0 | 12,977.0 | 367.5 | 426.9 | 0.0 | 0.0 | 741.5 | 741.5 |
| Missiles (N-E) | MITT | 0 | 12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 367.5 | 426.9 | 0.0 | 0.0 | 741.5 | 741.5 |
| Rockets (H-E) | MITT | 2,114 | 8 | 1,966.0 | 11.8 | 0.0 | 0.0 | 845.6 | 613.1 | 7.4 | 0.0 | 0.0 | 0.0 | 3.2 | 2.3 |
| Rockets (N-E) | MITT | 0 | 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **COUNTERMEASURES** | | | | | | | | | | | | | | | |
| Chaff | MITT | 25,840 | 0 | 1.5 | 3.9 | 0.0 | 0.0 | 7.3 | 6.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Flares | MITT | 25,600 | 0 | 1.5 | 3.9 | 0.0 | 0.0 | 7.2 | 6.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **TARGETS** | | | | | | | | | | | | | | | |
| Airborne targets | MITT | 12 | 0 | | | | | | | | | | | | |
| Surface targets | MITT | 200 | 0 | | | | | | | | | | | | |
| Expendable sub-surface targets | MITT | 87 | 0 | | | | | | | | | | | | |
| **TOTAL EMISSIONS (lbs per year)** | | | | 404,934 | 7,954 | 0 | 0 | 14,136 | 13,779 | 1,177 | 1,383 | 0 | 0 | 1,538 | 1,521 |
| **TOTAL EMISSIONS (tons per year)** | | | | 202.5 | 4.0 | 0.0 | 0.0 | 7.1 | 6.9 | 0.6 | 0.7 | 0.0 | 0.0 | 0.8 | 0.8 |

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## Table D-8: Vessel Emissions – Alternative 1

| Type Training | Training Ops (#) | OPERATIONAL INFORMATION - VESSELS | | | | | | | | | | EMISSIONS/YEAR (lb) BY JURISDICTION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ship / Vessel / Boat | | | | Range Time (hr) | | | Distribution (hr) | | | State (0-3 nm offshore) | | | | | | Waters of U S (3-12 nm) | | | | | |
| | | Number | Ship Type | Type | Participation | Per Ship | Time at Each Power Level (%) | Total | 0-3 nm from shore | 3-12 nm from shore | > 12 nm from shore | CO | $NO_x$ | HC | $SO_x$ | $PM_{10}$ | PM2.5 | CO | $NO_x$ | HC | $SO_x$ | $PM_{10}$ | PM2.5 |
| **ANTI-AIR WARFARE** | | | | | | | | | | | | | | | | | | | | | | | |
| Air Combat Maneuver | 3600 | | | | | | | | | | | | | | | | | | | | | | |
| Air Defense Exercise | 100 | | | | | | | | | | | | | | | | | | | | | | |
| Air Intercept Control | 5300 | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-A (Medium Caliber) | 36 | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise, A-A | 18 | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, S-A (Large Caliber) | 6 | 12 | FFG | Guided Missile Frigate | 2.00 | 2.0 | 100% | 24.0 | 0.0 | 0.0 | 24.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gunnery Exercise, S-A (Medium Caliber) | 13 | 26 | FFG | Guided Missile Frigate | 2.00 | 2.0 | 100% | 52.0 | 0.0 | 0.0 | 52.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Missile Exercise, S-A | 18 | 36 | FFG | Guided Missile Frigate | 2.00 | 2.0 | 100% | 72.0 | 0.0 | 0.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **STRIKE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | |
| Bombing Exercise, A-G | 2300 | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise, A-G | 115 | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-G | 36 | | | | | | | | | | | | | | | | | | | | | | |
| **AMPHIBIOUS WARFARE** | | | | | | | | | | | | | | | | | | | | | | | |
| Fire Support Exercise - Land-Based target | 10 | 10 | CG | Cruiser | 1 | 8.0 | 100% | 80.00 | 80.0 | 0.0 | 0.0 | 4,921 | 6,366 | 346 | 6,210 | 223 | 201 | 0 | 0 | 0 | 0 | 0 | 0 |
| Amphibious Rehearsal, No Landing - Marine Air Ground Task Force | 12 | 48 | LSD | Cruiser | 4 | 24.0 | 100% | 1152.0 | 1152.0 | 0.0 | 0.0 | 24,480 | 385,356 | 12,488 | 40,366 | 3,122 | 2,810 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 48 | LHA/LHD | Amphib. Assault Ship - Tarawa | 4 | 24.0 | 100% | 1152.0 | 1152.0 | 0.0 | 0.0 | 9,308 | 55,100 | 6,647 | 156,096 | 32,924 | 29,632 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 48 | LPD | Amphibious Transport Dock - Wasp | 4 | 24.0 | 100% | 1152.0 | 1152.0 | 0.0 | 0.0 | 4,009 | 24,192 | 2,972 | 70,065 | 14,803 | 13,323 | 0 | 0 | 0 | 0 | 0 | 0 |
| Amphibious Assault - Marine Air Ground Task Force | 12 | 12 | CG | Cruiser | 1 | 8.0 | 100% | 96.0 | 96.0 | 0.0 | 0.0 | 5,905 | 7,640 | 415 | 7,452 | 268 | 241 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 12 | LHA | Amphib. Assault Ship - Tarawa | 1 | 8.0 | 100% | 96.0 | 96.0 | 0.0 | 0.0 | 708 | 4,179 | 531 | 12,573 | 2,524 | 2,271 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 24 | LPD | Amphibious Transport Dock - Wasp | 2 | 8.0 | 100% | 192.0 | 192.0 | 0.0 | 0.0 | 668 | 4,032 | 495 | 11,677 | 2,467 | 2,220 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 24 | FFG | Guided Missile Frigate | 2 | 8.0 | 100% | 192.0 | 192.0 | 0.0 | 0.0 | 6,324 | 9,055 | 576 | 6,705 | 444 | 399 | 0 | 0 | 0 | 0 | 0 | 0 |
| Amphibious Raid - Special Purpose Marine Air Ground Task Force | 6 | 6 | LHA | Amphib. Assault Ship - Tarawa | 1 | 6.0 | 100% | 36.0 | 36.0 | 0.0 | 0.0 | 266 | 1,567 | 199 | 4,715 | 946 | 852 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 12 | LPD | Amphibious Transport Dock - Wasp | 2 | 2.5 | 100% | 30.0 | 30.0 | 0.0 | 0.0 | 104 | 630 | 77 | 1,825 | 386 | 347 | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Combatant Evacuation Operation | 5 | 5 | LHA | Amphib. Assault Ship - Tarawa | 1 | 80.0 | 100% | 400.0 | 400.0 | 0.0 | 0.0 | 2,952 | 17,412 | 2,212 | 52,388 | 10,516 | 9,464 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 10 | LPD | Amphibious Transport Dock - Wasp | 2 | 80.0 | 100% | 800.0 | 800.0 | 0.0 | 0.0 | 2,784 | 16,800 | 2,064 | 48,656 | 10,280 | 9,252 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 5 | LCU | Landing Craft Utility | 1 | 80.0 | 100% | 400.0 | 400.0 | 0.0 | 0.0 | 7,328 | 45,812 | 1,396 | 21,844 | 2,056 | 1,850 | 0 | 0 | 0 | 0 | 0 | 0 |
| Humanitarian Assistance/ Disaster Relief Operations | 5 | 5 | LHA | Amphib. Assault Ship - Tarawa | 1 | 8.0 | 100% | 40.0 | 40.0 | 0.0 | 0.0 | 295 | 1,741 | 221 | 5,239 | 1,052 | 946 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 10 | LPD | Amphibious Transport Dock - Wasp | 2 | 8.0 | 100% | 80.0 | 80.0 | 0.0 | 0.0 | 278 | 1,680 | 206 | 4,866 | 1,028 | 925 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 5 | LCAC | Landing Craft Air Cushioned | 1 | 8.0 | 100% | 40.0 | 40.0 | 0.0 | 0.0 | 733 | 4,581 | 140 | 2,184 | 206 | 185 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unmanned Aerial Vehicle - Intelligence, Surveillance, and Reconaissance | 100 | | | | | | | | | | | | | | | | | | | | | | |

| Type Training | EMISSIONS/YEAR (lb) BY JURISDICTION | | | | | | | | | | | | GHG Emissions (lb) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Int Waters (> 12 nm) | | | | | | Total Emissions | | | | | | | | | | | |
| | CO | $NO_x$ | HC | $SO_x$ | $PM_{10}$ | PM2.5 | CO | $NO_x$ | HC | $SO_x$ | $PM_{10}$ | PM2.5 | Fuel Flow (GPH) | Annual Fuel Consumption (gal) | $CO_2$ | $N_2O$ | $CH_4$ | $CO_{2-e}$ |
| **ANTI-AIR WARFARE** | | | | | | | | | | | | | | | | | | |
| Air Combat Maneuver | | | | | | | | | | | | | | | | | | |
| Air Defense Exercise | | | | | | | | | | | | | | | | | | |
| Air Intercept Control | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-A (Medium Caliber) | | | | | | | | | | | | | | | | | | |
| Missile Exercise, A-A | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, S-A (Large Caliber) | 791 | 1,132 | 72 | 838 | 55 | 50 | 791 | 1,132 | 72 | 838 | 55 | 50 | 79 | 1,896 | 39,918 | 1 | 1 | 40,344 |
| Gunnery Exercise, S-A (Medium Caliber) | 1,713 | 2,452 | 156 | 1,816 | 120 | 108 | 1,713 | 2,452 | 156 | 1,816 | 120 | 108 | 79 | 4,108 | 86,490 | 3 | 2 | 87,411 |
| Missile Exercise, S-A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 79 | 0 | 0 | 0 | 0 | 0 |
| **STRIKE WARFARE** | | | | | | | | | | | | | | | | | | |
| Bombing Exercise, A-G | | | | | | | | | | | | | | | | | | |
| Missile Exercise, A-G | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-G | | | | | | | | | | | | | | | | | | |
| **AMPHIBIOUS WARFARE** | | | | | | | | | | | | | | | | | | |
| Fire Support Exercise - Land-Based target | 0 | 0 | 0 | 0 | 0 | 0 | 4,921 | 6,366 | 346 | 6,210 | 223 | 201 | 184 | 14,720 | 309,915 | 10 | 9 | 313,215 |
| Amphibious Rehearsal, No Landing - Marine Air Ground Task Force | 0 | 0 | 0 | 0 | 0 | 0 | 24,480 | 385,356 | 12,488 | 40,366 | 3,122 | 2,810 | 184 | 1,461,888 | 30,778,590 | 998 | 870 | 31,106,382 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 9,308 | 55,100 | 6,647 | 156,096 | 32,924 | 29,632 | 373 | 1,461,888 | 30,778,590 | 998 | 870 | 31,106,382 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 4,009 | 24,192 | 2,972 | 70,065 | 14,803 | 13,323 | 373 | 1,461,888 | 30,778,590 | 998 | 870 | 31,106,382 |
| Amphibious Assault - Marine Air Ground Task Force | 0 | 0 | 0 | 0 | 0 | 0 | 5,905 | 7,640 | 415 | 7,452 | 268 | 241 | 184 | 121,824 | 2,564,882 | 83 | 72 | 2,592,198 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 708 | 4,179 | 531 | 12,573 | 2,524 | 2,271 | 373 | 121,824 | 2,564,882 | 83 | 72 | 2,592,198 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 668 | 4,032 | 495 | 11,677 | 2,467 | 2,220 | 373 | 243,648 | 5,129,765 | 166 | 145 | 5,184,397 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 6,324 | 9,055 | 576 | 6,705 | 444 | 399 | 79 | 243,648 | 5,129,765 | 166 | 145 | 5,184,397 |
| Amphibious Raid - Special Purpose Marine Air Ground Task Force | 0 | 0 | 0 | 0 | 0 | 0 | 266 | 1,567 | 199 | 4,715 | 946 | 852 | 373 | 45,684 | 961,831 | 31 | 27 | 972,074 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 104 | 630 | 77 | 1,825 | 386 | 347 | 373 | 38,070 | 801,526 | 26 | 23 | 810,062 |
| Non-Combatant Evacuation Operation | 0 | 0 | 0 | 0 | 0 | 0 | 2,952 | 17,412 | 2,212 | 52,388 | 10,516 | 9,464 | 373 | 149,200 | 3,141,257 | 102 | 89 | 3,174,711 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 2,784 | 16,800 | 2,064 | 48,656 | 10,280 | 9,252 | 373 | 298,400 | 6,282,514 | 204 | 178 | 6,349,422 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 7,328 | 45,812 | 1,396 | 21,844 | 2,056 | 1,850 | 611 | 244,400 | 5,145,598 | 167 | 145 | 5,200,398 |
| Humanitarian Assistance/ Disaster Relief Operations | 0 | 0 | 0 | 0 | 0 | 0 | 295 | 1,741 | 221 | 5,239 | 1,052 | 946 | 373 | 50,760 | 1,068,701 | 35 | 30 | 1,080,083 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 278 | 1,680 | 206 | 4,866 | 1,028 | 925 | 373 | 101,520 | 2,137,402 | 69 | 60 | 2,160,165 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 733 | 4,581 | 140 | 2,184 | 206 | 185 | 611 | 50,760 | 1,068,701 | 35 | 30 | 1,080,083 |
| Unmanned Aerial Vehicle - Intelligence, Surveillance, and Reconaissance | | | | | | | | | | | | | | | | | | |

## Table D-8: Vessel Emissions – Alternative 1 (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-SURFACE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-S (Small Caliber) - Ship | 321 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-S (Medium Caliber) - Ship | 120 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise (A-S) - Rocket | 110 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise (A-S) | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Laser Targeting | 600 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bombing Exercise (A-S) | 37 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise (Submarine to Surface) | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise (S-S) | 19 | 38 | FFG | Guided Missile Frigate | 2.00 | 2.0 | 100% | 76.0 | 0.0 | 0.0 | 76.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,503 | 3,584 | 228 | 2,654 | 176 | 158 | 2,503 | 3,584 | 228 | 2,654 | 176 | 158 | 79 | 6,004 | 126,408 | 4 | 4 | 127,754 |
| Gunner Exercise (Surface-to-Surface) Ship - Large-caliber | 140 | 30.8 | CG | Cruiser | 0.22 | 2.5 | 100% | 77.00 | 0.0 | 21.6 | 55.4 | 0 | 0 | 0 | 0 | 0 | 0 | 1,326 | 1,716 | 93 | 1,674 | 60 | 54 | 3,410 | 4,412 | 240 | 4,304 | 155 | 139 | 4,736 | 6,128 | 333 | 5,978 | 215 | 193 | 184 | 14,168 | 298,293 | 10 | 8 | 301,470 |
| | | 63 | DDG | | 0.45 | 2.5 | 100% | 157.5 | 0.0 | 44.1 | 113.4 | 0 | 0 | 0 | 0 | 0 | 0 | 2,653 | 5,050 | 177 | 3,904 | 161 | 144 | 6,822 | 12,987 | 455 | 10,039 | 413 | 371 | 9,475 | 18,037 | 632 | 13,943 | 573 | 516 | 187 | 29,453 | 620,093 | 20 | 18 | 626,697 |
| | | 21 | FFG | Guided Missile Frigate | 0.15 | 2.5 | 100% | 52.5 | 0.0 | 14.7 | 37.8 | 0 | 0 | 0 | 0 | 0 | 0 | 484 | 693 | 44 | 513 | 34 | 31 | 1,245 | 1,783 | 113 | 1,320 | 87 | 79 | 1,729 | 2,476 | 158 | 1,833 | 121 | 109 | 79 | 4,148 | 87,321 | 3 | 2 | 88,251 |
| | | 16.8 | USCG | US Coast Guard | 0.12 | 2.5 | 100% | 42.0 | 0.0 | 11.8 | 30.2 | 0 | 0 | 0 | 0 | 0 | 0 | 68 | 681 | 10 | 136 | 2 | 2 | 174 | 1,751 | 27 | 349 | 6 | 6 | 241 | 2,432 | 37 | 485 | 9 | 8 | 66 | 2,772 | 58,362 | 2 | 2 | 58,983 |
| Gunner Exercise (Surface-to-Surface) Ship - Medium-caliber | 100 | 22 | CG | Cruiser | 0.22 | 2.5 | 100% | 55.00 | 0.0 | 15.4 | 39.6 | 0 | 0 | 0 | 0 | 0 | 0 | 947 | 1,226 | 67 | 1,196 | 43 | 39 | 2,436 | 3,151 | 171 | 3,074 | 110 | 99 | 3,383 | 4,377 | 238 | 4,270 | 153 | 138 | 184 | 10,120 | 213,066 | 7 | 6 | 215,336 |
| | | 45 | DDG | | 0.45 | 2.5 | 100% | 112.5 | 0.0 | 31.5 | 81.0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,895 | 3,607 | 126 | 2,789 | 115 | 103 | 4,873 | 9,276 | 325 | 7,171 | 295 | 265 | 6,768 | 12,884 | 451 | 9,960 | 410 | 369 | 187 | 21,038 | 442,924 | 14 | 13 | 447,641 |
| | | 15 | FFG | Guided Missile Frigate | 0.15 | 2.5 | 100% | 37.5 | 0.0 | 10.5 | 27.0 | 0 | 0 | 0 | 0 | 0 | 0 | 346 | 495 | 32 | 367 | 24 | 22 | 889 | 1,273 | 81 | 943 | 62 | 56 | 1,235 | 1,769 | 113 | 1,310 | 87 | 78 | 79 | 2,963 | 62,372 | 2 | 2 | 63,037 |
| | | 1 | LPD | Amphibious Transport Dock - Wasp | 0.01 | 2.5 | 100% | 2.5 | 0.0 | 0.7 | 1.8 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 15 | 2 | 43 | 9 | 8 | 6 | 38 | 5 | 109 | 23 | 21 | 9 | 53 | 6 | 152 | 32 | 29 | 373 | 933 | 19,633 | 1 | 1 | 19,842 |
| | | 12 | USCG | US Coast Guard | 0.12 | 2.5 | 100% | 30.0 | 0.0 | 8.4 | 21.6 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 486 | 7 | 97 | 2 | 2 | 124 | 1,251 | 19 | 249 | 5 | 4 | 172 | 1,737 | 26 | 347 | 6 | 6 | 66 | 1,980 | 41,687 | 1 | 1 | 42,131 |
| Sinking Exercise (SINKEX) | 21 | 105 | FFG | Guided Missile Frigate | 5.00 | 16.0 | 100% | 1680.0 | 0.0 | 0.0 | 1680.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 55,339 | 79,229 | 5,040 | 58,666 | 3,881 | 3,493 | 55,339 | 79,229 | 5,040 | 58,666 | 3,881 | 3,493 | 79 | 132,720 | 2,794,287 | 91 | 79 | 2,824,046 |
| Gunnery Exercise (S-S) Boat - Medium-caliber | 20 | 100 | FFG | Guided Missile Frigate | 5.00 | 3.0 | 100% | 300.0 | 0.0 | 0.0 | 300.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9,882 | 14,148 | 900 | 10,476 | 693 | 624 | 9,882 | 14,148 | 900 | 10,476 | 693 | 624 | 79 | 23,700 | 498,980 | 16 | 14 | 504,294 |
| Gunnery Exercise (S-S) Small-caliber | 43 | 86 | CRRC | Combat Rubber Raiding Craft | 2 | 3.0 | 100% | 258.0 | 0.0 | 0.0 | 258.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 38 | 3,329 | 0 | 0 | 0 | 0 | 38 | 3,329 | 0 | 0 | 0 | 3 | 774 | 16,296 | 1 | 0 | 16,463 |
| Maritime Security Operations (MSO) | 40 | 40 | FFG | Guided Missile Frigate | 1 | 8.0 | 100% | 320.0 | 0.0 | 0.0 | 320.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10,541 | 15,091 | 960 | 11,174 | 739 | 665 | 10,541 | 15,091 | 960 | 11,174 | 739 | 665 | 79 | 25,280 | 532,245 | 17 | 15 | 537,314 |
| | | 40 | RHIB | Rigid Hulled Inflatable Boat | 1 | 8.0 | 100% | 320.0 | 0.0 | 0.0 | 320.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 108.8 | 2324.8 | 19.2 | 460.8 | 48.0 | 43 | 109 | 2,325 | 19 | 461 | 48 | 43 | 14 | 4,480 | 94,322 | 3 | 3 | 95,326 |
| | | 40 | CRRC | Combat Rubber Raiding Craft | 1 | 8.0 | 100% | 320.0 | 0.0 | 0.0 | 320.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 4,128 | 0 | 0 | 0 | 0 | 48 | 4,128 | 0 | 0 | 0 | 3 | 960 | 20,212 | 1 | 1 | 20,427 |

## Table D-8: Vessel Emissions – Alternative 1 (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-SUBMARINE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise-Helo | 65 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise-Helo | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise-Maritime Patrol Advanced Extended Echo Ranging Sonobuoys | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise -Maritime Patrol Aircraft | 36 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise-Maritime Patrol Aircraft | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise -Surface | 91 | 91 | FFG | Guided Missile Frigate | 1 | 2.0 | 100% | 182.0 | 0.0 | 91.0 | 91.0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,998 | 4,292 | 273 | 3,178 | 210 | 189 | 2,998 | 4,292 | 273 | 3,178 | 210 | 189 | 5,995 | 8,583 | 546 | 6,355 | 420 | 378 | 79 | 14,378 | 302,714 | 10 | 9 | 305,938 |
| Torpedo Exercise-Surface | 4 | 4 | FFG | Guided Missile Frigate | 1 | 2.0 | 100% | 8.0 | 0.0 | 4.0 | 4.0 | 0 | 0 | 0 | 0 | 0 | 0 | 132 | 189 | 12 | 140 | 9 | 8 | 132 | 189 | 12 | 140 | 9 | 8 | 264 | 377 | 24 | 279 | 18 | 17 | 79 | 632 | 13,306 | 0 | 0 | 13,448 |
| Tracking Exercise- Submarine | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise - Submarine | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Small Joint Coordinated ASW exercise (Multi-Sail/GUAMEX) | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **MAJOR TRAINING EVENTS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Joint Expeditionary Exercise | 1 | 1.0 | CVN | Nuclear Carrier (No emissions) | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1.0 | CG | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 4,921 | 6,366 | 346 | 6,210 | 223 | 201 | 0 | 0 | 0 | 0 | 0 | 0 | 4,921 | 6,366 | 346 | 6,210 | 223 | 201 | 184 | 14,720 | 309,915 | 10 | 9 | 313,215 |
| | | 2.0 | FFG | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,270 | 7,546 | 480 | 5,587 | 370 | 333 | 0 | 0 | 0 | 0 | 0 | 0 | 5,270 | 7,546 | 480 | 5,587 | 370 | 333 | 79 | 12,640 | 266,123 | 9 | 8 | 268,957 |
| | | 5.0 | DDG | | 5 | 80.0 | 100% | 400.0 | 0.0 | 400.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 24,064 | 45,808 | 1,604 | 35,412 | 1,456 | 1,310 | 0 | 0 | 0 | 0 | 0 | 0 | 24,064 | 45,808 | 1,604 | 35,412 | 1,456 | 1,310 | 187 | 74,800 | 1,574,839 | 51 | 45 | 1,591,611 |
| | | 1.0 | LHD/LHA | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 590 | 3,482 | 442 | 10,478 | 2,103 | 1,893 | 0 | 0 | 0 | 0 | 0 | 0 | 590 | 3,482 | 442 | 10,478 | 2,103 | 1,893 | 373 | 29,840 | 628,251 | 20 | 18 | 634,942 |
| | | 2.0 | LSD | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,293 | 7,653 | 923 | 21,680 | 4,573 | 4,116 | 0 | 0 | 0 | 0 | 0 | 0 | 1,293 | 7,653 | 923 | 21,680 | 4,573 | 4,116 | 373 | 59,680 | 1,256,503 | 41 | 36 | 1,269,884 |
| | | 1.0 | LPD | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 278 | 1,680 | 206 | 4,866 | 1,028 | 925 | 0 | 0 | 0 | 0 | 0 | 0 | 278 | 1,680 | 206 | 4,866 | 1,028 | 925 | 373 | 29,840 | 628,251 | 20 | 18 | 634,942 |
| | | 1.0 | TAOE | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 8,781 | 24,905 | 848 | 9,599 | 833 | 750 | 0 | 0 | 0 | 0 | 0 | 0 | 8,781 | 24,905 | 848 | 9,599 | 833 | 750 | 1,865 | 149,200 | 3,141,257 | 102 | 89 | 3,174,711 |
| | | 1.0 | SSN | Nuclear Carrier (No emissions) | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1.0 | SSGN | Nuclear Carrier (No emissions) | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 2.0 | T-AGO(LFA) | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,067 | 6,299 | 800 | 19,109 | 3,803 | 3,423 | 0 | 0 | 0 | 0 | 0 | 0 | 1,067 | 6,299 | 800 | 19,109 | 3,803 | 3,423 | 1,865 | 298,400 | 6,282,514 | 204 | 178 | 6,343,422 |
| | | 1.0 | CG-PARTNER | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 8,623 | 3,768 | 792 | 1,680 | 208 | 187 | 0 | 0 | 0 | 0 | 0 | 0 | 8,623 | 3,768 | 792 | 1,680 | 208 | 187 | 184 | 14,720 | 309,915 | 10 | 9 | 313,215 |
| | | 2.0 | DDG-PARTNER | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 16,638 | 7,984 | 1,440 | 2,864 | 400 | 360 | 0 | 0 | 0 | 0 | 0 | 0 | 16,638 | 7,984 | 1,440 | 2,864 | 400 | 360 | 187 | 29,920 | 629,936 | 20 | 18 | 636,644 |
| | | 1.0 | SS-PARTNER | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 235 | 1,386 | 176 | 4,169 | 837 | 753 | 0 | 0 | 0 | 0 | 0 | 0 | 235 | 1,386 | 176 | 4,169 | 837 | 753 | 373 | 29,840 | 628,251 | 20 | 18 | 634,942 |
| | | 5.0 | LCAC | | 5 | 80.0 | 100% | 400.0 | 0.0 | 400.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,328 | 45,812 | 1,396 | 21,844 | 2,056 | 1,850 | 0 | 0 | 0 | 0 | 0 | 0 | 7,328 | 45,812 | 1,396 | 21,844 | 2,056 | 1,850 | 611 | 507,600 | 10,687,010 | 347 | 302 | 10,800,827 |
| | | 2.0 | LCU | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,931 | 18,325 | 558 | 8,738 | 822 | 740 | 0 | 0 | 0 | 0 | 0 | 0 | 2,931 | 18,325 | 558 | 8,738 | 822 | 740 | 611 | 97,760 | 2,058,239 | 67 | 58 | 2,080,159 |
| | | 19.0 | CRRC | | 19 | 80.0 | 100% | 1520.0 | 0.0 | 1520.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 226 | 19,610 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 226 | 19,610 | 0 | 0 | 0 | 3 | 4,560 | 96,006 | 3 | 3 | 97,029 |
| | | 2.0 | RHIB | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 1,462 | 10 | 230 | 24 | 22 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 1,462 | 10 | 230 | 24 | 22 | 373 | 59,680 | 1,256,503 | 41 | 36 | 1,269,884 |
| | | 14.0 | AAV | | 14 | 80.0 | 100% | 1120.0 | 0.0 | 1120.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 851 | 6,966 | 318 | 1,400 | 231 | 262 | 0 | 0 | 0 | 0 | 0 | 0 | 851 | 6,966 | 318 | 1,400 | 231 | 262 | 3 | 3,360 | 70,741 | 2 | 2 | 71,495 |
| Joint Multi-Strike Group Exercise | 1 | 3.0 | CVN | | 3 | 80.0 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 3.0 | CG | | 3 | 80.0 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14,762 | 19,099 | 1,037 | 18,631 | 670 | 603 | 14,762 | 19,099 | 1,037 | 18,631 | 670 | 603 | 184 | 44,160 | 929,745 | 30 | 26 | 939,646 |
| | | 3.0 | FFG | | 3 | 80.0 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,906 | 11,318 | 720 | 8,381 | 554 | 499 | 7,906 | 11,318 | 720 | 8,381 | 554 | 499 | 79 | 18,960 | 399,184 | 13 | 11 | 403,435 |
| | | 12.0 | DDG | | 12 | 80.0 | 100% | 960.0 | 0.0 | 0.0 | 960.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 57,754 | 109,939 | 3,850 | 84,989 | 3,494 | 3,145 | 57,754 | 109,939 | 3,850 | 84,989 | 3,494 | 3,145 | 187 | 179,520 | 3,779,614 | 123 | 107 | 3,819,867 |
| | | 3.0 | TAOE | | 3 | 80.0 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26,342 | 74,714 | 2,544 | 28,798 | 2,498 | 2,249 | 26,342 | 74,714 | 2,544 | 28,798 | 2,498 | 2,249 | 1,865 | 447,600 | 9,423,770 | 306 | 266 | 9,524,134 |
| | | 5.0 | SSN | | 5 | 80.0 | 100% | 400.0 | 0.0 | 0.0 | 400.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 2.0 | T-AGO(LFA) | | 2 | 80.0 | 100% | 160.0 | 0.0 | 0.0 | 160.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,067 | 6,299 | 800 | 19,109 | 3,803 | 3,423 | 1,067 | 6,299 | 800 | 19,109 | 3,803 | 3,423 | 1,865 | 298,400 | 6,282,514 | 204 | 178 | 6,343,422 |
| | | 1.0 | SS-PARTNER | | 1 | 80.0 | 100% | 80.0 | 0.0 | 0.0 | 80.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 235 | 1,386 | 176 | 4,169 | 837 | 753 | 235 | 1,386 | 176 | 4,169 | 837 | 753 | 373 | 29,840 | 628,251 | 20 | 18 | 634,942 |
| Marine Air Ground Task Force Exercise (Amphibious) | 4 | 4.0 | LHD/LHA | | 1 | 80.0 | 100% | 320.0 | 320.0 | 0.0 | 0.0 | 2,362 | 13,930 | 1,770 | 41,910 | 8,413 | 7,572 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,362 | 13,930 | 1,770 | 41,910 | 8,413 | 7,572 | 373 | 119,360 | 2,513,005 | 82 | 71 | 2,539,769 |
| | | 4.0 | LSD | | 1 | 80.0 | 100% | 320.0 | 320.0 | 0.0 | 0.0 | 2,586 | 15,306 | 1,846 | 43,360 | 9,146 | 8,231 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,586 | 15,306 | 1,846 | 43,360 | 9,146 | 8,231 | 373 | 119,360 | 2,513,005 | 82 | 71 | 2,539,769 |
| | | 4.0 | LPD | | 1 | 80.0 | 100% | 320.0 | 320.0 | 0.0 | 0.0 | 1,114 | 6,720 | 826 | 19,462 | 4,112 | 3,701 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,114 | 6,720 | 826 | 19,462 | 4,112 | 3,701 | 373 | 119,360 | 2,513,005 | 82 | 71 | 2,539,769 |
| Special Purpose Marine Air Ground Task Force Exercise | 2 | 2.0 | LHA | Amphib. Assault Ship - Tarawa | 1 | 80.0 | 100% | 160.0 | 52.8 | 52.8 | 54.4 | 390 | 2,298 | 292 | 6,915 | 1,388 | 1,249 | 390 | 2,298 | 292 | 6,915 | 1,388 | 1,249 | 401 | 2,368 | 301 | 7,125 | 1,430 | 1,287 | 1,181 | 6,965 | 885 | 20,955 | 4,206 | 3,786 | 373 | 59,680 | 1,256,503 | 41 | 36 | 1,269,884 |
| | | 4.0 | LPD | Amphibious Transport Dock - Wasp | 2 | 80.0 | 100% | 320.0 | 105.6 | 105.6 | 108.8 | 367 | 2,218 | 272 | 6,423 | 1,357 | 1,221 | 367 | 2,218 | 272 | 6,423 | 1,357 | 1,221 | 379 | 2,285 | 281 | 6,617 | 1,398 | 1,258 | 1,114 | 6,720 | 826 | 19,462 | 4,112 | 3,701 | 373 | 119,360 | 2,513,005 | 82 | 71 | 2,539,769 |

## Table D-8: Vessel Emissions – Alternative 1 (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ELECTRONIC WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Electronic Warfare Operations | 522 | 522 | FFG | Guided Missile Frigate | 1 | 4 | 100% | 2088.0 | 0.0 | 0.0 | 2088.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 68,779 | 98,470 | 6,264 | 72,913 | 4,823 | 4,341 | 68,779 | 98,470 | 6,264 | 72,913 | 4,823 | 4,341 | 79 | 164,952 | 3,472,899 | 113 | 98 | 3,509,886 |
| Flare Exercise | 2200 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chaff Exercise - Ship | 41 | 41 | FFG | Guided Missile Frigate | 1 | 4 | 100% | 164.0 | 0.0 | 0.0 | 164.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,402 | 7,734 | 492 | 5,727 | 379 | 341 | 5,402 | 7,734 | 492 | 5,727 | 379 | 341 | 79 | 12,956 | 272,776 | 9 | 8 | 275,681 |
| Chaff Exercise - Aircraft | 2200 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **MINE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Civilian Port Defense | 1 | 1 | RHIB | Rigid Hulled Inflatable Boat | 1 | 24.0 | 100% | 24.0 | 24.0 | 0.0 | 0.0 | 8.2 | 219.4 | 1.4 | 34.6 | 3.6 | 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 8 | 219 | 1 | 35 | 4 | 3 | 14 | 336 | 7,074 | 0 | 0 | 7,149 |
| Mine Laying - Aircraft | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mine Neutralization - Explosive Ordnance Disposal | 20 | 60 | RHIB | Rigid Hulled Inflatable Boat | 3 | 12.0 | 100% | 720.0 | 720.0 | 0.0 | 0.0 | 244.8 | 6580.8 | 43.2 | 1036.8 | 108.0 | 37 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 245 | 6,581 | 43 | 1,037 | 108 | 37 | 14 | 10,080 | 212,224 | 7 | 6 | 214,485 |
| Limpet Mine Neutralization System/Shock Wave Generator | 60 | 60 | RHIB | Rigid Hulled Inflatable Boat | 1 | 4.0 | 100% | 240.0 | 240.0 | 0.0 | 0.0 | 81.6 | 2193.6 | 14.4 | 345.6 | 36.0 | 32 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 82 | 2,194 | 14 | 346 | 36 | 32 | 14 | 3,360 | 70,741 | 2 | 2 | 71,495 |
| Airborne Mine Countermeasure - Mine Detection | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mine Countermeasure Exercise - Towed Sonar (AQS-20,LCS) | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mine Countermeasure Exercise - Surface (SMCMEX) Sonar (SQQ-32, MCM) | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mine Neutralization - Remotely Operated Vehicle Soanr (ASQ-235 [AQS-20], SLQ-48) | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mine Countermeasure - Towed Mine Detection | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Underwater Demolition Qualification/Certification | 45 | 45 | CRRC | Combat Rubber Raiding Craft | 1 | 8.0 | 100% | 360.0 | 0.0 | 360.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 53 | 4,645 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 53 | 4,645 | 0 | 0 | 0 | 3 | 1,080 | 22,738 | 1 | 1 | 22,980 |
| Submarine Mine Exercise | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **NAVAL SPECIAL WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Personnel I&E | 365 | 1825 | RHIB | Rigid Hulled Inflatable Boat | 5 | 8.0 | 100% | 14600.0 | 14600.0 | 0.0 | 0.0 | 4964.0 | ###### | 876.0 | 21024.0 | 2190.0 | 1,971 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 4,964 | 133,444 | 876 | 21,024 | 2,190 | 1,971 | 48 | 700,800 | 14,754,643 | 479 | 417 | 14,911,780 |
| | | 2190 | CRRC | Combat Rubber Raiding Craft | 6 | 8.0 | 100% | 17520.0 | 17520.0 | 0.0 | 0.0 | 0 | 2,603 | 226,033 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,603 | 226,033 | 0 | 0 | 0 | 3 | 52,560 | 1,106,598 | 36 | 31 | 1,118,384 |
| Parachute Insertion | 64 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Embassy Reinforcement | 0 | 0 | LCAC | Landing Craft Air Cushioned | 1 | 24.0 | 100% | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 611 | 0 | 0 | 0 | 0 | 0 |
| Underwater Demolition Qualifications | 0 | 0 | CRRC | Combat Rubber Raiding Craft | 1 | 8.0 | 100% | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| Intelligence, Surveillance, Reconnaissance | 44 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Urban Warfare Training | 0 | 0.0 | LHA | Amphib. Assault Ship - Tarawa | 1 | 40.0 | 100% | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 373 | 0 | 0 | 0 | 0 | 0 |
| | | 0.0 | LPD | Amphibious Transport Dock - Wasp | 2 | 40.0 | 100% | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 373 | 0 | 0 | 0 | 0 | 0 |

## Table D-8: Vessel Emissions – Alternative 1 (continued)

| OTHER | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direct Action (Tactical Air Control Party) | 30 | | | | | | | | | | | | | | | | | | | | | | |
| Intelligence, Surveillance, Reconnaissanc | 44 | | | | | | | | | | | | | | | | | | | | | | |
| Surface Ship Sonar Maintenance | 44 | 44 | FFG | Guided Missile Frigate | 1 | 4.0 | 100% | 176.0 | 176.0 | 0.0 | 0.0 | 5,797 | 8,300 | 528 | 6,146 | 407 | 366 | 0 | 0 | 0 | 0 | 0 | 0 |
| Submarine Sonar Maintenance | 32 | | | | | | | | | | | | | | | | | | | | | | |
| Small Boat Attack | 18 | 18 | CRRC | Combat Rubber Raiding Craft | 1 | 4.0 | 100% | 72.0 | 0.0 | 72.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 929 | 0 | 0 | 0 |
| Sub Navigation / Sub Nav Under Ice | 8 | | | | | | | | | | | | | | | | | | | | | | |
| Precision Anchoring | 18 | 18 | FFG | Guided Missile Frigate | 1 | 4.0 | 100% | 72.0 | 72.0 | 0.0 | 0.0 | 2,372 | 3,396 | 216 | 2,514 | 166 | 150 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unmanned Aerial Vehicle Operation | 350 | | | | | | | | | | | | | | | | | | | | | | |
| Search and Rescue At Sea | 45 | | | | | | | | | | | | | | | | | | | | | | |
| Underwater Survey | 32 | 96 | RHIB | Rigid Hulled Inflatable Boat | 3 | 8.0 | 100% | 768.0 | 768.0 | 0.0 | 0.0 | 261.1 | 7019.5 | 46.1 | 1105.9 | 115.2 | 104 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 |
| | | 96 | CRRC | Combat Rubber Raiding Craft | 3 | 8.0 | 100% | 768.0 | 768.0 | 0.0 | 0.0 | 0 | 114 | 3,908 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unmanned Underwater Vehicle Training | 64 | | | | | | | | | | | | | | | | | | | | | | |
| **TOTAL TRAINING (lbs per year)** | | | | | | | | | **41,944** | **###** | **###** | **91,611** | **790,484** | **273,658** | **603,139** | **110,685** | **99,617** | **94,583** | **212,698** | **37,531** | **181,238** | **22,441** | **20,197** |
| **TOTAL TRAINING (tons per year)** | | | | | | | | | | | | **46** | **395** | **137** | **302** | **55** | **50** | **47** | **106** | **19** | **91** | **11** | **10** |

| OTHER | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direct Action (Tactical Air Control Party) | | | | | | | | | | | | | | | | | | |
| Intelligence, Surveillance, Reconnaissanc | | | | | | | | | | | | | | | | | | |
| Surface Ship Sonar Maintenance | 0 | 0 | 0 | 0 | 0 | 0 | 5,797 | 8,300 | 528 | 6,146 | 407 | 366 | 79 | 13,904 | 292,735 | 9 | 8 | 295,852 |
| Submarine Sonar Maintenance | | | | | | | | | | | | | | | | | | |
| Small Boat Attack | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 929 | 0 | 0 | 0 | 3 | 216 | 4,548 | 0 | 0 | 4,596 |
| Sub Navigation / Sub Nav Under Ice | | | | | | | | | | | | | | | | | | |
| Precision Anchoring | 0 | 0 | 0 | 0 | 0 | 0 | 2,372 | 3,396 | 216 | 2,514 | 166 | 150 | 79 | 5,688 | 119,755 | 4 | 3 | 121,031 |
| Unmanned Aerial Vehicle Operation | | | | | | | | | | | | | | | | | | |
| Search and Rescue At Sea | | | | | | | | | | | | | | | | | | |
| Underwater Survey | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 261 | 7,020 | 46 | 1,106 | 115 | 104 | 48 | 36,864 | 776,135 | 25 | 22 | 784,400 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 114 | 3,908 | 0 | 0 | 0 | 3 | 2,304 | 48,508 | 2 | 1 | 49,025 |
| Unmanned Underwater Vehicle Training | | | | | | | | | | | | | | | | | | |
| **TOTAL TRAINING (lbs per year)** | **287,014** | **492,662** | **33,016** | **373,419** | **26,975** | **24,278** | **473,208** | **1,495,844** | **344,205** | **1,157,796** | **160,102** | **144,092** | | **10,389,887** | **218,748,670** | **7,096** | **6,182** | **221,078,343** |
| **TOTAL TRAINING (tons per year)** | **144** | **246** | **17** | **187** | **13** | **12** | **237** | **748** | **172** | **579** | **80** | **72** | | | **109,374** | **4** | **3** | **110,539** |

## Table D-9: Aircraft Emissions – Alternative 1

**OPERATIONAL INFORMATION – AIRCRAFT**

| Type Training | Training Ops (#) | Aircraft: Distribution | Aircraft: A/C Sorties (#) | Aircraft: Type | Time: Ave Time on Range (hr) | Time: Total Time on Range (hr) | Altitude: Time < 3,000 ft (%) | Altitude: Time < 3,000 ft (hr) | Distribution (%): 0-3 nm from shore | Distribution (%): 3-12 nm from Shore | Distribution (%): > 12 nm from Shore | Distribution (hr): Total Time 0-3 nm from shore | Distribution (hr): Total Time 3-12 nm from shore | Distribution (hr): Total Time > 12 nm from shore |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-AIR WARFARE** | | | | | | | | | | | | | | |
| Air Combat Maneuver | 3600 | 1 | 3600 | FA-18E/F | 1.0 | 3600.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| | | 1 | 3600 | AV-8B | 1.0 | 3600.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| Air Defense Exercise | 100 | 2 | 200 | FA-18E/F | 1.0 | 200.0 | 50% | 100.0 | 0% | 0% | 100% | 0.00 | 0.00 | 100.00 |
| Air Intercept Control | 5300 | 2 | 10600 | FA-18E/F | 1.0 | 10600.0 | 50% | 5300.0 | 0% | 0% | 100% | 0.00 | 0.00 | 5300.00 |
| Gunnery Exercise, A-A (Medium Caliber) | 36 | 1 | 36 | AV-8B | 1.0 | 36.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| | | 1 | 36 | FA-18E/F | 1.0 | 36.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| Missile Exercise, A-A | 18 | 1 | 18 | AV-8B | 1.0 | 18.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| | | 1 | 18 | FA-18E/F | 1.0 | 18.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| Gunnery Exercise, S-A (Large Caliber) | 6 | | | | | | | | | | | | | |
| Gunnery Exercise, S-A (Medium Caliber) | 13 | | | | | | | | | | | | | |
| Missile Exercise, S-A | 18 | | | | | | | | | | | | | |
| **STRIKE WARFARE** | | | | | | | | | | | | | | |
| Bombing Exercise, A-G | 2300 | 1 | 2300 | FA-18E/F | 1.0 | 2300.0 | 10% | 230.0 | 0% | 0% | 100% | 0.00 | 0.00 | 230.00 |
| Missile Exercise, A-G | 115 | 0.5 | 58 | FA-18E/F | 2.0 | 115.0 | 10% | 11.5 | 0% | 0% | 100% | 0.00 | 0.00 | 11.50 |
| | | 0.5 | 58 | SH-60B | 2.0 | 115.0 | 100% | 115.0 | 0% | 0% | 100% | 0.00 | 0.00 | 115.00 |
| Gunnery Exercise, A-G | 36 | 0.5 | 48 | FA-18E/F | 2.0 | 36.0 | 10% | 3.6 | 0% | 0% | 100% | 0.00 | 0.00 | 3.60 |
| | | 0.5 | 48 | SH-60B | 2.0 | 36.0 | 100% | 36.0 | 0% | 0% | 100% | 0.00 | 0.00 | 36.00 |

**EMISSIONS/YEAR (lb) BY JURISDICTION**

| Type Training | State (0-3 nm offshore): CO | $NO_x$ | HC | $SO_x$ | PM | $PM_{2.5}$ | Waters of U S (3-12 nm): CO | $NO_x$ | HC | $SO_x$ | PM | $PM_{2.5}$ | Int Waters (> 12 nm): CO | $NO_x$ | HC | $SO_x$ | PM | $PM_{2.5}$ | Total Emissions: CO | $NO_x$ | HC | $SO_x$ | PM | $PM_{2.5}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-AIR WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | |
| Air Combat Maneuver | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Air Defense Exercise | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 744 | 15249 | 124 | 414 | 6782 | 6104 | 744 | 15249 | 124 | 414 | 6782 | 6104 |
| Air Intercept Control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39450 | 808173 | 6575 | 21917 | 359432 | 323488 | 39450 | 808173 | 6575 | 21917 | 359432 | 323488 |
| Gunnery Exercise, A-A (Medium Caliber) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Missile Exercise, A-A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gunnery Exercise, S-A (Large Caliber) | | | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, S-A (Medium Caliber) | | | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise, S-A | | | | | | | | | | | | | | | | | | | | | | | | |
| **STRIKE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | |
| Bombing Exercise, A-G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1712 | 35072 | 285 | 951 | 15598 | 14038 | 1712 | 35072 | 285 | 951 | 15598 | 14038 |
| Missile Exercise, A-G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 86 | 1754 | 14 | 48 | 780 | 702 | 86 | 1754 | 14 | 48 | 780 | 702 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 863 | 883 | 76 | 55 | 580 | 522 | 863 | 883 | 76 | 55 | 580 | 522 |
| Gunnery Exercise, A-G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 71 | 1464 | 12 | 40 | 651 | 586 | 71 | 1464 | 12 | 40 | 651 | 586 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 720 | 737 | 63 | 46 | 484 | 435 | 720 | 737 | 63 | 46 | 484 | 435 |

| Type Training | Training Platform Information: Engine Model | Engines (#) | Fuel Flow (lb/hr) | Annual Fuel Use (total): Pounds | Gallons | GHG Emissions (lb): $CO_2$ | $N_2O$ | $CH_4$ | $CO_{2-e}$ |
|---|---|---|---|---|---|---|---|---|---|
| **ANTI-AIR WARFARE** | | | | | | | | | |
| Air Combat Maneuver | F414-GE | 2 | 10,338 | 37216800 | 5473059 | 115229780 | 3738 | 3256 | 116,456,377 |
| | F402-RF | 1 | 6,000 | 21600000 | 3176471 | 66877412 | 2170 | 1890 | 67,589,656 |
| Air Defense Exercise | F414-GE | 2 | 10,338 | 2067600 | 304059 | 6401654 | 208 | 181 | 6,469,832 |
| Air Intercept Control | F414-GE | 2 | 10,338 | 1.1E+08 | 16115118 | 339287687 | 11007 | 9588 | 342,901,039 |
| Gunnery Exercise, A-A (Medium Caliber) | F402-RF | 1 | 6,000 | 216000 | 31765 | 668774 | 22 | 19 | 675,897 |
| | F414-GE | 2 | 10,338 | 372168 | 54731 | 1152298 | 37 | 33 | 1,164,570 |
| Missile Exercise, A-A | F402-RF | 1 | 6,000 | 108000 | 15882 | 334387 | 11 | 9 | 337,948 |
| | F414-GE | 2 | 10,338 | 186084 | 27365 | 576149 | 19 | 16 | 582,285 |
| Gunnery Exercise, S-A (Large Caliber) | | | | | | | | | |
| Gunnery Exercise, S-A (Medium Caliber) | | | | | | | | | |
| Missile Exercise, S-A | | | | | | | | | |
| **STRIKE WARFARE** | | | | | | | | | |
| Bombing Exercise, A-G | F414-GE | 2 | 10,338 | 23777400 | 3496676 | 73619026 | 2388 | 2081 | 74,403,069 |
| Missile Exercise, A-G | F414-GE | 2 | 10,338 | 1188870 | 174834 | 3680951 | 119 | 104 | 3,720,153 |
| | T700-GE | 2 | 1200 | 138000 | 20294 | 427272 | 14 | 12 | 431,823 |
| Gunnery Exercise, A-G | F414-GE | 2 | 10,338 | 992448 | 145948 | 3072734 | 100 | 87 | 3,105,513 |
| | T700-GE | 2 | 1200 | 115200 | 16941 | 356680 | 12 | 10 | 360,478 |

## Table D-9: Aircraft Emissions – Alternative 1 (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **AMPHIBIOUS WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fire Support Exercise - Land-Based target | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Amphibious Rehearsal, No Landing – Marine Air Ground Task Force | 12 | 4 | 48.0 | CH-53 | 18.0 | 864.0 | 100% | 864.0 | 100% | 0% | 0% | 864.00 | 0.00 | 0.00 | 8215 | 31164 | 579 | 1543 | 8524 | 7671 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8215 | 31164 | 579 | 1543 | 8524 | 7671 | T64-GE- | 3 | 4,464 | 3856896 | 567191 | 11941631 | 387 | 337 | 12,066,809 |
| | | 10 | 120.0 | MV-22 | 18.0 | 2160.0 | 100% | 2160.0 | 100% | 0% | 0% | 2160.00 | 0.00 | 0.00 | 47755 | 9532 | 8298 | 968 | 4306 | 3876 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 47755 | 9532 | 8298 | 968 | 4306 | 3876 | | 2 | 2240 | 4838400 | 711529 | 14980540 | 486 | 423 | 15,140,083 |
| | | 2 | 24.0 | UH-1 | 18.0 | 432.0 | 100% | 432.0 | 100% | 0% | 0% | 432.00 | 0.00 | 0.00 | 779 | 1101 | 40 | 93 | 980 | 882 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 779 | 1101 | 40 | 93 | 980 | 882 | T400-CF | 2 | 540 | 233280 | 34306 | 722276 | 23 | 20 | 729,968 |
| | | 4 | 48.0 | AH-1 | 18.0 | 864.0 | 100% | 864.0 | 100% | 0% | 0% | 864.00 | 0.00 | 0.00 | 7865 | 3817 | 400 | 281 | 2947 | 2652 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7865 | 3817 | 400 | 281 | 2947 | 2652 | T700-GE | 2 | 812 | 701568 | 103172 | 2172178 | 70 | 61 | 2,195,312 |
| | | 4 | 48.0 | AV-8 | 18.0 | 864.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RF | 1 | 6,000 | 5184000 | 762353 | 16050579 | 521 | 454 | 16,221,517 |
| Amphibious Assault - Marine Air Ground Task Force | 12 | 4 | 48.0 | CH-53 | 18.0 | 864.0 | 100% | 864.0 | 100% | 0% | 0% | 864.00 | 0.00 | 0.00 | 8215 | 31164 | 579 | 1543 | 8524 | 7671 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8215 | 31164 | 579 | 1543 | 8524 | 7671 | T64-GE- | 3 | 4,464 | 3856896 | 567191 | 11941631 | 387 | 337 | 12,066,809 |
| | | 10 | 120.0 | MV-22 | 18.0 | 2160.0 | 100% | 2160.0 | 100% | 0% | 0% | 2160.00 | 0.00 | 0.00 | 47755 | 9532 | 8298 | 968 | 4306 | 3876 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 47755 | 9532 | 8298 | 968 | 4306 | 3876 | | 2 | 2240 | 4838400 | 711529 | 14980540 | 486 | 423 | 15,140,083 |
| | | 2 | 24.0 | UH-1 | 18.0 | 432.0 | 100% | 432.0 | 100% | 0% | 0% | 432.00 | 0.00 | 0.00 | 779 | 1101 | 40 | 93 | 980 | 882 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 779 | 1101 | 40 | 93 | 980 | 882 | T400-CF | 2 | 540 | 233280 | 34306 | 722276 | 23 | 20 | 729,968 |
| | | 4 | 48.0 | AH-1 | 18.0 | 864.0 | 100% | 864.0 | 100% | 0% | 0% | 864.00 | 0.00 | 0.00 | 7865 | 3817 | 400 | 281 | 2947 | 2652 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7865 | 3817 | 400 | 281 | 2947 | 2652 | T700-GE | 2 | 812 | 701568 | 103172 | 2172178 | 70 | 61 | 2,195,312 |
| | | 4 | 48.0 | AV-8 | 18.0 | 864.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RF | 1 | 6,000 | 5184000 | 762353 | 16050579 | 521 | 454 | 16,221,517 |
| Amphibious Raid - Special Purpose Marine Air Ground Task Force | 6 | 4 | 24.0 | H-53 | 12.0 | 288.0 | 100% | 288.0 | 100% | 0% | 0% | 288.00 | 0.00 | 0.00 | 2738 | 10388 | 193 | 514 | 2841 | 2557 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2738 | 10388 | 193 | 514 | 2841 | 2557 | T64-GE- | 3 | 4,464 | 1285632 | 189064 | 3980544 | 129 | 112 | 4,022,936 |
| | | 10 | 60.0 | MV-22 | 12.0 | 720.0 | 100% | 720.0 | 100% | 0% | 0% | 720.00 | 0.00 | 0.00 | 15918 | 3177 | 2766 | 323 | 1435 | 1292 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15918 | 3177 | 2766 | 323 | 1435 | 1292 | | 2 | 2240 | 1612800 | 237176 | 4993513 | 162 | 141 | 5,046,694 |
| | | 2 | 12.0 | UH-1 | 12.0 | 144.0 | 100% | 144.0 | 100% | 0% | 0% | 144.00 | 0.00 | 0.00 | 260 | 367 | 13 | 31 | 327 | 294 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 260 | 367 | 13 | 31 | 327 | 294 | T400-CF | 2 | 540 | 77760 | 11435 | 240759 | 8 | 7 | 243,323 |
| | | 4 | 24.0 | AH-1 | 12.0 | 288.0 | 100% | 288.0 | 100% | 0% | 0% | 288.00 | 0.00 | 0.00 | 2622 | 1272 | 133 | 94 | 982 | 884 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2622 | 1272 | 133 | 94 | 982 | 884 | T700-GE | 2 | 812 | 233856 | 34391 | 724059 | 23 | 20 | 731,771 |
| | | 4 | 24.0 | AV-8 | 12.0 | 288.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RF | 1 | 6,000 | 1728000 | 254118 | 5350193 | 174 | 151 | 5,407,172 |
| Non-Combatant Evacuation Operation | 5 | 10 | 50 | MV-22 | 20.0 | 1000.0 | 100% | 1000.0 | 100% | 0% | 0% | 1000.00 | 0.00 | 0.00 | 22109 | 4413 | 3842 | 448 | 1994 | 1794 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22109 | 4413 | 3842 | 448 | 1994 | 1794 | | 2 | 2240 | 2240000 | 329412 | 6935435 | 225 | 196 | 7,009,298 |
| | | 4 | 20 | H-53 | 20.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 3803 | 14428 | 268 | 714 | 3946 | 3552 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3803 | 14428 | 268 | 714 | 3946 | 3552 | T64-GE- | 3 | 4,464 | 1785600 | 262588 | 5528533 | 179 | 156 | 5,587,412 |
| | | 2 | 10 | UH-1 | 20.0 | 200.0 | 100% | 200.0 | 100% | 0% | 0% | 200.00 | 0.00 | 0.00 | 361 | 510 | 18 | 43 | 454 | 408 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 361 | 510 | 18 | 43 | 454 | 408 | T400-CF | 2 | 540 | 108000 | 15882 | 334387 | 11 | 9 | 337,348 |
| | | 4 | 20 | AH-1 | 20.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 3641 | 1767 | 185 | 130 | 1364 | 1228 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3641 | 1767 | 185 | 130 | 1364 | 1228 | T700-GE | 2 | 812 | 324800 | 47765 | 1005638 | 33 | 28 | 1,016,348 |
| | | 4 | 20 | AV-8 | 20.0 | 400.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RF | 1 | 6,000 | 2400000 | 352941 | 7430824 | 241 | 210 | 7,509,962 |
| Humanitarian Assistance/ Disaster Relief Operations | 5 | 10 | 50 | MV-22 | 20.0 | 1000.0 | 100% | 1000.0 | 100% | 0% | 0% | 1000.00 | 0.00 | 0.00 | 22109 | 4413 | 3842 | 448 | 1994 | 1794 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22109 | 4413 | 3842 | 448 | 1994 | 1794 | | 2 | 2240 | 2240000 | 329412 | 6935435 | 225 | 196 | 7,009,298 |
| | | 4 | 20 | H-53 | 20.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 3803 | 14428 | 268 | 714 | 3946 | 3552 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3803 | 14428 | 268 | 714 | 3946 | 3552 | T64-GE- | 3 | 4,464 | 1785600 | 262588 | 5528533 | 179 | 156 | 5,587,412 |
| | | 2 | 10 | UH-1 | 20.0 | 200.0 | 100% | 200.0 | 100% | 0% | 0% | 200.00 | 0.00 | 0.00 | 361 | 510 | 18 | 43 | 454 | 408 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 361 | 510 | 18 | 43 | 454 | 408 | T400-CF | 2 | 540 | 108000 | 15882 | 334387 | 11 | 9 | 337,348 |
| | | 4 | 20 | AH-1 | 20.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 3641 | 1767 | 185 | 130 | 1364 | 1228 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3641 | 1767 | 185 | 130 | 1364 | 1228 | T700-GE | 2 | 812 | 324800 | 47765 | 1005638 | 33 | 28 | 1,016,348 |
| | | 4 | 20 | AV-8 | 20.0 | 400.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RF | 1 | 6,000 | 2400000 | 352941 | 7430824 | 241 | 210 | 7,509,962 |
| Unmanned Aerial Vehicle - Intelligence, Surveillance, and Reconaissance | 100 | 1 | 100.0 | MQ-4C | 4.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 840 | 15536 | 264 | 1416 | 244 | 220 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 840 | 15536 | 264 | 1416 | 244 | 220 | AE3007I | 1 | 2,532 | 1012800 | 148941 | 3135808 | 102 | 89 | 3,169,204 |

## Table D-9: Aircraft Emissions – Alternative 1 (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-SURFACE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-S (Small Caliber) - Ship | 321 | 0.25 | 80.25 | FA-18E/F | 2.0 | 160.5 | 10% | 16.1 | 0% | 0% | 100% | 0.00 | 0.00 | 16.05 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 119 | 2447 | 20 | 66 | 1088 | 980 | 119 | 2447 | 20 | 66 | 1088 | 980 | F414-GE | 2 | 10,338 | 1659249 | 244007 | 5137328 | 167 | 145 | 5,192,040 |
| | | 0.75 | 240.8 | SH-60B | 2.0 | 481.5 | 100% | 481.5 | 0% | 0% | 100% | 0.00 | 0.00 | 481.50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3611 | 3698 | 318 | 231 | 2427 | 2184 | 3611 | 3698 | 318 | 231 | 2427 | 2184 | T700-GE | 2 | 1200 | 577800 | 84971 | 1788971 | 58 | 51 | 1,808,023 |
| Gunnery Exercise, A-S (Medium Caliber) - Ship | 120 | 0.25 | 30 | FA-18E/F | 2.0 | 60.0 | 10% | 6.0 | 0% | 0% | 100% | 0.00 | 0.00 | 6.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 45 | 915 | 7 | 25 | 407 | 366 | 45 | 915 | 7 | 25 | 407 | 366 | F414-GE | 2 | 10,338 | 620280 | 91218 | 1920436 | 62 | 54 | 1,940,950 |
| | | 0.75 | 90 | SH-60B | 2.0 | 180.0 | 100% | 180.0 | 0% | 0% | 100% | 0.00 | 0.00 | 180.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1350 | 1382 | 119 | 86 | 907 | 816 | 1350 | 1382 | 119 | 86 | 907 | 816 | T700-GE | 2 | 1200 | 216000 | 31765 | 668774 | 22 | 19 | 675,897 |
| Missile Exercise (A-S) - Rocket | 110 | 0.33 | 36.3 | FA-18E/F | 2.0 | 72.6 | 10% | 7.3 | 0% | 0% | 100% | 0.00 | 0.00 | 7.26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 1107 | 9 | 30 | 492 | 443 | 54 | 1107 | 9 | 30 | 492 | 443 | F414-GE | 2 | 10,338 | 750538.8 | 110373 | 2323801 | 75 | 66 | 2,348,549 |
| | | 0.66 | 72.6 | SH-60B | 2.0 | 145.2 | 100% | 145.2 | 0% | 0% | 100% | 0.00 | 0.00 | 145.20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1089 | 1115 | 96 | 70 | 732 | 659 | 1089 | 1115 | 96 | 70 | 732 | 659 | T700-GE | 2 | 1200 | 174240 | 25624 | 539478 | 18 | 15 | 545,223 |
| Missile Exercise (A-S) | 10 | 0.5 | 5 | FA-18E/F | 2.0 | 10.0 | 10% | 1.0 | 0% | 0% | 100% | 0.00 | 0.00 | 1.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 152 | 1 | 4 | 68 | 61 | 7 | 152 | 1 | 4 | 68 | 61 | F414-GE | 2 | 10,338 | 103380 | 15203 | 320083 | 10 | 9 | 323,492 |
| | | 0.5 | 5 | SH-60B | 2.0 | 10.0 | 100% | 10.0 | 0% | 0% | 100% | 0.00 | 0.00 | 10.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 75 | 77 | 7 | 5 | 50 | 45 | 75 | 77 | 7 | 5 | 50 | 45 | T700-GE | 2 | 1200 | 12000 | 1765 | 37154 | 1 | 1 | 37,550 |
| Laser Targeting | 600 | 0.5 | 300 | FA-18E/F | 1.0 | 300.0 | 10% | 30.0 | 0% | 0% | 100% | 0.00 | 0.00 | 30.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 223 | 4575 | 37 | 124 | 2035 | 1831 | 223 | 4575 | 37 | 124 | 2035 | 1831 | F414-GE | 2 | 10,338 | 3101400 | 456088 | 9602482 | 312 | 271 | 9,704,748 |
| | | 0.5 | 300 | SH-60B | 1.0 | 300.0 | 100% | 300.0 | 0% | 0% | 100% | 0.00 | 0.00 | 300.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2250 | 2304 | 198 | 144 | 1512 | 1361 | 2250 | 2304 | 198 | 144 | 1512 | 1361 | T700-GE | 2 | 1200 | 360000 | 52941 | 1114624 | 36 | 32 | 1,126,494 |
| Bombing Exercise (A-S) | 37 | 0.5 | 19 | FA-18E/F | 1.0 | 18.5 | 10% | 1.9 | 0% | 0% | 100% | 0.00 | 0.00 | 1.85 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 282 | 2 | 8 | 125 | 113 | 14 | 282 | 2 | 8 | 125 | 113 | F414-GE | 2 | 10,338 | 191253 | 28125 | 592153 | 19 | 17 | 598,459 |
| | | 0.5 | 19 | P-3 | 1.0 | 18.5 | 10% | 1.9 | 0% | 0% | 100% | 0.00 | 0.00 | 1.85 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 69 | 5 | 4 | 35 | 32 | 22 | 69 | 5 | 4 | 35 | 32 | T56-A-14 | 4 | 4,800 | 88800 | 13059 | 274940 | 9 | 8 | 277,869 |
| Torpedo Exercise (Submarine to Surface) | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise (S-S) | 19 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sinking Exercise (SINKEX) | 1 | 2 | 2 | FA-18E/F | 8.0 | 16.0 | 10% | 1.6 | 0% | 0% | 100% | 0.00 | 0.00 | 1.60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 244 | 2 | 7 | 109 | 98 | 12 | 244 | 2 | 7 | 109 | 98 | F414-GE | 2 | 10,338 | 165408 | 24325 | 512132 | 17 | 14 | 517,587 |
| | | 1 | 1 | P-3 | 8.0 | 8.0 | 10% | 0.8 | 0% | 0% | 100% | 0.00 | 0.00 | 0.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 30 | 2 | 2 | 15 | 14 | 10 | 30 | 2 | 2 | 15 | 14 | T56-A-14 | 4 | 4,800 | 38400 | 5647 | 118893 | 4 | 3 | 120,159 |
| | | 1 | 1 | SH-60B | 8.0 | 8.0 | 100% | 8.0 | 0% | 0% | 100% | 0.00 | 0.00 | 8.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 61 | 5 | 4 | 40 | 36 | 60 | 61 | 5 | 4 | 40 | 36 | T700-GE | 2 | 1200 | 9600 | 1412 | 29723 | 1 | 1 | 30,040 |
| Gunnery Exercise (S-S) Boat - Medium-caliber | 20 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise (S-S) Small-caliber | 43 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Maritime Security Operations (MSO) | 40 | 1 | 40 | SH-60B | 4.0 | 160.0 | 100% | 160.0 | 100% | 0% | 0% | 160.00 | 0.00 | 0.00 | 1200 | 1229 | 106 | 77 | 806 | 726 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1200 | 1229 | 106 | 77 | 806 | 726 | T700-GE | 2 | 1200 | 192000 | 28235 | 594466 | 19 | 17 | 600,797 |

## Table D-9: Aircraft Emissions – Alternative 1 (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-SUBMARINE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise-Helo | 65 | 3 | 195 | SH-60B | 4.0 | 780.0 | 100% | 780.0 | 0% | 100% | 0% | 0.00 | 780.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 5850 | 5990 | 515 | 374 | 3931 | 3538 | 0 | 0 | 0 | 0 | 0 | 0 | 5850 | 5990 | 515 | 374 | 3931 | 3538 | T700-GE | 2 | 1200 | 936000 | 137647 | 2898021 | 91 | 82 | 2,928,885 |
| Torpedo Exercise-Helo | 4 | 3 | 12 | SH-60B | 4.0 | 48.0 | 100% | 48.0 | 0% | 100% | 0% | 0.00 | 48.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 360 | 369 | 32 | 23 | 242 | 218 | 0 | 0 | 0 | 0 | 0 | 0 | 360 | 369 | 32 | 23 | 242 | 218 | T700-GE | 2 | 1200 | 57600 | 8471 | 178340 | 6 | 5 | 180,239 |
| Tracking Exercise-Maritime Patrol Advanced Extended Echo Ranging Sonobuoys | 0 | 1 | 0 | P-3 | 6.0 | 0.0 | 75% | 0.0 | 0% | 100% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | T56-A-14 | 4 | 4,800 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tracking Exercise - Maritime Patrol Aircraft | 36 | 1 | 36 | P-3 | 6.0 | 216.0 | 75% | 162.0 | 0% | 100% | 0% | 0.00 | 162.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 1952 | 6011 | 451 | 311 | 3087 | 2778 | 0 | 0 | 0 | 0 | 0 | 0 | 1952 | 6011 | 451 | 311 | 3087 | 2778 | T56-A-14 | 4 | 4,800 | 1036800 | 152471 | 3210116 | 104 | 91 | 3,244,303 |
| Torpedo Exercise-Maritime Patrol Aircraft | 4 | 1 | 4 | P-3 | 6.0 | 24.0 | 75% | 18.0 | 0% | 100% | 0% | 0.00 | 18.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 217 | 668 | 50 | 35 | 343 | 309 | 0 | 0 | 0 | 0 | 0 | 0 | 217 | 668 | 50 | 35 | 343 | 309 | T56-A-14 | 4 | 4,800 | 115200 | 16941 | 356680 | 12 | 10 | 360,478 |
| Tracking Exercise -Surface | 31 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise-Surface | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise-Submarine | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise - Submarine | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **MAJOR TRAINING EVENTS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Joint Expeditionary Exercise | 1 | 48 | 48 | FA-18E/F | 8.0 | 384.0 | 10% | 38.4 | 0% | 100% | 0% | 0.00 | 38.40 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 286 | 5855 | 48 | 159 | 2604 | 2344 | 0 | 0 | 0 | 0 | 0 | 0 | 286 | 5855 | 48 | 159 | 2604 | 2344 | F414-GE | 2 | 10,338 | 3969792 | 583793 | 12291177 | 399 | 347 | 12,422,078 |
| | | 4 | 4 | EA-6B | 8.0 | 32.0 | 10% | 3.2 | 0% | 100% | 0% | 0.00 | 3.20 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 148 | 165 | 10 | 8 | 73 | 66 | 0 | 0 | 0 | 0 | 0 | 0 | 148 | 165 | 10 | 8 | 73 | 66 | F402-RF | 1 | 6,000 | 192000 | 28235 | 594466 | 19 | 17 | 600,797 |
| | | 4 | 4 | E-2 | 8.0 | 32.0 | 10% | 3.2 | 0% | 100% | 0% | 0.00 | 3.20 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 71 | 3 | 3 | 7 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 71 | 3 | 3 | 7 | 6 | T56-A-4 | 1 | 1,100 | 35200 | 5176 | 108985 | 4 | 3 | 110,146 |
| | | 3 | 3 | P-3 | 8.0 | 24.0 | 10% | 2.4 | 0% | 100% | 0% | 0.00 | 2.40 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 89 | 7 | 5 | 46 | 41 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 89 | 7 | 5 | 46 | 41 | T56-A-14 | 4 | 4,800 | 115200 | 16941 | 356680 | 12 | 10 | 360,478 |
| | | 6 | 6 | AV-8B | 8.0 | 48.0 | 10% | 4.8 | 0% | 100% | 0% | 0.00 | 4.80 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 222 | 248 | 16 | 12 | 109 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 222 | 248 | 16 | 12 | 109 | 98 | F402-RF | 1 | 6,000 | 288000 | 42353 | 891699 | 29 | 25 | 901,195 |
| | | 2 | 2 | C-130 | 8.0 | 16.0 | 10% | 1.6 | 0% | 100% | 0% | 0.00 | 1.60 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 59 | 3 | 3 | 29 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 59 | 3 | 3 | 29 | 26 | T56-A-4 | 4 | 4,500 | 72000 | 10588 | 222925 | 7 | 6 | 225,299 |
| | | 4 | 4 | A-10 | 8.0 | 32.0 | 10% | 3.2 | 0% | 100% | 0% | 0.00 | 3.20 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 86 | 4 | 4 | 26 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 86 | 4 | 4 | 26 | 23 | | 2 | 6,052 | 193664 | 28480 | 599618 | 19 | 17 | 606,004 |
| | | 1 | 1 | E-3 | 8.0 | 8.0 | 10% | 0.8 | 0% | 100% | 0% | 0.00 | 0.80 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 221 | 8 | 10 | 7 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 221 | 8 | 10 | 7 | 6 | | 4 | 130,736 | 1045888 | 153807 | 3238254 | 105 | 92 | 3,272,741 |
| | | 1 | 1 | KC-135 | 8.0 | 8.0 | 10% | 0.8 | 0% | 100% | 0% | 0.00 | 0.80 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 247 | 1 | 7 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 247 | 1 | 7 | 2 | 2 | | 4 | 91,552 | 732416 | 107708 | 2267689 | 74 | 64 | 2,291,840 |
| | | 15 | 15 | SH-60B | 8.0 | 120.0 | 100% | 120.0 | 0% | 100% | 0% | 0.00 | 120.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 900 | 922 | 79 | 58 | 605 | 544 | 0 | 0 | 0 | 0 | 0 | 0 | 900 | 922 | 79 | 58 | 605 | 544 | T700-GE | 2 | 1200 | 144000 | 21176 | 445849 | 14 | 13 | 450,598 |
| | | 4 | 4 | CH-53 | 8.0 | 32.0 | 100% | 32.0 | 0% | 100% | 0% | 0.00 | 32.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 304 | 1154 | 21 | 57 | 316 | 284 | 0 | 0 | 0 | 0 | 0 | 0 | 304 | 1154 | 21 | 57 | 316 | 284 | T64-GE- | 3 | 4,464 | 142848 | 21007 | 442283 | 14 | 12 | 446,993 |
| | | 12 | 12 | CH-46 | 8.0 | 96.0 | 100% | 96.0 | 0% | 100% | 0% | 0.00 | 96.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 2454 | 593 | 380 | 58 | 256 | 231 | 0 | 0 | 0 | 0 | 0 | 0 | 2454 | 593 | 380 | 58 | 256 | 231 | T58-GE- | 2 | 1200 | 144000 | 21176 | 445849 | 14 | 13 | 450,598 |
| | | 4 | 4 | AH-1 | 8.0 | 32.0 | 100% | 32.0 | 0% | 100% | 0% | 0.00 | 32.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 291 | 141 | 15 | 10 | 109 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 291 | 141 | 15 | 10 | 109 | 98 | T700-GE | 2 | 812 | 25984 | 3821 | 80451 | 3 | 2 | 81,308 |
| | | 2 | 2 | UH-1 | 8.0 | 16.0 | 100% | 16.0 | 0% | 100% | 0% | 0.00 | 16.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 41 | 1 | 3 | 36 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 41 | 1 | 3 | 36 | 33 | T400-CF | 2 | 540 | 8640 | 1271 | 26751 | 1 | 1 | 27,036 |
| | | 10 | 10 | MV-22 | 8.0 | 80.0 | 100% | 80.0 | 0% | 100% | 0% | 0.00 | 80.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 1769 | 353 | 307 | 36 | 159 | 144 | 0 | 0 | 0 | 0 | 0 | 0 | 1769 | 353 | 307 | 36 | 159 | 144 | | 2 | 2240 | 179200 | 26353 | 554835 | 18 | 16 | 560,744 |
| Joint Multi-Strike Group Exercise | 1 | 144 | 144 | FA-18E/F | 8.0 | 1152.0 | 10% | 115.2 | 0% | 0% | 100% | 0.00 | 0.00 | 115.20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 857 | 17566 | 143 | 476 | 7813 | 7031 | 857 | 17566 | 143 | 476 | 7813 | 7031 | F414-GE | 2 | 10,338 | 11909376 | 1751379 | 36873530 | 1196 | 1042 | 37,266,233 |
| | | 12 | 12 | EA-6B | 8.0 | 96.0 | 10% | 9.6 | 0% | 0% | 100% | 0.00 | 0.00 | 9.60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 444 | 495 | 31 | 23 | 219 | 197 | 444 | 495 | 31 | 23 | 219 | 197 | F402-RF | 1 | 6,000 | 576000 | 84706 | 1783398 | 58 | 50 | 1,802,391 |
| | | 12 | 12 | E-2 | 8.0 | 96.0 | 10% | 9.6 | 0% | 0% | 100% | 0.00 | 0.00 | 9.60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 212 | 8 | 8 | 20 | 18 | 54 | 212 | 8 | 8 | 20 | 18 | T56-A-4 | 1 | 1,100 | 105600 | 15529 | 326956 | 11 | 9 | 330,438 |
| | | 5 | 5 | P-3 | 8.0 | 40.0 | 10% | 4.0 | 0% | 0% | 100% | 0.00 | 0.00 | 4.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 148 | 11 | 8 | 76 | 69 | 48 | 148 | 11 | 8 | 76 | 69 | T56-A-14 | 4 | 4,800 | 192000 | 28235 | 594466 | 19 | 17 | 600,797 |
| | | 1 | 1 | E-3 | 8.0 | 8.0 | 10% | 0.8 | 0% | 0% | 100% | 0.00 | 0.00 | 0.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 221 | 8 | 10 | 7 | 6 | 54 | 221 | 8 | 10 | 7 | 6 | | 4 | 130,736 | 1045888 | 153807 | 3238254 | 105 | 92 | 3,272,741 |
| | | 2 | 2 | KC-135 | 8.0 | 16.0 | 10% | 1.6 | 0% | 0% | 100% | 0.00 | 0.00 | 1.60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 49 | 494 | 1 | 15 | 5 | 4 | 49 | 494 | 1 | 15 | 5 | 4 | | 4 | 91,552 | 1464832 | 215416 | 4535378 | 147 | 128 | 4,583,680 |
| | | 6 | 6 | B-1B | 8.0 | 48.0 | 10% | 4.8 | 0% | 0% | 100% | 0.00 | 0.00 | 4.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 418 | 4 | 13 | 4 | 4 | 27 | 418 | 4 | 13 | 4 | 4 | | 4 | 26,560 | 1274880 | 187482 | 3947253 | 128 | 112 | 3,989,292 |
| | | 24 | 24 | F-15 | 8.0 | 192.0 | 10% | 19.2 | 0% | 0% | 100% | 0.00 | 0.00 | 19.20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 431 | 5558 | 77 | 48 | 970 | 873 | 431 | 5558 | 77 | 48 | 970 | 873 | F100-Pw | 2 | 6196 | 1189632 | 174946 | 3683311 | 119 | 104 | 3,722,538 |
| | | 45 | 45 | SH-60B | 8.0 | 360.0 | 100% | 360.0 | 0% | 0% | 100% | 0.00 | 0.00 | 360.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2700 | 2765 | 238 | 173 | 1814 | 1633 | 2700 | 2765 | 238 | 173 | 1814 | 1633 | T700-GE | 2 | 1200 | 432000 | 63529 | 1337548 | 43 | 38 | 1,351,793 |
| Marine Air Ground Task Force Exercise (Amphibious) | 4 | 1 | 4 | C-130 | 8.0 | 32.0 | 10% | 3.2 | 50% | 50% | 0% | 1.60 | 1.60 | 0.00 | 15 | 59 | 3 | 3 | 29 | 26 | 15 | 59 | 3 | 3 | 29 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 118 | 7 | 6 | 57 | 51 | T56-A-4 | 4 | 4,500 | 144000 | 21176 | 445849 | 14 | 13 | 450,598 |
| | | 2 | 8 | SH-60B | 8.0 | 64.0 | 100% | 64.0 | 50% | 50% | 0% | 32.00 | 32.00 | 0.00 | 240 | 246 | 21 | 15 | 161 | 145 | 240 | 246 | 21 | 15 | 161 | 145 | 0 | 0 | 0 | 0 | 0 | 0 | 480 | 492 | 42 | 31 | 323 | 290 | T700-GE | 2 | 1200 | 76800 | 11294 | 237786 | 8 | 7 | 240,319 |
| | | 4 | 16 | CH-53 | 8.0 | 128.0 | 100% | 128.0 | 50% | 50% | 0% | 64.00 | 64.00 | 0.00 | 609 | 2308 | 43 | 114 | 631 | 568 | 609 | 2308 | 43 | 114 | 631 | 568 | 0 | 0 | 0 | 0 | 0 | 0 | 1217 | 4617 | 86 | 229 | 1263 | 1136 | T64-GE- | 3 | 4,464 | 571392 | 84028 | 1769130 | 57 | 50 | 1,787,972 |
| | | 12 | 48 | CH-46 | 8.0 | 384.0 | 100% | 384.0 | 50% | 50% | 0% | 192.00 | 192.00 | 0.00 | 3926 | 3926 | 608 | 92 | 410 | 369 | 3926 | 949 | 608 | 92 | 410 | 369 | 0 | 0 | 0 | 0 | 0 | 0 | 7852 | 4875 | 1217 | 184 | 820 | 738 | T58-GE- | 2 | 1200 | 460800 | 67765 | 1426718 | 46 | 40 | 1,441,913 |
| | | 4 | 16 | AH-1 | 8.0 | 128.0 | 100% | 128.0 | 50% | 50% | 0% | 64.00 | 64.00 | 0.00 | 583 | 283 | 30 | 21 | 218 | 196 | 583 | 283 | 30 | 21 | 218 | 196 | 0 | 0 | 0 | 0 | 0 | 0 | 1165 | 565 | 59 | 42 | 437 | 393 | T700-GE | 2 | 812 | 103936 | 15285 | 321804 | 10 | 9 | 325,231 |
| | | 2 | 8 | UH-1 | 8.0 | 64.0 | 100% | 64.0 | 50% | 50% | 0% | 32.00 | 32.00 | 0.00 | 58 | 82 | 3 | 7 | 73 | 65 | 58 | 82 | 3 | 7 | 73 | 65 | 0 | 0 | 0 | 0 | 0 | 0 | 115 | 163 | 6 | 14 | 145 | 131 | T400-CF | 2 | 540 | 34560 | 5082 | 107004 | 3 | 3 | 108,143 |
| | | 10 | 40 | MV-22 | 8.0 | 320.0 | 100% | 320.0 | 50% | 50% | 0% | 160.00 | 160.00 | 0.00 | 3537 | 706 | 615 | 72 | 319 | 287 | 3537 | 706 | 615 | 72 | 319 | 287 | 0 | 0 | 0 | 0 | 0 | 0 | 7075 | 1412 | 1229 | 143 | 638 | 574 | | 2 | 2240 | 716800 | 105412 | 2219339 | 72 | 63 | 2,242,375 |
| Special Purpose Marine Air Ground Task Force Exercise | 2 | 1 | 2 | C-130 | 8.0 | 16.0 | 10% | 1.6 | 50% | 50% | 0% | 0.80 | 0.80 | 0.00 | 7 | 29 | 2 | 1 | 14 | 13 | 7 | 29 | 2 | 1 | 14 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 59 | 3 | 3 | 29 | 26 | T56-A-4 | 4 | 4,500 | 72000 | 10588 | 222925 | 7 | 6 | 225,299 |
| | | 4 | 8 | CH-53 | 8.0 | 64.0 | 100% | 64.0 | 50% | 50% | 0% | 32.00 | 32.00 | 0.00 | 304 | 1154 | 21 | 57 | 316 | 284 | 304 | 1154 | 21 | 57 | 316 | 284 | 0 | 0 | 0 | 0 | 0 | 0 | 609 | 2308 | 43 | 114 | 631 | 568 | T64-GE- | 3 | 4,464 | 285696 | 42014 | 884565 | 29 | 25 | 893,986 |
| | | 12 | 24 | CH-46 | 8.0 | 192.0 | 100% | 192.0 | 50% | 50% | 0% | 96.00 | 96.00 | 0.00 | 1963 | 1963 | 304 | 46 | 205 | 185 | 1963 | 475 | 304 | 46 | 205 | 185 | 0 | 0 | 0 | 0 | 0 | 0 | 3926 | 2438 | 608 | 92 | 410 | 369 | T58-GE- | 2 | 1200 | 230400 | 33882 | 713359 | 23 | 20 | 720,956 |
| | | 4 | 8 | AH-1 | 8.0 | 64.0 | 100% | 64.0 | 50% | 50% | 0% | 32.00 | 32.00 | 0.00 | 291 | 141 | 15 | 10 | 109 | 98 | 291 | 141 | 15 | 10 | 109 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 583 | 283 | 30 | 21 | 218 | 196 | T700-GE | 2 | 812 | 51968 | 7642 | 160902 | 5 | 5 | 162,616 |
| | | 2 | 4 | UH-1 | 8.0 | 32.0 | 100% | 32.0 | 50% | 50% | 0% | 16.00 | 16.00 | 0.00 | 29 | 41 | 1 | 3 | 36 | 33 | 29 | 41 | 1 | 3 | 36 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 58 | 82 | 3 | 7 | 73 | 65 | T400-CF | 2 | 540 | 17280 | 2541 | 53502 | 2 | 2 | 54,072 |
| | | 10 | 20 | MV-22 | 8.0 | 160.0 | 100% | 160.0 | 50% | 50% | 0% | 80.00 | 80.00 | 0.00 | 1769 | 353 | 307 | 36 | 159 | 144 | 1769 | 353 | 307 | 36 | 159 | 144 | 0 | 0 | 0 | 0 | 0 | 0 | 3537 | 706 | 615 | 72 | 319 | 287 | | 2 | 2240 | 358400 | 52706 | 1109670 | 36 | 31 | 1,121,488 |

## Table D-9: Aircraft Emissions – Alternative 1 (continued)

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ELECTRONIC WARFARE** | | | | | | | | | | | | | | |
| Electronic Warfare | 522 | 1 | 522 | FA-18E | 2.0 | 1044.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| Flare Exercise | 2200 | 0.9 | 1980 | F-15 | 3.0 | 5940.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| | | 0.06 | 132 | FA-18E | 3.0 | 396.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| | | 0.04 | 88 | SH-60E | 3.0 | 264.0 | 100% | 264.0 | 0% | 0% | 100% | 0.00 | 0.00 | 264.00 |
| Chaff Exercise - SH | 41 | | | | | | | | | | | | | |
| Chaff Exercise - Aircraft | 2200 | 0.9 | 1980 | F-15 | 3.0 | 5940.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| | | 0.06 | 132 | FA-18E | 3.0 | 396.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| | | 0.04 | 88 | SH-60E | 3.0 | 264.0 | 100% | 264.0 | 0% | 0% | 100% | 0.00 | 0.00 | 264.00 |
| **MINE WARFARE** | | | | | | | | | | | | | | |
| Mine Laying - Aircraft | 4 | 0.5 | 2 | FA-18E | 0.5 | 1.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| | | 0.5 | 2 | P-3 | 1.0 | 2.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| Mine Neutralization - Explosive Ordnance | 20 | | | | | | | | | | | | | |
| Limpet Mine Neutralization System/Shock Wave Generator | 60 | | | | | | | | | | | | | |
| **NAVAL SPECIAL WARFARE** | | | | | | | | | | | | | | |
| Personnel I&E | 364 | 4 | 1456 | H-60 | 8.0 | 11648.0 | 100% | 11648.0 | 100% | 0% | 0% | 11648.00 | 0.00 | 0.00 |
| | | 2 | 728 | MV-22 | 8.0 | 5824.0 | 100% | 5824.0 | 100% | 0% | 0% | 5824.00 | 0.00 | 0.00 |
| Parachute Insertion | 64 | 1 | 64 | C-130 | 4.0 | 256.0 | 100% | 256.0 | 100% | 0% | 0% | 256.00 | 0.00 | 0.00 |
| | | 1 | 64 | CH-46 | 4.0 | 256.0 | 100% | 256.0 | 100% | 0% | 0% | 256.00 | 0.00 | 0.00 |
| | | 1 | 64 | H-60 | 4.0 | 256.0 | 100% | 256.0 | 100% | 0% | 0% | 256.00 | 0.00 | 0.00 |
| **OTHER** | | | | | | | | | | | | | | |
| Surface Ship Sonar | 44 | | | | | | | | | | | | | |
| Submarine Sonar Maintenance | 32 | | | | | | | | | | | | | |
| Small Boat Attack | 18 | | | | | | | | | | | | | |
| Sub Navigation/ Sub Nav Under | 8 | | | | | | | | | | | | | |
| Precision Anchoring | 18 | | | | | | | | | | | | | |
| Intelligence, Surveillance, Reconnaissance | 44 | 1 | 44.0 | MQ-4C | 4.0 | 176.0 | 100% | 176.0 | 0% | 50% | 50% | 0.00 | 88.00 | 0.00 |
| Underwater Survey | 32 | 1 | 32 | SH-60E | 2.0 | 64.0 | 100% | 64.0 | 100% | 0% | 0% | 64.00 | 0.00 | 0.00 |
| Unmanned Underwater Vehicle Training | 64 | | | | | | | | | | | | | |
| Unmanned Aerial Vehicle Operation | 950 | | | | | | | | | | | | | |
| **TOTAL TRAINING (lbs per year)** | | | | | | | | | | | | | | |
| **TOTAL TRAINING (tons per year)** | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ELECTRONIC WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | |
| Electronic Warfare | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Flare Exercise | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1980 | 2028 | 174 | 127 | 1331 | 1198 | 1980 | 2028 | 174 | 127 | 1331 | 1198 |
| Chaff Exercise - SH | | | | | | | | | | | | | | | | | | | | | | | | |
| Chaff Exercise - Aircraft | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1980 | 2028 | 174 | 127 | 1331 | 1198 | 1980 | 2028 | 174 | 127 | 1331 | 1198 |
| **MINE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | |
| Mine Laying - Aircraft | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mine Neutralization - Explosive Ordnance | | | | | | | | | | | | | | | | | | | | | | | | |
| Limpet Mine Neutralization System/Shock Wave Generator | | | | | | | | | | | | | | | | | | | | | | | | |
| **NAVAL SPECIAL WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | |
| Personnel I&E | 87360 | 89457 | 7688 | 5591 | 58706 | 52835 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 87360 | 89457 | 7688 | 5591 | 58706 | 52835 |
| | 128762 | 25700 | 22373 | 2609 | 11611 | 10450 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 128762 | 25700 | 22373 | 2609 | 11611 | 10450 |
| Parachute Insertion | 2385 | 9400 | 541 | 461 | 4573 | 4116 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2385 | 9400 | 541 | 461 | 4573 | 4116 |
| | 5235 | 0 | 811 | 123 | 547 | 492 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5235 | 0 | 811 | 123 | 547 | 492 |
| | 1920 | 1966 | 169 | 123 | 1290 | 1161 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1920 | 1966 | 169 | 123 | 1290 | 1161 |
| **OTHER** | | | | | | | | | | | | | | | | | | | | | | | | |
| Surface Ship Sonar | | | | | | | | | | | | | | | | | | | | | | | | |
| Submarine Sonar Maintenance | | | | | | | | | | | | | | | | | | | | | | | | |
| Small Boat Attack | | | | | | | | | | | | | | | | | | | | | | | | |
| Sub Navigation/ Sub Nav Under | | | | | | | | | | | | | | | | | | | | | | | | |
| Precision Anchoring | | | | | | | | | | | | | | | | | | | | | | | | |
| Intelligence, Surveillance, Reconnaissance | 0 | 0 | 0 | 0 | 0 | 0 | 185 | 3418 | 58 | 312 | 54 | 48 | 0 | 0 | 0 | 0 | 0 | 0 | 185 | 3418 | 58 | 312 | 54 | 48 |
| Underwater Survey | 480 | 492 | 42 | 31 | 323 | 290 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 480 | 492 | 42 | 31 | 323 | 290 |
| Unmanned Underwater Vehicle Training | | | | | | | | | | | | | | | | | | | | | | | | |
| Unmanned Aerial Vehicle Operation | | | | | | | | | | | | | | | | | | | | | | | | |
| **TOTAL TRAINING (lbs per year)** | 452,105 | 303,735 | 64,331 | 20,310 | 135,394 | 121,855 | 28,476 | 33,526 | 3,982 | 1,965 | 14,722 | 13,250 | 61,211 | 913,723 | 8,847 | 25,306 | 407,937 | 367,144 | 541,792 | 1,250,984 | 77,161 | 47,580 | 558,054 | 502,248 |
| **TOTAL TRAINING (tons per year)** | 226 | 152 | 32 | 10 | 68 | 61 | 14 | 17 | 2 | 1 | 7 | 7 | 31 | 457 | 4 | 13 | 204 | 184 | 271 | 625 | 39 | 24 | 279 | 251 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **ELECTRONIC WARFARE** | | | | | | | | |
| Electronic Warfare | 2 | 10,338 | 10792872 | 1587187 | 33416636 | 1084 | 944 | 33,772,523 |
| Flare Exercise | 2 | 6196 | 36804240 | 5412388 | 113952422 | 3697 | 3220 | 115,166,015 |
| | 2 | 10,338 | 4093848 | 602036 | 12675276 | 411 | 358 | 12,810,267 |
| | 2 | 1200 | 316800 | 46588 | 980869 | 32 | 28 | 991,315 |
| Chaff Exercise - SH | | | | | | | | |
| Chaff Exercise - Aircraft | 2 | 6196 | 36804240 | 5412388 | 113952422 | 3697 | 3220 | 115,166,015 |
| | 2 | 10,338 | 4093848 | 602036 | 12675276 | 411 | 358 | 12,810,267 |
| | 2 | 1200 | 316800 | 46588 | 980869 | 32 | 28 | 991,315 |
| **MINE WARFARE** | | | | | | | | |
| Mine Laying - Aircraft | 2 | 10,338 | 10338 | 1520 | 32008 | 1 | 1 | 32,349 |
| | 4 | 4,800 | 9600 | 1412 | 29723 | 1 | 1 | 30,040 |
| | | | 0 | 0 | 0 | 0.00 | 0.00 | 0 |
| Mine Neutralization - Explosive Ordnance | | | | | | | | |
| Limpet Mine Neutralization System/Shock Wave Generator | | | | | | | | |
| **NAVAL SPECIAL WARFARE** | | | | | | | | |
| Personnel I&E | 2 | 1200 | 13977600 | 2055529 | 43277116 | 1404 | 1223 | 43,738,017 |
| | 2 | 2240 | 13045760 | 1918494 | 40391975 | 1310 | 1142 | 40,822,149 |
| Parachute Insertion | 4 | 4,500 | 1152000 | 169412 | 3566795 | 116 | 101 | 3,604,782 |
| | 2 | 1200 | 307200 | 45176 | 951145 | 31 | 27 | 961,275 |
| | 2 | 1200 | 307200 | 45176 | 951145 | 31 | 27 | 961,275 |
| **OTHER** | | | | | | | | |
| Surface Ship Sonar | | | | | | | | |
| Submarine Sonar Maintenance | | | | | | | | |
| Small Boat Attack | | | | | | | | |
| Sub Navigation/ Sub Nav Under | | | | | | | | |
| Precision Anchoring | | | | | | | | |
| Intelligence, Surveillance, Reconnaissance | 1 | 2,532 | 445632 | 65534 | 1379755 | 45 | 39 | 1,394,450 |
| Underwater Survey | 2 | 1200 | 76800 | 11294 | 237786 | 8 | 7 | 240,319 |
| Unmanned Underwater Vehicle Training | | | | | | | | |
| Unmanned Aerial Vehicle Operation | | | | | | | | |
| **TOTAL TRAINING (lbs per year)** | | | 408,421,105 | 60,061,327 | 1,264,543,815 | 41,022 | 35,737 | 1,278,011,200 |
| **TOTAL TRAINING (tons per year)** | | | 204,211 | 60,061,327 | 632,272 | 21 | 18 | 639,006 |

## Table D-10: Emissions from Ordnance – Alternative 1

| MEM Category | Location | Training MEM | Testing MEM | Emissions (lb/year) Training | | | | | | Emissions (lb/year) Testing | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | #/yr | #/yr | CO | NOx | VOC | SOx | PM10 | PM2.5 | CO | NOx | VOC | SOx | PM10 | PM2.5 |
| **BOMBS** | | | | | | | | | | | | | | | |
| Bombs (H-E) | MITT | 6,454 | 0 | 394,551.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Bombs (N-E) | MITT | 2,820 | 0 | 719.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **PROJECTILES** | | | | | | | | | | | | | | | |
| Small Caliber | MITT | 307,105 | 0 | 706.3 | 29.8 | 0.0 | 0.0 | 15.7 | 11.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Medium Caliber (H-E) | MITT | 22,780 | 4082 | 91.1 | 29.6 | 0.0 | 0.0 | 216.4 | 116.2 | 16.3 | 5.3 | 0.0 | 0.0 | 38.8 | 20.8 |
| Medium Caliber (N-E) | MITT | 218,855 | 0 | 569.0 | 21.2 | 0.0 | 0.0 | 30.6 | 26.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Large Caliber (H-E) | MITT | 5,102 | 240 | 653.1 | 816.3 | 0.0 | 0.0 | 49.0 | 38.0 | 30.7 | 38.4 | 0.0 | 0.0 | 2.3 | 1.8 |
| Large Caliber (N-E) | MITT | 16,370 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Missiles (H-E) | MITT | 240 | 20 | 7,349.7 | 8,537.8 | 0.0 | 0.0 | 14,830.8 | 14,830.8 | 612.5 | 711.5 | 0.0 | 0.0 | 1,235.9 | 1,235.9 |
| Missiles (N-E) | MITT | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rockets (H-E) | MITT | 4,100 | 16 | 3,813.0 | 23.0 | 0.0 | 0.0 | 1,640.0 | 1,189.0 | 14.9 | 0.1 | 0.0 | 0.0 | 6.4 | 4.6 |
| Rockets (N-E) | MITT | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **COUNTERMEASURES** | | | | | | | | | | | | | | | |
| Chaff | MITT | 17,844 | 0 | 1.1 | 2.7 | 0.0 | 0.0 | 5.0 | 4.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Flares | MITT | 17,600 | 0 | 1.0 | 2.7 | 0.0 | 0.0 | 5.0 | 4.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **TARGETS** | | | | | | | | | | | | | | | |
| Airborne targets | MITT | 16 | 0 | | | | | | | | | | | | |
| Surface targets | MITT | 240 | 0 | | | | | | | | | | | | |
| Expendable sub-surface targets | MITT | 261 | 0 | | | | | | | | | | | | |
| **TOTAL EMISSIONS (lbs per year)** | | | | 408,454 | 9,463 | 0 | 0 | 16,792 | 16,221 | 674 | 755 | 0 | 0 | 1,283 | 1,263 |
| **TOTAL EMISSIONS (tons per year)** | | | | 204.2 | 4.7 | 0.0 | 0.0 | 8.4 | 8.1 | 0.3 | 0.4 | 0.0 | 0.0 | 0.6 | 0.6 |

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## Table D-11: Vessel Emissions – Alternative 2

| Type Training | Training Ops (#) | OPERATIONAL INFORMATION - VESSELS: Ship / Vessel / Boat | | | | Range Time (hr) | | | Distribution (hr) | | | EMISSIONS/YEAR (lb) BY JURISDICTION: State (0-3 nm offshore) | | | | | | Waters of U S (3-12 nm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number | Ship Type | Type | Participation | Per Ship | Time at Each Power Level (%) | Total | 0-3 nm from shore | 3-12 nm from shore | >12 nm from shore | CO | $NO_x$ | HC | $SO_x$ | $PM_{10}$ | PM2.5 | CO | $NO_x$ | HC | $SO_x$ | $PM_{10}$ | PM2.5 |
| **ANTI-AIR WARFARE** | | | | | | | | | | | | | | | | | | | | | | | |
| Air Combat Maneuver | 3600 | | | | | | | | | | | | | | | | | | | | | | |
| Air Defense Exercise | 100 | | | | | | | | | | | | | | | | | | | | | | |
| Air Intercept Control | 5300 | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-A (Medium Caliber) | 36 | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise, A-A | 18 | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, S-A (Large Caliber) | 9 | 18 | FFG | Guided M | 2.00 | 2.0 | 100% | 36.0 | 0.0 | 0.0 | 36.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gunnery Exercise, S-A (Medium Caliber) | 19 | 38 | FFG | Guided M | 2.00 | 2.0 | 100% | 76.0 | 0.0 | 0.0 | 76.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Missile Exercise, S-A | 27 | 54 | FFG | Guided M | 2.00 | 2.0 | 100% | 108.0 | 0.0 | 0.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **STRIKE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | |
| Bombing Exercise, A-G | 7100 | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise, A-G | 80 | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-G | 26 | | | | | | | | | | | | | | | | | | | | | | |
| **AMPHIBIOUS WARFARE** | | | | | | | | | | | | | | | | | | | | | | | |
| Fire Support Exercise - Land-Based target | 15 | 15 | CG | Cruiser | 1 | 8.0 | 100% | 120.00 | 120.0 | 0.0 | 0.0 | 7,381 | 9,550 | 518 | 9,316 | 335 | 301 | 0 | 0 | 0 | 0 | 0 | 0 |
| Amphibious Rehearsal, No Landing - Marine Air Ground Task Force | 12 | 48 | LSD | Cruiser | 4 | 24.0 | 100% | 1152.0 | 1152.0 | 0.0 | 0.0 | 24,480 | 385,356 | 12,488 | 40,366 | 3,122 | 2,810 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 48 | LHA/LHD | Amphib. A | 4 | 24.0 | 100% | 1152.0 | 1152.0 | 0.0 | 0.0 | 9,308 | 55,100 | 6,647 | 156,096 | 32,924 | 29,632 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 48 | LPD | Amphibio | 4 | 24.0 | 100% | 1152.0 | 1152.0 | 0.0 | 0.0 | 4,009 | 24,192 | 2,972 | 70,065 | 14,803 | 13,323 | 0 | 0 | 0 | 0 | 0 | 0 |
| Amphibious Assault - Marine Air Ground Task Force | 12 | 12 | CG | Cruiser | 1 | 8.0 | 100% | 96.0 | 96.0 | 0.0 | 0.0 | 5,905 | 7,640 | 415 | 7,452 | 268 | 241 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 12 | LHA | Amphib. A | 1 | 8.0 | 100% | 96.0 | 96.0 | 0.0 | 0.0 | 708 | 4,179 | 531 | 12,573 | 2,524 | 2,271 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 24 | LPD | Amphibio | 2 | 8.0 | 100% | 192.0 | 192.0 | 0.0 | 0.0 | 668 | 4,032 | 495 | 11,677 | 2,467 | 2,220 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 24 | FFG | Guided M | 2 | 8.0 | 100% | 192.0 | 192.0 | 0.0 | 0.0 | 6,324 | 9,055 | 576 | 6,705 | 444 | 399 | 0 | 0 | 0 | 0 | 0 | 0 |
| Amphibious Raid - Special Purpose Marine Air Ground Task Force | 6 | 6 | LHA | Amphib. A | 1 | 6.0 | 100% | 36.0 | 36.0 | 0.0 | 0.0 | 266 | 1,567 | 199 | 4,715 | 946 | 852 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 12 | LPD | Amphibio | 2 | 2.5 | 100% | 30.0 | 30.0 | 0.0 | 0.0 | 104 | 630 | 77 | 1,825 | 386 | 347 | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Combatant Evacuation Operation | 5 | 5 | LHA | Amphib. A | 1 | 80.0 | 100% | 400.0 | 400.0 | 0.0 | 0.0 | 2,952 | 17,412 | 2,212 | 52,388 | 10,516 | 9,464 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 10 | LPD | Amphibio | 2 | 80.0 | 100% | 800.0 | 800.0 | 0.0 | 0.0 | 2,784 | 16,800 | 2,064 | 48,656 | 10,280 | 9,252 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 5 | LCU | Landing ( | 1 | 80.0 | 100% | 400.0 | 400.0 | 0.0 | 0.0 | 7,328 | 45,812 | 1,396 | 21,844 | 2,056 | 1,850 | 0 | 0 | 0 | 0 | 0 | 0 |
| Humanitarian Assistance/ Disaster Relief Operations | 5 | 5 | LHA | Amphib. A | 1 | 8.0 | 100% | 40.0 | 40.0 | 0.0 | 0.0 | 295 | 1,741 | 221 | 5,239 | 1,052 | 946 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 10 | LPD | Amphibio | 2 | 8.0 | 100% | 80.0 | 80.0 | 0.0 | 0.0 | 278 | 1,680 | 206 | 4,866 | 1,028 | 925 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 5 | LCAC | Landing ( | 1 | 8.0 | 100% | 40.0 | 40.0 | 0.0 | 0.0 | 733 | 4,581 | 140 | 2,184 | 206 | 185 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unmanned Aerial Vehicle - Intelligence, Surveillance, and Reconaissance | 100 | | | | | | | | | | | | | | | | | | | | | | |

| Type Training | EMISSIONS/YEAR (lb) BY JURISDICTION: Int Waters (> 12 nm) | | | | | | Total Emissions | | | | | | GHG Emissions (lb) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO | $NO_x$ | HC | $SO_x$ | $PM_{10}$ | PM2.5 | CO | $NO_x$ | HC | $SO_x$ | $PM_{10}$ | PM2.5 | Fuel Flow (GP | Annual Fuel Consumption (gal) | $CO_2$ | $N_2O$ | $CH_4$ | $CO_{2e}$ |
| **ANTI-AIR WARFARE** | | | | | | | | | | | | | | | | | | |
| Air Combat Maneuver | | | | | | | | | | | | | | | | | | |
| Air Defense Exercise | | | | | | | | | | | | | | | | | | |
| Air Intercept Control | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-A (Medium Caliber) | | | | | | | | | | | | | | | | | | |
| Missile Exercise, A-A | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, S-A (Large Caliber) | 1,186 | 1,698 | 108 | 1,257 | 83 | 75 | 1,186 | 1,698 | 108 | 1,257 | 83 | 75 | 79 | 2,844 | 59,878 | 2 | 2 | 60,515 |
| Gunnery Exercise, S-A (Medium Caliber) | 2,503 | 3,584 | 228 | 2,654 | 176 | 158 | 2,503 | 3,584 | 228 | 2,654 | 176 | 158 | 79 | 6,004 | 126,408 | 4 | 4 | 127,754 |
| Missile Exercise, S-A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 79 | 0 | 0 | 0 | 0 | 0 |
| **STRIKE WARFARE** | | | | | | | | | | | | | | | | | | |
| Bombing Exercise, A-G | | | | | | | | | | | | | | | | | | |
| Missile Exercise, A-G | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-G | | | | | | | | | | | | | | | | | | |
| **AMPHIBIOUS WARFARE** | | | | | | | | | | | | | | | | | | |
| Fire Support Exercise - Land-Based target | 0 | 0 | 0 | 0 | 0 | 0 | 7,381 | 9,550 | 518 | 9,316 | 335 | 301 | 184 | 22,080 | 464,872 | 15 | 13 | 469,823 |
| Amphibious Rehearsal, No Landing - Marine Air Ground Task Force | 0 | 0 | 0 | 0 | 0 | 0 | 24,480 | 385,356 | 12,488 | 40,366 | 3,122 | 2,810 | 184 | 1,461,888 | 30,778,590 | 998 | 870 | 31,106,382 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 9,308 | 55,100 | 6,647 | 156,096 | 32,924 | 29,632 | 373 | 1,461,888 | 30,778,590 | 998 | 870 | 31,106,382 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 4,009 | 24,192 | 2,972 | 70,065 | 14,803 | 13,323 | 373 | 1,461,888 | 30,778,590 | 998 | 870 | 31,106,382 |
| Amphibious Assault - Marine Air Ground Task Force | 0 | 0 | 0 | 0 | 0 | 0 | 5,905 | 7,640 | 415 | 7,452 | 268 | 241 | 184 | 121,824 | 2,564,882 | 83 | 72 | 2,592,198 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 708 | 4,179 | 531 | 12,573 | 2,524 | 2,271 | 373 | 121,824 | 2,564,882 | 83 | 72 | 2,592,198 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 668 | 4,032 | 495 | 11,677 | 2,467 | 2,220 | 373 | 243,648 | 5,129,765 | 166 | 145 | 5,184,397 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 6,324 | 9,055 | 576 | 6,705 | 444 | 399 | 79 | 243,648 | 5,129,765 | 166 | 145 | 5,184,397 |
| Amphibious Raid - Special Purpose Marine Air Ground Task Force | 0 | 0 | 0 | 0 | 0 | 0 | 266 | 1,567 | 199 | 4,715 | 946 | 852 | 373 | 45,684 | 961,831 | 31 | 27 | 972,074 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 104 | 630 | 77 | 1,825 | 386 | 347 | 373 | 38,070 | 801,526 | 26 | 23 | 810,062 |
| Non-Combatant Evacuation Operation | 0 | 0 | 0 | 0 | 0 | 0 | 2,952 | 17,412 | 2,212 | 52,388 | 10,516 | 9,464 | 373 | 149,200 | 3,141,257 | 102 | 89 | 3,174,711 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 2,784 | 16,800 | 2,064 | 48,656 | 10,280 | 9,252 | 373 | 298,400 | 6,282,514 | 204 | 178 | 6,349,422 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 7,328 | 45,812 | 1,396 | 21,844 | 2,056 | 1,850 | 611 | 244,400 | 5,145,598 | 167 | 145 | 5,200,398 |
| Humanitarian Assistance/ Disaster Relief Operations | 0 | 0 | 0 | 0 | 0 | 0 | 295 | 1,741 | 221 | 5,239 | 1,052 | 946 | 373 | 50,760 | 1,068,701 | 35 | 30 | 1,080,083 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 278 | 1,680 | 206 | 4,866 | 1,028 | 925 | 373 | 101,520 | 2,137,402 | 69 | 60 | 2,160,165 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 733 | 4,581 | 140 | 2,184 | 206 | 185 | 611 | 50,760 | 1,068,701 | 35 | 30 | 1,080,083 |
| Unmanned Aerial Vehicle - Intelligence, Surveillance, and Reconaissance | | | | | | | | | | | | | | | | | | |

## Table D-11: Vessel Emissions – Alternative 2 (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANTI-SURFACE WARFARE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-S (Small Caliber) - Ship | 220 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gunnery Exercise, A-S (Medium Caliber) - Ship | 295 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise (A-S) - Rocket | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise (A-S) | 20 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Laser Targeting | 60 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bombing Exercise (A-S) | 37 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise (Submarine to Surface) | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Missile Exercise (S-S) | 12 | 24 | FFG | Guided M | 2.00 | 2.0 | 100% | 48.0 | 0.0 | 0.0 | 48.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,581 | 2,264 | 144 | 1,676 | 111 | 100 | 1,581 | 2,264 | 144 | 1,676 | 111 | 100 | 79 | 3,732 | 79,837 | 3 | 2 | 80,687 |
| Gunner Exercise (Surface-to-Surface) Ship - Large-caliber | 140 | 30.8 | CG | Cruiser | 0.22 | 2.5 | 100% | 77.00 | 0.0 | 21.6 | 55.4 | 0 | 0 | 0 | 0 | 0 | 0 | 1,326 | 1,716 | 93 | 1,674 | 60 | 54 | 3,410 | 4,412 | 240 | 4,304 | 155 | 139 | 4,736 | 6,128 | 333 | 5,978 | 215 | 193 | 184 | 14,168 | 298,293 | 10 | 8 | 301,470 |
| | | 63 | DDG | | 0.45 | 2.5 | 100% | 157.5 | 0.0 | 44.1 | 113.4 | 0 | 0 | 0 | 0 | 0 | 0 | 2,653 | 5,050 | 177 | 3,904 | 161 | 144 | 6,822 | 12,987 | 455 | 10,039 | 413 | 371 | 9,475 | 18,037 | 632 | 13,943 | 573 | 516 | 187 | 29,453 | 620,093 | 20 | 18 | 626,697 |
| | | 21 | FFG | Guided M | 0.15 | 2.5 | 100% | 52.5 | 0.0 | 14.7 | 37.8 | 0 | 0 | 0 | 0 | 0 | 0 | 484 | 693 | 44 | 513 | 34 | 31 | 1,245 | 1,783 | 113 | 1,320 | 87 | 79 | 1,729 | 2,476 | 158 | 1,833 | 121 | 109 | 79 | 4,148 | 87,321 | 3 | 2 | 88,251 |
| | | 16.8 | USCG | US Coast | 0.12 | 2.5 | 100% | 42.0 | 0.0 | 11.8 | 30.2 | 0 | 0 | 0 | 0 | 0 | 0 | 68 | 681 | 10 | 136 | 2 | 2 | 174 | 1,751 | 27 | 349 | 6 | 6 | 241 | 2,432 | 37 | 485 | 9 | 8 | 66 | 2,772 | 58,362 | 2 | 2 | 58,983 |
| Gunner Exercise (Surface-to-Surface) Ship - Medium-caliber | 100 | 22 | CG | Cruiser | 0.22 | 2.5 | 100% | 55.00 | 0.0 | 15.4 | 39.6 | 0 | 0 | 0 | 0 | 0 | 0 | 347 | 1,226 | 67 | 1,196 | 43 | 39 | 2,436 | 3,151 | 171 | 3,074 | 110 | 99 | 3,383 | 4,377 | 238 | 4,270 | 153 | 138 | 184 | 10,120 | 213,066 | 7 | 6 | 215,336 |
| | | 45 | DDG | | 0.45 | 2.5 | 100% | 112.5 | 0.0 | 31.5 | 81.0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,895 | 3,607 | 126 | 2,789 | 115 | 103 | 4,873 | 9,276 | 325 | 7,171 | 295 | 265 | 6,768 | 12,884 | 451 | 9,960 | 410 | 369 | 187 | 21,038 | 442,924 | 14 | 13 | 447,641 |
| | | 15 | FFG | Guided M | 0.15 | 2.5 | 100% | 37.5 | 0.0 | 10.5 | 27.0 | 0 | 0 | 0 | 0 | 0 | 0 | 346 | 495 | 32 | 367 | 24 | 22 | 889 | 1,273 | 81 | 943 | 62 | 56 | 1,235 | 1,769 | 113 | 1,310 | 87 | 78 | 79 | 2,963 | 62,372 | 2 | 2 | 63,037 |
| | | 1 | LPD | Amphibio | 0.01 | 2.5 | 100% | 2.5 | 0.0 | 0.7 | 1.8 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 15 | 2 | 43 | 9 | 8 | 6 | 38 | 5 | 109 | 23 | 21 | 9 | 53 | 6 | 152 | 32 | 29 | 373 | 933 | 19,633 | 1 | 1 | 19,842 |
| | | 12 | USCG | US Coast | 0.12 | 2.5 | 100% | 30.0 | 0.0 | 8.4 | 21.6 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 486 | 7 | 97 | 2 | 2 | 124 | 1,251 | 19 | 249 | 5 | 4 | 172 | 1,737 | 26 | 347 | 6 | 6 | 66 | 1,980 | 41,687 | 1 | 1 | 42,131 |
| Sinking Exercise (SINKEX) | 2 | 10 | FFG | Guided M | 5.00 | 16.0 | 100% | 160.0 | 0.0 | 0.0 | 160.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,270 | 7,546 | 480 | 5,587 | 370 | 333 | 5,270 | 7,546 | 480 | 5,587 | 370 | 333 | 79 | 12,640 | 266,123 | 9 | 8 | 268,957 |
| Gunnery Exercise (S-S) Boat - Medium-caliber | 10 | 50 | FFG | Guided M | 5.00 | 3.0 | 100% | 150.0 | 0.0 | 0.0 | 150.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4,941 | 7,074 | 450 | 5,238 | 347 | 312 | 4,941 | 7,074 | 450 | 5,238 | 347 | 312 | 79 | 11,850 | 249,490 | 8 | 7 | 252,147 |
| Gunnery Exercise (S-S) Small-caliber | 40 | 80 | CRRC | Combat F | 2 | 3.0 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 3,096 | 0 | 0 | 0 | 0 | 36 | 3,096 | 0 | 0 | 0 | 3 | 720 | 15,159 | 0 | 0 | 15,320 |
| Maritime Security Operations (MSO) | 8 | 8 | FFG | Guided M | 1 | 8.0 | 100% | 64.0 | 0.0 | 0.0 | 64.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,108 | 3,018 | 192 | 2,235 | 148 | 133 | 2,108 | 3,018 | 192 | 2,235 | 148 | 133 | 79 | 5,056 | 106,449 | 3 | 3 | 107,583 |
| | | 8 | RHIB | Rigid Hull | 1 | 8.0 | 100% | 64.0 | 0.0 | 0.0 | 64.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 21.8 | 585.0 | 3.8 | 92.2 | 9.6 | 9 | 22 | 585 | 4 | 92 | 10 | 9 | 14 | 896 | 18,864 | 1 | 1 | 19,065 |
| | | 8 | CRRC | Combat F | 1 | 8.0 | 100% | 64.0 | 0.0 | 0.0 | 64.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 826 | 0 | 0 | 0 | 0 | 10 | 826 | 0 | 0 | 0 | 3 | 192 | 4,042 | 0 | 0 | 4,085 |

## Table D-11: Vessel Emissions – Alternative 2 (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-SUBMARINE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise-Helo | 65 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise-Helo | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise-Maritime Patrol Advanced Extended Echo Ranging Sonobuoys | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise -Maritime Patrol Aircraft | 36 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise-Maritime Patrol Aircraft | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise -Surface | 31 | 31 | FFG | Guided M | 1 | 2.0 | 100% | 182.0 | 0.0 | 31.0 | 31.0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,998 | 4,232 | 273 | 3,178 | 210 | 189 | 2,998 | 4,232 | 273 | 3,178 | 210 | 189 | 5,995 | 8,583 | 546 | 6,355 | 420 | 378 | 79 | 14,378 | 302,714 | 10 | 9 | 305,338 |
| Torpedo Exercise-Surface | 6 | 6 | FFG | Guided M | 1 | 2.0 | 100% | 12.0 | 0.0 | 6.0 | 6.0 | 0 | 0 | 0 | 0 | 0 | 0 | 198 | 283 | 18 | 210 | 14 | 12 | 198 | 283 | 18 | 210 | 14 | 12 | 395 | 566 | 36 | 419 | 28 | 25 | 79 | 948 | 19,959 | 1 | 1 | 20,172 |
| Tracking Exercise- Submarine | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise - Submarine | 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **MAJOR TRAINING EVENTS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Joint Expeditionary Exercise | 1 | 1.0 | CVN | Nuclear C | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1.0 | CG | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 4,921 | 6,366 | 346 | 6,210 | 223 | 201 | 0 | 0 | 0 | 0 | 0 | 0 | 4,921 | 6,366 | 346 | 6,210 | 223 | 201 | 184 | 14,720 | 309,915 | 10 | 9 | 313,215 |
| | | 2.0 | FFG | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,270 | 7,546 | 480 | 5,587 | 370 | 333 | 0 | 0 | 0 | 0 | 0 | 0 | 5,270 | 7,546 | 480 | 5,587 | 370 | 333 | 79 | 12,640 | 266,123 | 9 | 8 | 268,957 |
| | | 5.0 | DDG | | 5 | 80.0 | 100% | 400.0 | 0.0 | 400.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 24,064 | 45,808 | 1,604 | 35,412 | 1,456 | 1,310 | 0 | 0 | 0 | 0 | 0 | 0 | 24,064 | 45,808 | 1,604 | 35,412 | 1,456 | 1,310 | 187 | 74,800 | 1,574,839 | 51 | 45 | 1,591,611 |
| | | 1.0 | LHD/LHA | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 590 | 3,482 | 442 | 10,478 | 2,103 | 1,893 | 0 | 0 | 0 | 0 | 0 | 0 | 590 | 3,482 | 442 | 10,478 | 2,103 | 1,893 | 373 | 29,840 | 628,251 | 20 | 18 | 634,942 |
| | | 2.0 | LSD | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,293 | 7,653 | 923 | 21,680 | 4,573 | 4,116 | 0 | 0 | 0 | 0 | 0 | 0 | 1,293 | 7,653 | 923 | 21,680 | 4,573 | 4,116 | 373 | 59,680 | 1,256,503 | 41 | 36 | 1,269,884 |
| | | 1.0 | LPD | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 278 | 1,680 | 206 | 4,866 | 1,028 | 925 | 0 | 0 | 0 | 0 | 0 | 0 | 278 | 1,680 | 206 | 4,866 | 1,028 | 925 | 373 | 29,840 | 628,251 | 20 | 18 | 634,942 |
| | | 1.0 | TAOE | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 8,781 | 24,905 | 848 | 9,599 | 833 | 750 | 0 | 0 | 0 | 0 | 0 | 0 | 8,781 | 24,905 | 848 | 9,599 | 833 | 750 | 1,865 | 149,200 | 3,141,257 | 102 | 89 | 3,174,711 |
| | | 1.0 | SSN | Nuclear C | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1.0 | SSGN | Nuclear C | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 2.0 | T-AGO(LFA) | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,067 | 6,299 | 800 | 19,109 | 3,803 | 3,423 | 0 | 0 | 0 | 0 | 0 | 0 | 1,067 | 6,299 | 800 | 19,109 | 3,803 | 3,423 | 1,865 | 298,400 | 6,282,514 | 204 | 178 | 6,349,422 |
| | | 1.0 | CG-PARTNER | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 8,623 | 3,768 | 792 | 1,680 | 208 | 187 | 0 | 0 | 0 | 0 | 0 | 0 | 8,623 | 3,768 | 792 | 1,680 | 208 | 187 | 184 | 14,720 | 309,915 | 10 | 9 | 313,215 |
| | | 2.0 | DDG-PARTNER | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 16,638 | 7,984 | 1,440 | 2,864 | 400 | 360 | 0 | 0 | 0 | 0 | 0 | 0 | 16,638 | 7,984 | 1,440 | 2,864 | 400 | 360 | 187 | 29,920 | 629,936 | 20 | 18 | 636,644 |
| | | 1.0 | SS-PARTNER | | 1 | 80.0 | 100% | 80.0 | 0.0 | 80.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 235 | 1,386 | 176 | 4,169 | 837 | 753 | 0 | 0 | 0 | 0 | 0 | 0 | 235 | 1,386 | 176 | 4,169 | 837 | 753 | 373 | 29,840 | 628,251 | 20 | 18 | 634,942 |
| | | 5.0 | LCAC | | 5 | 80.0 | 100% | 400.0 | 0.0 | 400.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,328 | 45,812 | 1,396 | 21,844 | 2,056 | 1,850 | 0 | 0 | 0 | 0 | 0 | 0 | 7,328 | 45,812 | 1,396 | 21,844 | 2,056 | 1,850 | 611 | 507,600 | 10,687,010 | 347 | 302 | 10,800,827 |
| | | 2.0 | LCU | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,931 | 18,325 | 558 | 8,738 | 822 | 740 | 0 | 0 | 0 | 0 | 0 | 0 | 2,931 | 18,325 | 558 | 8,738 | 822 | 740 | 611 | 97,760 | 2,058,239 | 67 | 58 | 2,080,159 |
| | | 19.0 | CRRC | | 19 | 80.0 | 100% | 1520.0 | 0.0 | 1520.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 226 | 19,610 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 226 | 19,610 | 0 | 0 | 0 | 3 | 4,560 | 96,006 | 3 | 3 | 97,029 |
| | | 2.0 | RHIB | | 2 | 80.0 | 100% | 160.0 | 0.0 | 160.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 1,462 | 10 | 230 | 24 | 22 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 1,462 | 10 | 230 | 24 | 22 | 373 | 59,680 | 1,256,503 | 41 | 36 | 1,269,884 |
| | | 14.0 | AAV | | 14 | 80.0 | 100% | 1120.0 | 0.0 | 1120.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 851 | 6,966 | 918 | 1,400 | 291 | 262 | 0 | 0 | 0 | 0 | 0 | 0 | 851 | 6,966 | 918 | 1,400 | 291 | 262 | 3 | 3,360 | 70,741 | 2 | 2 | 71,495 |
| Joint Multi-Strike Group Exercise | 1 | 3.0 | CVN | | 3 | 80.0 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 3.0 | CG | | 3 | 80.0 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14,762 | 19,099 | 1,037 | 18,631 | 670 | 603 | 14,762 | 19,099 | 1,037 | 18,631 | 670 | 603 | 184 | 44,160 | 929,745 | 30 | 26 | 939,646 |
| | | 3.0 | FFG | | 3 | 80.0 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,906 | 11,318 | 720 | 8,381 | 554 | 499 | 7,906 | 11,318 | 720 | 8,381 | 554 | 499 | 79 | 18,960 | 399,184 | 13 | 11 | 403,435 |
| | | 12.0 | DDG | | 12 | 80.0 | 100% | 960.0 | 0.0 | 0.0 | 960.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 57,754 | 109,939 | 3,850 | 84,989 | 3,494 | 3,145 | 57,754 | 109,939 | 3,850 | 84,989 | 3,494 | 3,145 | 187 | 179,520 | 3,779,614 | 123 | 107 | 3,819,867 |
| | | 3.0 | TAOE | | 3 | 80.0 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26,342 | 74,714 | 2,544 | 28,798 | 2,498 | 2,249 | 26,342 | 74,714 | 2,544 | 28,798 | 2,498 | 2,249 | 1,865 | 447,600 | 9,423,770 | 306 | 266 | 9,524,134 |
| | | 5.0 | SSN | | 5 | 80.0 | 100% | 400.0 | 0.0 | 0.0 | 400.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 2.0 | T-AGO(LFA) | | 2 | 80.0 | 100% | 160.0 | 0.0 | 0.0 | 160.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,067 | 6,299 | 800 | 19,109 | 3,803 | 3,423 | 1,067 | 6,299 | 800 | 19,109 | 3,803 | 3,423 | 1,865 | 298,400 | 6,282,514 | 204 | 178 | 6,349,422 |
| | | 1.0 | SS-PARTNER | | 1 | 80.0 | 100% | 80.0 | 0.0 | 0.0 | 80.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 235 | 1,386 | 176 | 4,169 | 837 | 753 | 235 | 1,386 | 176 | 4,169 | 837 | 753 | 373 | 29,840 | 628,251 | 20 | 18 | 634,942 |
| Marine Air Ground Task Force Exercise (Amphibious) | 4 | 4.0 | LHD/LHA | | 1 | 80.0 | 100% | 320.0 | 320.0 | 0.0 | 0.0 | 2,362 | 13,930 | 1,770 | 41,910 | 8,413 | 7,572 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,362 | 13,930 | 1,770 | 41,910 | 8,413 | 7,572 | 373 | 119,360 | 2,513,005 | 82 | 71 | 2,539,769 |
| | | 4.0 | LSD | | 1 | 80.0 | 100% | 320.0 | 320.0 | 0.0 | 0.0 | 2,586 | 15,306 | 1,846 | 43,360 | 9,146 | 8,231 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,586 | 15,306 | 1,846 | 43,360 | 9,146 | 8,231 | 373 | 119,360 | 2,513,005 | 82 | 71 | 2,539,769 |
| | | 4.0 | LPD | | 1 | 80.0 | 100% | 320.0 | 320.0 | 0.0 | 0.0 | 1,114 | 6,720 | 826 | 19,462 | 4,112 | 3,701 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,114 | 6,720 | 826 | 19,462 | 4,112 | 3,701 | 373 | 119,360 | 2,513,005 | 82 | 71 | 2,539,769 |
| Special Purpose Marine Air Ground Task Force Exercise | 2 | 2.0 | LHA | Amphib. A | 1 | 80.0 | 100% | 160.0 | 52.8 | 52.8 | 54.4 | 390 | 2,298 | 292 | 6,915 | 1,388 | 1,249 | 390 | 2,298 | 292 | 6,915 | 1,388 | 1,249 | 401 | 2,368 | 301 | 7,125 | 1,430 | 1,287 | 1,181 | 6,965 | 885 | 20,955 | 4,206 | 3,786 | 373 | 59,680 | 1,256,503 | 41 | 36 | 1,269,884 |
| | | 4.0 | LPD | Amphibio | 2 | 80.0 | 100% | 320.0 | 105.6 | 105.6 | 108.8 | 367 | 2,218 | 272 | 6,423 | 1,357 | 1,221 | 367 | 2,218 | 272 | 6,423 | 1,357 | 1,221 | 379 | 2,285 | 281 | 6,617 | 1,398 | 1,258 | 1,114 | 6,720 | 826 | 19,462 | 4,112 | 3,701 | 373 | 119,360 | 2,513,005 | 82 | 71 | 2,539,769 |

## Table D-11: Vessel Emissions – Alternative 2 (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ELECTRONIC WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Electronic Warfare Operations | 522 | 522 | FFG | Guided M | 1 | 4 | 100% | 2088.0 | 0.0 | 0.0 | 2088.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 68,779 | 98,470 | 6,264 | 72,913 | 4,823 | 4,341 | 68,779 | 98,470 | 6,264 | 72,913 | 4,823 | 4,341 | 79 | 164,952 | 3,472,899 | 113 | 98 | 3,509,886 |
| Flare Exercise | 2200 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chaff Exercise - Ship | 60 | 60 | FFG | Guided M | 1 | 4 | 100% | 240.0 | 0.0 | 0.0 | 240.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,906 | 11,318 | 720 | 8,381 | 554 | 499 | 7,906 | 11,318 | 720 | 8,381 | 554 | 499 | 79 | 18,960 | 399,184 | 13 | 11 | 403,435 |
| Chaff Exercise - Aircraft | 2200 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **MINE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Civilian Port Defense | 1 | 1 | RHIB | Rigid Hull | 1 | 24.0 | 100% | 24.0 | 24.0 | 0.0 | 0.0 | 8.2 | 219.4 | 1.4 | 34.6 | 3.6 | 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 8 | 219 | 1 | 35 | 4 | 3 | 0 | 336 | 7,074 | 0 | 0 | 7,149 |
| Mine Laying - Aircraft | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mine Neutralization - Explosive Ordnance Disposal | 20 | 60 | RHIB | Rigid Hull | 3 | 12.0 | 100% | 720.0 | 720.0 | 0.0 | 0.0 | 244.8 | 6580.8 | 43.2 | 1036.8 | 108.0 | 97 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 245 | 6,581 | 43 | 1,037 | 108 | 97 | 66 | 47,520 | 1,000,486 | 32 | 28 | 1,011,141 |
| Limpet Mine Neutralization System/Shock Wave Generator | 40 | 40 | RHIB | Rigid Hull | 1 | 4.0 | 100% | 160.0 | 160.0 | 0.0 | 0.0 | 54.4 | 1462.4 | 9.6 | 230.4 | 24.0 | 22 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 54 | 1,462 | 10 | 230 | 24 | 22 | 14 | 2,240 | 47,161 | 2 | 1 | 47,663 |
| **NAVAL SPECIAL WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Personnel I&E | 364 | 1820 | RHIB | Rigid Hull | 5 | 8.0 | 100% | 14560.0 | 14560.0 | 0.0 | 0.0 | 4950.4 | 133078.4 | 873.6 | 20966.4 | 2184.0 | 1,966 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 4,950 | 133,078 | 874 | 20,966 | 2,184 | 1,966 | 48 | 698,880 | 14,714,220 | 477 | 416 | 14,870,926 |
| | | 2184 | CRRC | Combat F | 6 | 8.0 | 100% | 17472.0 | 17472.0 | 0.0 | 0.0 | 0 | 2,595 | 225,414 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,595 | 225,414 | 0 | 0 | 0 | 3 | 52,416 | 1,103,566 | 36 | 31 | 1,115,319 |
| Parachute Insertion | 64 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **OTHER** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Surface Ship Sonar Maintenance | 44 | 44 | FFG | Guided M | 1 | 4.0 | 100% | 176.0 | 176.0 | 0.0 | 0.0 | 5,797 | 8,300 | 528 | 6,146 | 407 | 366 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,797 | 8,300 | 528 | 6,146 | 407 | 366 | 79 | 13,904 | 292,735 | 9 | 8 | 295,852 |
| Submarine Sonar Maintenance | 32 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Small Boat Attack | 27 | 27 | CRRC | Combat F | 1 | 4.0 | 100% | 108.0 | 0.0 | 108.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 1,393 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 1,393 | 0 | 0 | 0 | 3 | 324 | 6,821 | 0 | 0 | 6,894 |
| Sub Navigation / Sub Nav Under Ice | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Precision Anchoring | 18 | 18 | FFG | Guided M | 1 | 4.0 | 100% | 72.0 | 72.0 | 0.0 | 0.0 | 2,372 | 3,396 | 216 | 2,514 | 166 | 150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,372 | 3,396 | 216 | 2,514 | 166 | 150 | 79 | 5,688 | 119,755 | 4 | 3 | 121,031 |
| Direct Action (TAC-P) | 30 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Underwater Demolition Qualifications | 30 | 30 | CRRC | Combat F | 1 | 8.0 | 100% | 240.0 | 0.0 | 240.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 3,096 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 3,096 | 0 | 0 | 0 | 3 | 720 | 15,159 | 0 | 0 | 15,320 |
| Intelligence, Surveillance, Reconnaissance | 44 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Underwater Survey | 32 | 96 | RHIB | Rigid Hull | 3 | 8.0 | 100% | 768.0 | 768.0 | 0.0 | 0.0 | 261.1 | 7019.5 | 46.1 | 1105.9 | 115.2 | 104 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 261 | 7,020 | 46 | 1,106 | 115 | 104 | 48 | 36,864 | 776,135 | 25 | 22 | 784,400 |
| | | 96 | CRRC | Combat F | 3 | 8.0 | 100% | 768.0 | 768.0 | 0.0 | 0.0 | 0 | 114 | 9,908 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 114 | 9,908 | 0 | 0 | 0 | 3 | 2,304 | 48,508 | 2 | 1 | 49,025 |
| Unmanned Aerial Vehicle Operation | 350 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Unmanned Underwater Vehicle Training | 64 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Search and Rescue At Sea | 45 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **TOTAL TRAINING (lbs per year)** | | | | | | | | | 38,136 | 5,687 | 6,050 | 34,390 | 792,565 | 273,202 | 377,085 | 65,552 | 58,997 | 86,879 | 198,805 | 35,431 | 170,591 | 21,996 | 19,797 | 206,338 | 367,585 | 22,511 | 281,238 | 21,530 | 19,377 | 362,654 | 915,048 | 306,053 | 828,314 | 109,079 | 98,171 | | 6,518,630 | 137,244,499 | 4,452 | 6,121 | 218,775,098 |
| **TOTAL TRAINING (tons per year)** | | | | | | | | | | | | 47 | 396 | 137 | 189 | 33 | 29 | 43 | 99 | 18 | 85 | 11 | 10 | 103 | 184 | 11 | 141 | 11 | 10 | 181 | 458 | 153 | 414 | 55 | 49 | | | 68,622 | 2 | 3 | 109,388 |

## Table D-12: Aircraft Emissions – Alternative 2

**OPERATIONAL INFORMATION – AIRCRAFT**

| Type Training | Training Ops (#) | Aircraft: Distribution | Aircraft: A/C Sorties (#) | Aircraft: Type | Time: Ave Time on Range (hr) | Time: Total Time on Range (hr) | Altitude: Time < 3,000 ft (%) | Altitude: Time < 3,000 ft (hr) | Distribution (%): 0-3 nm from shore | Distribution (%): 3-12 nm from Shore | Distribution (%): > 12 nm from Shore | Distribution (hr): Total Time 0-3 nm from shore | Distribution (hr): Total Time 3-12 nm from shore | Distribution (hr): Total Time > 12 nm from shore |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-AIR WARFARE** | | | | | | | | | | | | | | |
| Air Combat Maneuv | 3600 | 1 | 3600 | FA-18E/F | 1.0 | 3600.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| | | 1 | 3600 | AV-8B | 1.0 | 3600.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| Air Defense Exercis | 100 | 2 | 200 | FA-18E/F | 1.0 | 200.0 | 50% | 100.0 | 0% | 0% | 100% | 0.00 | 0.00 | 100.00 |
| Air Intercept Contro | 5300 | 2 | 10600 | FA-18E/F | 1.0 | 10600.0 | 50% | 5300.0 | 0% | 0% | 100% | 0.00 | 0.00 | 5300.00 |
| Gunnery Exercise, A-A (Medium | 36 | 1 | 36 | AV-8B | 1.0 | 36.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| | | 1 | 36 | FA-18E/F | 1.0 | 36.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| Missile Exercise, A- | 18 | 1 | 18 | AV-8B | 1.0 | 18.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| | | 1 | 18 | FA-18E/F | 1.0 | 18.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 |
| Gunnery Exercise, S-A (Large Caliber) | 3 | | | | | | | | | | | | | |
| Gunnery Exercise, S-A (Medium | 19 | | | | | | | | | | | | | |
| Missile Exercise, S-A | 27 | | | | | | | | | | | | | |
| **STRIKE WARFARE** | | | | | | | | | | | | | | |
| Bombing Exercise, A-G | 2300 | 1 | 2300 | FA-18E/F | 1.0 | 2300.0 | 10% | 230.0 | 0% | 0% | 100% | 0.00 | 0.00 | 230.00 |
| Missile Exercise, A-G | 115 | 0.5 | 58 | FA-18E/F | 2.0 | 115.0 | 10% | 11.5 | 0% | 0% | 100% | 0.00 | 0.00 | 11.50 |
| | | 0.5 | 58 | SH-60B | 2.0 | 115.0 | 100% | 115.0 | 0% | 0% | 100% | 0.00 | 0.00 | 115.00 |
| Gunnery Exercise, A-G | 36 | 0.5 | 48 | FA-18E/F | 2.0 | 36.0 | 10% | 3.6 | 0% | 0% | 100% | 0.00 | 0.00 | 3.60 |
| | | 0.5 | 48 | SH-60B | 2.0 | 36.0 | 100% | 36.0 | 0% | 0% | 100% | 0.00 | 0.00 | 36.00 |

**EMISSIONS/YEAR (lb) BY JURISDICTION**

| Type Training | State (0-3 nm offshore) CO | $NO_x$ | HC | $SO_x$ | PM | $PM_{2.5}$ | Waters of U S (3-12 nm) CO | $NO_x$ | HC | $SO_x$ | PM | $PM_{2.5}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-AIR WARFARE** | | | | | | | | | | | | |
| Air Combat Maneuv | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Air Defense Exercis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Air Intercept Contro | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gunnery Exercise, A-A (Medium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Missile Exercise, A- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gunnery Exercise, S-A (Large Caliber) | | | | | | | | | | | | |
| Gunnery Exercise, S-A (Medium | | | | | | | | | | | | |
| Missile Exercise, S-A | | | | | | | | | | | | |
| **STRIKE WARFARE** | | | | | | | | | | | | |
| Bombing Exercise, A-G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Missile Exercise, A-G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gunnery Exercise, A-G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**EMISSIONS/YEAR (lb) BY JURISDICTION**

| Type Training | Int Waters (> 12 nm) CO | $NO_x$ | HC | $SO_x$ | PM | $PM_{2.5}$ | Total Emissions CO | $NO_x$ | HC | $SO_x$ | PM | $PM_{2.5}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANTI-AIR WARFARE** | | | | | | | | | | | | |
| Air Combat Maneuv | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Air Defense Exercis | 744 | 15249 | 124 | 414 | 6782 | 6104 | 744 | 15249 | 124 | 414 | 6782 | 6104 |
| Air Intercept Contro | 39450 | 808173 | 6575 | 21317 | 359432 | 323488 | 39450 | 808173 | 6575 | 21317 | 359432 | 323488 |
| Gunnery Exercise, A-A (Medium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Missile Exercise, A- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gunnery Exercise, S-A (Large Caliber) | | | | | | | | | | | | |
| Gunnery Exercise, S-A (Medium | | | | | | | | | | | | |
| Missile Exercise, S-A | | | | | | | | | | | | |
| **STRIKE WARFARE** | | | | | | | | | | | | |
| Bombing Exercise, A-G | 1712 | 35072 | 285 | 951 | 15598 | 14038 | 1712 | 35072 | 285 | 951 | 15598 | 14038 |
| Missile Exercise, A-G | 86 | 1754 | 14 | 48 | 780 | 702 | 86 | 1754 | 14 | 48 | 780 | 702 |
| | 863 | 883 | 76 | 55 | 580 | 522 | 863 | 883 | 76 | 55 | 580 | 522 |
| Gunnery Exercise, A-G | 71 | 1464 | 12 | 40 | 651 | 586 | 71 | 1464 | 12 | 40 | 651 | 586 |
| | 720 | 737 | 63 | 46 | 484 | 435 | 720 | 737 | 63 | 46 | 484 | 435 |

| Type Training | Training Platform Information: Engine Model | Engines (#) | Fuel Flow (lb/hr) | Annual Fuel Use (total): Pounds | Gallons | GHG Emissions (lb): $CO_2$ | $N_2O$ | $CH_4$ | $CO_{2-e}$ |
|---|---|---|---|---|---|---|---|---|---|
| **ANTI-AIR WARFARE** | | | | | | | | | |
| Air Combat Maneuv | F414-GE | 2 | 10,338 | 37216800 | 5473059 | 115229780 | 3738 | 3256 | 116,456,977 |
| | F402-RF | 1 | 6,000 | 21600000 | 3176471 | 66877412 | 2170 | 1890 | 67,583,656 |
| Air Defense Exercis | F414-GE | 2 | 10,338 | 2067600 | 304059 | 6401654 | 208 | 181 | 6,469,832 |
| Air Intercept Contro | F414-GE | 2 | 10,338 | 103582800 | 16115118 | 339287687 | 11007 | 9588 | 342,901,099 |
| Gunnery Exercise, A-A (Medium | F402-RF | 1 | 6,000 | 216000 | 31765 | 668774 | 22 | 19 | 675,837 |
| | F414-GE | 2 | 10,338 | 372168 | 54731 | 1152298 | 37 | 33 | 1,164,570 |
| Missile Exercise, A- | F402-RF | 1 | 6,000 | 108000 | 15882 | 334387 | 11 | 9 | 337,948 |
| | F414-GE | 2 | 10,338 | 186084 | 27365 | 576149 | 19 | 16 | 582,285 |
| Gunnery Exercise, S-A (Large Caliber) | | | | | | | | | |
| Gunnery Exercise, S-A (Medium | | | | | | | | | |
| Missile Exercise, S-A | | | | | | | | | |
| **STRIKE WARFARE** | | | | | | | | | |
| Bombing Exercise, A-G | F414-GE | 2 | 10,338 | 23777400 | 3496676 | 73619026 | 2388 | 2081 | 74,403,069 |
| Missile Exercise, A-G | F414-GE | 2 | 10,338 | 1188870 | 174834 | 3680951 | 119 | 104 | 3,720,153 |
| | T700-GE | 2 | 1200 | 138000 | 20294 | 427272 | 14 | 12 | 431,823 |
| Gunnery Exercise, A-G | F414-GE | 2 | 10,338 | 992448 | 145948 | 3072794 | 100 | 87 | 3,105,519 |
| | T700-GE | 2 | 1200 | 115200 | 16941 | 356680 | 12 | 10 | 360,478 |

## Table D-12: Aircraft Emissions – Alternative 2 (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **AMPHIBIOUS WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fire Support Exercise - Land-Based target | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Amphibious Rehearsal, No Landing – Marine Air Ground Task Force | 12 | 4 | 48.0 | CH-53 | 18.0 | 864.0 | 100% | 864.0 | 100% | 0% | 0% | 864.00 | 0.00 | 0.00 | 8215 | 31164 | 579 | 1543 | 8524 | 7671 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8215 | 31164 | 579 | 1543 | 8524 | 7671 | T64-GE- | 3 | 4,464 | 3856836 | 567191 | 11941631 | 387 | 337 | 12,068,809 |
| | | 10 | 120.0 | MV-22 | 18.0 | 2160.0 | 100% | 2160.0 | 100% | 0% | 0% | 2160.00 | 0.00 | 0.00 | 47755 | 9532 | 8298 | 968 | 4306 | 3876 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 47755 | 9532 | 8298 | 968 | 4306 | 3876 | | 2 | 2240 | 4838400 | 711529 | 14980540 | 486 | 423 | 15,140,083 |
| | | 2 | 24.0 | UH-1 | 18.0 | 432.0 | 100% | 432.0 | 100% | 0% | 0% | 432.00 | 0.00 | 0.00 | 779 | 1101 | 40 | 93 | 980 | 882 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 779 | 1101 | 40 | 93 | 980 | 882 | T400-CF | 2 | 540 | 233280 | 34306 | 722276 | 23 | 20 | 729,968 |
| | | 4 | 48.0 | AH-1 | 18.0 | 864.0 | 100% | 864.0 | 100% | 0% | 0% | 864.00 | 0.00 | 0.00 | 7865 | 3817 | 400 | 281 | 2947 | 2652 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7865 | 3817 | 400 | 281 | 2947 | 2652 | T700-GE | 2 | 812 | 701568 | 103172 | 2172178 | 70 | 61 | 2,195,312 |
| | | 4 | 48.0 | AV-8 | 18.0 | 864.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RF | 1 | 6,000 | 5184000 | 762353 | 16050579 | 521 | 454 | 16,221,517 |
| Amphibious Assault - Marine Air Ground Task F | 12 | 4 | 48.0 | CH-53 | 18.0 | 864.0 | 100% | 864.0 | 100% | 0% | 0% | 864.00 | 0.00 | 0.00 | 8215 | 31164 | 579 | 1543 | 8524 | 7671 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8215 | 31164 | 579 | 1543 | 8524 | 7671 | T64-GE- | 3 | 4,464 | 3856836 | 567191 | 11941631 | 387 | 337 | 12,068,809 |
| | | 10 | 120.0 | MV-22 | 18.0 | 2160.0 | 100% | 2160.0 | 100% | 0% | 0% | 2160.00 | 0.00 | 0.00 | 47755 | 9532 | 8298 | 968 | 4306 | 3876 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 47755 | 9532 | 8298 | 968 | 4306 | 3876 | | 2 | 2240 | 4838400 | 711529 | 14980540 | 486 | 423 | 15,140,083 |
| | | 2 | 24.0 | UH-1 | 18.0 | 432.0 | 100% | 432.0 | 100% | 0% | 0% | 432.00 | 0.00 | 0.00 | 779 | 1101 | 40 | 93 | 980 | 882 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 779 | 1101 | 40 | 93 | 980 | 882 | T400-CF | 2 | 540 | 233280 | 34306 | 722276 | 23 | 20 | 729,968 |
| | | 4 | 48.0 | AH-1 | 18.0 | 864.0 | 100% | 864.0 | 100% | 0% | 0% | 864.00 | 0.00 | 0.00 | 7865 | 3817 | 400 | 281 | 2947 | 2652 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7865 | 3817 | 400 | 281 | 2947 | 2652 | T700-GE | 2 | 812 | 701568 | 103172 | 2172178 | 70 | 61 | 2,195,312 |
| | | 4 | 48.0 | AV-8 | 18.0 | 864.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RF | 1 | 6,000 | 5184000 | 762353 | 16050579 | 521 | 454 | 16,221,517 |
| Amphibious Raid - Special Purpose Marine Air Ground Task Force | 6 | 4 | 24.0 | H-53 | 12.0 | 288.0 | 100% | 288.0 | 100% | 0% | 0% | 288.00 | 0.00 | 0.00 | 2738 | 10388 | 193 | 514 | 2841 | 2557 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2738 | 10388 | 193 | 514 | 2841 | 2557 | T64-GE- | 3 | 4,464 | 1285632 | 189064 | 3980544 | 129 | 112 | 4,022,936 |
| | | 10 | 60.0 | MV-22 | 12.0 | 720.0 | 100% | 720.0 | 100% | 0% | 0% | 720.00 | 0.00 | 0.00 | 15918 | 3177 | 2766 | 323 | 1435 | 1292 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15918 | 3177 | 2766 | 323 | 1435 | 1292 | | 2 | 2240 | 1612800 | 237176 | 4993513 | 162 | 141 | 5,046,694 |
| | | 2 | 12.0 | UH-1 | 12.0 | 144.0 | 100% | 144.0 | 100% | 0% | 0% | 144.00 | 0.00 | 0.00 | 260 | 367 | 13 | 31 | 327 | 294 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 260 | 367 | 13 | 31 | 327 | 294 | T400-CF | 2 | 540 | 77760 | 11435 | 240759 | 8 | 7 | 243,323 |
| | | 4 | 24.0 | AH-1 | 12.0 | 288.0 | 100% | 288.0 | 100% | 0% | 0% | 288.00 | 0.00 | 0.00 | 2622 | 1272 | 133 | 94 | 982 | 884 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2622 | 1272 | 133 | 94 | 982 | 884 | T700-GE | 2 | 812 | 233856 | 34391 | 724059 | 23 | 20 | 731,771 |
| | | 4 | 24.0 | AV-8 | 12.0 | 288.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RF | 1 | 6,000 | 1728000 | 254118 | 5350193 | 174 | 151 | 5,407,172 |
| Non-Combatant Evacuation Operation | 5 | 10 | 50 | MV-22 | 20.0 | 1000.0 | 100% | 1000.0 | 100% | 0% | 0% | 1000.00 | 0.00 | 0.00 | 22109 | 4413 | 3842 | 448 | 1994 | 1794 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22109 | 4413 | 3842 | 448 | 1994 | 1794 | | 2 | 2240 | 2240000 | 329412 | 6935435 | 225 | 196 | 7,009,298 |
| | | 4 | 20 | H-53 | 20.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 3803 | 14428 | 268 | 714 | 3946 | 3552 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3803 | 14428 | 268 | 714 | 3946 | 3552 | T64-GE- | 3 | 4,464 | 1785600 | 262588 | 5528533 | 179 | 156 | 5,587,412 |
| | | 2 | 10 | UH-1 | 20.0 | 200.0 | 100% | 200.0 | 100% | 0% | 0% | 200.00 | 0.00 | 0.00 | 361 | 510 | 18 | 43 | 454 | 408 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 361 | 510 | 18 | 43 | 454 | 408 | T400-CF | 2 | 540 | 108000 | 15882 | 334387 | 11 | 9 | 337,948 |
| | | 4 | 20 | AH-1 | 20.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 3641 | 1767 | 185 | 130 | 1364 | 1228 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3641 | 1767 | 185 | 130 | 1364 | 1228 | T700-GE | 2 | 812 | 324800 | 47765 | 1005638 | 33 | 28 | 1,016,348 |
| | | 4 | 20 | AV-8 | 20.0 | 400.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RF | 1 | 6,000 | 2400000 | 352941 | 7430824 | 241 | 210 | 7,509,962 |
| Humanitarian Assistance/ Disaster Relief Operations | 5 | 10 | 50 | MV-22 | 20.0 | 1000.0 | 100% | 1000.0 | 100% | 0% | 0% | 1000.00 | 0.00 | 0.00 | 22109 | 4413 | 3842 | 448 | 1994 | 1794 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22109 | 4413 | 3842 | 448 | 1994 | 1794 | | 2 | 2240 | 2240000 | 329412 | 6935435 | 225 | 196 | 7,009,298 |
| | | 4 | 20 | H-53 | 20.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 3803 | 14428 | 268 | 714 | 3946 | 3552 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3803 | 14428 | 268 | 714 | 3946 | 3552 | T64-GE- | 3 | 4,464 | 1785600 | 262588 | 5528533 | 179 | 156 | 5,587,412 |
| | | 2 | 10 | UH-1 | 20.0 | 200.0 | 100% | 200.0 | 100% | 0% | 0% | 200.00 | 0.00 | 0.00 | 361 | 510 | 18 | 43 | 454 | 408 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 361 | 510 | 18 | 43 | 454 | 408 | T400-CF | 2 | 540 | 108000 | 15882 | 334387 | 11 | 9 | 337,948 |
| | | 4 | 20 | AH-1 | 20.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 3641 | 1767 | 185 | 130 | 1364 | 1228 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3641 | 1767 | 185 | 130 | 1364 | 1228 | T700-GE | 2 | 812 | 324800 | 47765 | 1005638 | 33 | 28 | 1,016,348 |
| | | 4 | 20 | AV-8 | 20.0 | 400.0 | 0% | 0.0 | 100% | 0% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F402-RF | 1 | 6,000 | 2400000 | 352941 | 7430824 | 241 | 210 | 7,509,962 |
| Unmanned Aerial Vehicle - Intelligence, Surveillance, and Reconaissance | 100 | 1 | 100.0 | MQ-4C | 4.0 | 400.0 | 100% | 400.0 | 100% | 0% | 0% | 400.00 | 0.00 | 0.00 | 840 | 15536 | 264 | 1416 | 244 | 220 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 840 | 15536 | 264 | 1416 | 244 | 220 | AE3007I | 1 | 2,532 | 1012800 | 148941 | 3135808 | 102 | 89 | 3,169,204 |

## Table D-12: Aircraft Emissions – Alternative 2 (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANTI-SUBMARINE WARFARE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise-Helo | 65 | 3 | 195 | SH-60B | 4.0 | 780.0 | 100% | 780.0 | 0% | 100% | 0% | 0.00 | 780.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 5850 | 5990 | 515 | 374 | 3931 | 3538 | 0 | 0 | 0 | 0 | 0 | 0 | 5850 | 5990 | 515 | 374 | 3931 | 3538 | T700-GE | 2 | 1200 | 936000 | 137647 | 2898021 | 94 | 82 | 2,928,885 |
| Torpedo Exercise-Helo | 6 | 3 | 18 | SH-60B | 4.0 | 72.0 | 100% | 72.0 | 0% | 100% | 0% | 0.00 | 72.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 540 | 553 | 48 | 35 | 363 | 327 | 0 | 0 | 0 | 0 | 0 | 0 | 540 | 553 | 48 | 35 | 363 | 327 | T700-GE | 2 | 1200 | 86400 | 12706 | 267510 | 9 | 8 | 270,359 |
| Tracking Exercise-Maritime Patrol Advanced Extended Echo Ranging Sonobuoys | 0 | 1 | 0 | P-3 | 6.0 | 0.0 | 75% | 0.0 | 0% | 100% | 0% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | T56-A-14 | 4 | 4,800 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tracking Exercise - Maritime Patrol Aircraft | 36 | 1 | 36 | P-3 | 6.0 | 216.0 | 75% | 162.0 | 0% | 100% | 0% | 0.00 | 162.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 1952 | 6011 | 451 | 311 | 3087 | 2778 | 0 | 0 | 0 | 0 | 0 | 0 | 1952 | 6011 | 451 | 311 | 3087 | 2778 | T56-A-14 | 4 | 4,800 | 1036800 | 152471 | 3210116 | 104 | 91 | 3,244,303 |
| Torpedo Exercise-Maritime Patrol Aircraft | 6 | 1 | 6 | P-3 | 6.0 | 36.0 | 75% | 27.0 | 0% | 100% | 0% | 0.00 | 27.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 325 | 1002 | 75 | 52 | 515 | 463 | 0 | 0 | 0 | 0 | 0 | 0 | 325 | 1002 | 75 | 52 | 515 | 463 | T56-A-14 | 4 | 4,800 | 172800 | 25412 | 535019 | 17 | 15 | 540,717 |
| Tracking Exercise -Surface | 91 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise-Surface | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise-Submarine | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise - Submarine | 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MAJOR TRAINING EVENTS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Joint Expeditionary | 1 | 48 | 48 | FA-18E/F | 8.0 | 384.0 | 10% | 38.4 | 0% | 100% | 0% | 0.00 | 38.40 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 286 | 5855 | 48 | 153 | 2604 | 2344 | 0 | 0 | 0 | 0 | 0 | 0 | 286 | 5855 | 48 | 153 | 2604 | 2344 | F414-GE | 2 | 10,338 | 3969792 | 583793 | 12291177 | 399 | 347 | 12,422,078 |
| | | 4 | 4 | EA-6B | 8.0 | 32.0 | 10% | 3.2 | 0% | 100% | 0% | 0.00 | 3.20 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 148 | 165 | 10 | 8 | 73 | 66 | 0 | 0 | 0 | 0 | 0 | 0 | 148 | 165 | 10 | 8 | 73 | 66 | F402-RF | 1 | 6,000 | 192000 | 28235 | 594466 | 19 | 17 | 600,737 |
| | | 4 | 4 | E-2 | 8.0 | 32.0 | 10% | 3.2 | 0% | 100% | 0% | 0.00 | 3.20 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 71 | 3 | 3 | 7 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 71 | 3 | 3 | 7 | 6 | T56-A-4: | 1 | 1,100 | 35200 | 5176 | 108985 | 4 | 3 | 110,146 |
| | | 3 | 3 | P-3 | 8.0 | 24.0 | 10% | 2.4 | 0% | 100% | 0% | 0.00 | 2.40 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 89 | 7 | 5 | 46 | 41 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 89 | 7 | 5 | 46 | 41 | T56-A-14 | 4 | 4,800 | 115200 | 16941 | 356680 | 12 | 10 | 360,478 |
| | | 6 | 6 | AV-8B | 8.0 | 48.0 | 10% | 4.8 | 0% | 100% | 0% | 0.00 | 4.80 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 222 | 248 | 16 | 12 | 109 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 222 | 248 | 16 | 12 | 109 | 98 | F402-RF | 1 | 6,000 | 288000 | 42353 | 891699 | 29 | 25 | 901,195 |
| | | 2 | 2 | C-130 | 8.0 | 16.0 | 10% | 1.6 | 0% | 100% | 0% | 0.00 | 1.60 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 59 | 3 | 3 | 29 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 59 | 3 | 3 | 29 | 26 | T56-A-4: | 4 | 4,500 | 72000 | 10588 | 222925 | 7 | 6 | 225,299 |
| | | 4 | 4 | A-10 | 8.0 | 32.0 | 10% | 3.2 | 0% | 100% | 0% | 0.00 | 3.20 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 86 | 4 | 4 | 26 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 86 | 4 | 4 | 26 | 23 | | 2 | 6,052 | 193664 | 28480 | 599618 | 19 | 17 | 606,004 |
| | | 1 | 1 | E-3 | 8.0 | 8.0 | 10% | 0.8 | 0% | 100% | 0% | 0.00 | 0.80 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 221 | 8 | 10 | 7 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 221 | 8 | 10 | 7 | 6 | | 4 | 130,736 | 1045888 | 153807 | 3238254 | 105 | 92 | 3,272,741 |
| | | 1 | 1 | KC-135 | 8.0 | 8.0 | 10% | 0.8 | 0% | 100% | 0% | 0.00 | 0.80 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 247 | 1 | 7 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 247 | 1 | 7 | 2 | 2 | | 4 | 91,552 | 732416 | 107708 | 2267689 | 74 | 64 | 2,291,840 |
| | | 15 | 15 | SH-60B | 8.0 | 120.0 | 100% | 120.0 | 0% | 100% | 0% | 0.00 | 120.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 900 | 922 | 79 | 58 | 605 | 544 | 0 | 0 | 0 | 0 | 0 | 0 | 900 | 922 | 79 | 58 | 605 | 544 | T700-GE | 2 | 1200 | 144000 | 21176 | 445849 | 14 | 13 | 450,598 |
| | | 4 | 4 | CH-53 | 8.0 | 32.0 | 100% | 32.0 | 0% | 100% | 0% | 0.00 | 32.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 304 | 1154 | 21 | 57 | 316 | 284 | 0 | 0 | 0 | 0 | 0 | 0 | 304 | 1154 | 21 | 57 | 316 | 284 | T64-GE- | 3 | 4,464 | 142848 | 21007 | 442283 | 14 | 12 | 446,993 |
| | | 12 | 12 | CH-46 | 8.0 | 96.0 | 100% | 96.0 | 0% | 100% | 0% | 0.00 | 96.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 2454 | 593 | 380 | 58 | 256 | 231 | 0 | 0 | 0 | 0 | 0 | 0 | 2454 | 593 | 380 | 58 | 256 | 231 | T58-GE- | 2 | 1200 | 144000 | 21176 | 445849 | 14 | 13 | 450,598 |
| | | 4 | 4 | AH-1 | 8.0 | 32.0 | 100% | 32.0 | 0% | 100% | 0% | 0.00 | 32.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 291 | 141 | 15 | 10 | 109 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 291 | 141 | 15 | 10 | 109 | 98 | T700-GE | 2 | 812 | 25984 | 3821 | 80451 | 3 | 2 | 81,308 |
| | | 2 | 2 | UH-1 | 8.0 | 16.0 | 100% | 16.0 | 0% | 100% | 0% | 0.00 | 16.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 41 | 1 | 3 | 36 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 41 | 1 | 3 | 36 | 33 | T400-CF | 2 | 540 | 8640 | 1271 | 26751 | 1 | 1 | 27,036 |
| | | 10 | 10 | MV-22 | 8.0 | 80.0 | 100% | 80.0 | 0% | 100% | 0% | 0.00 | 80.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 1769 | 353 | 307 | 36 | 159 | 144 | 0 | 0 | 0 | 0 | 0 | 0 | 1769 | 353 | 307 | 36 | 159 | 144 | | 2 | 2240 | 179200 | 26353 | 554835 | 18 | 16 | 560,744 |
| Joint Multi-Strike Group Exercise | 1 | 144 | 144 | FA-18E/F | 8.0 | 1152.0 | 10% | 115.2 | 0% | 0% | 100% | 0.00 | 0.00 | 115.20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 857 | 17566 | 143 | 476 | 7813 | 7031 | 857 | 17566 | 143 | 476 | 7813 | 7031 | F414-GE | 2 | 10,338 | 11909376 | 1751379 | 36873530 | 1196 | 1042 | 37,266,233 |
| | | 12 | 12 | EA-6B | 8.0 | 96.0 | 10% | 9.6 | 0% | 0% | 100% | 0.00 | 0.00 | 9.60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 444 | 495 | 31 | 23 | 219 | 197 | 444 | 495 | 31 | 23 | 219 | 197 | F402-RF | 1 | 6,000 | 576000 | 84706 | 1783398 | 58 | 50 | 1,802,391 |
| | | 12 | 12 | E-2 | 8.0 | 96.0 | 10% | 9.6 | 0% | 0% | 100% | 0.00 | 0.00 | 9.60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 212 | 8 | 8 | 20 | 18 | 54 | 212 | 8 | 8 | 20 | 18 | T56-A-4: | 1 | 1,100 | 105600 | 15529 | 326956 | 11 | 9 | 330,438 |
| | | 5 | 5 | P-3 | 8.0 | 40.0 | 10% | 4.0 | 0% | 0% | 100% | 0.00 | 0.00 | 4.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 148 | 11 | 8 | 76 | 69 | 48 | 148 | 11 | 8 | 76 | 69 | T56-A-14 | 4 | 4,800 | 192000 | 28235 | 594466 | 19 | 17 | 600,737 |
| | | 1 | 1 | E-3 | 8.0 | 8.0 | 10% | 0.8 | 0% | 0% | 100% | 0.00 | 0.00 | 0.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 221 | 8 | 10 | 7 | 6 | 54 | 221 | 8 | 10 | 7 | 6 | | 4 | 130,736 | 1045888 | 153807 | 3238254 | 105 | 92 | 3,272,741 |
| | | 2 | 2 | KC-135 | 8.0 | 16.0 | 10% | 1.6 | 0% | 0% | 100% | 0.00 | 0.00 | 1.60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 49 | 434 | 1 | 15 | 5 | 4 | 49 | 434 | 1 | 15 | 5 | 4 | | 4 | 91,552 | 1464832 | 215416 | 4535378 | 147 | 128 | 4,583,680 |
| | | 6 | 6 | B-1B | 8.0 | 48.0 | 10% | 4.8 | 0% | 0% | 100% | 0.00 | 0.00 | 4.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 418 | 4 | 13 | 4 | 4 | 27 | 418 | 4 | 13 | 4 | 4 | | 4 | 26,560 | 1274880 | 187482 | 3947253 | 128 | 112 | 3,989,292 |
| | | 24 | 24 | F-15 | 8.0 | 192.0 | 10% | 19.2 | 0% | 0% | 100% | 0.00 | 0.00 | 19.20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 431 | 5558 | 77 | 48 | 970 | 873 | 431 | 5558 | 77 | 48 | 970 | 873 | F100-PW | 2 | 6196 | 1189632 | 174946 | 3683311 | 119 | 104 | 3,722,538 |
| | | 45 | 45 | SH-60B | 8.0 | 360.0 | 100% | 360.0 | 0% | 0% | 100% | 0.00 | 0.00 | 360.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2700 | 2765 | 238 | 173 | 1814 | 1633 | 2700 | 2765 | 238 | 173 | 1814 | 1633 | T700-GE | 2 | 1200 | 432000 | 63529 | 1337548 | 43 | 38 | 1,351,793 |
| Marine Air Ground Task Force Exercise (Amphibious) | 4 | 1 | 4 | C-130 | 8.0 | 32.0 | 10% | 3.2 | 50% | 50% | 0% | 1.60 | 1.60 | 0.00 | 15 | 59 | 3 | 3 | 29 | 26 | 15 | 59 | 3 | 3 | 29 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 118 | 7 | 6 | 57 | 51 | T56-A-4: | 4 | 4,500 | 144000 | 21176 | 445849 | 14 | 13 | 450,598 |
| | | 2 | 8 | SH-60B | 8.0 | 64.0 | 100% | 64.0 | 50% | 50% | 0% | 32.00 | 32.00 | 0.00 | 240 | 246 | 21 | 15 | 161 | 145 | 240 | 246 | 21 | 15 | 161 | 145 | 0 | 0 | 0 | 0 | 0 | 0 | 480 | 492 | 42 | 31 | 323 | 290 | T700-GE | 2 | 1200 | 76800 | 11294 | 237786 | 8 | 7 | 240,319 |
| | | 4 | 16 | CH-53 | 8.0 | 128.0 | 100% | 128.0 | 50% | 50% | 0% | 64.00 | 64.00 | 0.00 | 609 | 2308 | 43 | 114 | 631 | 568 | 609 | 2308 | 43 | 114 | 631 | 568 | 0 | 0 | 0 | 0 | 0 | 0 | 1217 | 4617 | 86 | 229 | 1263 | 1136 | T64-GE- | 3 | 4,464 | 571392 | 84028 | 1769130 | 57 | 50 | 1,787,372 |
| | | 12 | 48 | CH-46 | 8.0 | 384.0 | 100% | 384.0 | 50% | 50% | 0% | 192.00 | 192.00 | 0.00 | 3926 | 3926 | 608 | 92 | 410 | 369 | 3926 | 949 | 608 | 92 | 410 | 369 | 0 | 0 | 0 | 0 | 0 | 0 | 7852 | 4875 | 1217 | 184 | 820 | 738 | T58-GE- | 2 | 1200 | 460800 | 67765 | 1426718 | 46 | 40 | 1,441,913 |
| | | 4 | 16 | AH-1 | 8.0 | 128.0 | 100% | 128.0 | 50% | 50% | 0% | 64.00 | 64.00 | 0.00 | 583 | 283 | 30 | 21 | 218 | 196 | 583 | 283 | 30 | 21 | 218 | 196 | 0 | 0 | 0 | 0 | 0 | 0 | 1165 | 565 | 59 | 42 | 437 | 393 | T700-GE | 2 | 812 | 103936 | 15285 | 321804 | 10 | 9 | 325,231 |
| | | 2 | 8 | UH-1 | 8.0 | 64.0 | 100% | 64.0 | 50% | 50% | 0% | 32.00 | 32.00 | 0.00 | 58 | 82 | 3 | 7 | 73 | 65 | 58 | 82 | 3 | 7 | 73 | 65 | 0 | 0 | 0 | 0 | 0 | 0 | 115 | 163 | 6 | 14 | 145 | 131 | T400-CF | 2 | 540 | 34560 | 5082 | 107004 | 3 | 3 | 108,143 |
| | | 10 | 40 | MV-22 | 8.0 | 320.0 | 100% | 320.0 | 50% | 50% | 0% | 160.00 | 160.00 | 0.00 | 3537 | 706 | 615 | 72 | 319 | 287 | 3537 | 706 | 615 | 72 | 319 | 287 | 0 | 0 | 0 | 0 | 0 | 0 | 7075 | 1412 | 1229 | 143 | 638 | 574 | | 2 | 2240 | 716800 | 105412 | 2219339 | 72 | 63 | 2,242,975 |
| Special Purpose Marine Air Ground Task Force Exercise | 2 | 1 | 2 | C-130 | 8.0 | 16.0 | 10% | 1.6 | 50% | 50% | 0% | 0.80 | 0.80 | 0.00 | 7 | 29 | 2 | 1 | 14 | 13 | 7 | 29 | 2 | 1 | 14 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 59 | 3 | 3 | 29 | 26 | T56-A-4: | 4 | 4,500 | 72000 | 10588 | 222925 | 7 | 6 | 225,299 |
| | | 4 | 8 | CH-53 | 8.0 | 64.0 | 100% | 64.0 | 50% | 50% | 0% | 32.00 | 32.00 | 0.00 | 304 | 1154 | 21 | 57 | 316 | 284 | 304 | 1154 | 21 | 57 | 316 | 284 | 0 | 0 | 0 | 0 | 0 | 0 | 609 | 2308 | 43 | 114 | 631 | 568 | T64-GE- | 3 | 4,464 | 285696 | 42014 | 884565 | 29 | 25 | 893,986 |
| | | 12 | 24 | CH-46 | 8.0 | 192.0 | 100% | 192.0 | 50% | 50% | 0% | 96.00 | 96.00 | 0.00 | 1963 | 1963 | 304 | 46 | 205 | 185 | 1963 | 475 | 304 | 46 | 205 | 185 | 0 | 0 | 0 | 0 | 0 | 0 | 3926 | 2438 | 608 | 92 | 410 | 369 | T58-GE- | 2 | 1200 | 230400 | 33882 | 713359 | 23 | 20 | 720,956 |
| | | 4 | 8 | AH-1 | 8.0 | 64.0 | 100% | 64.0 | 50% | 50% | 0% | 32.00 | 32.00 | 0.00 | 291 | 141 | 15 | 10 | 109 | 98 | 291 | 141 | 15 | 10 | 109 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 583 | 283 | 30 | 21 | 218 | 196 | T700-GE | 2 | 812 | 51968 | 7642 | 160902 | 5 | 5 | 162,616 |
| | | 2 | 4 | UH-1 | 8.0 | 32.0 | 100% | 32.0 | 50% | 50% | 0% | 16.00 | 16.00 | 0.00 | 29 | 41 | 1 | 3 | 36 | 33 | 29 | 41 | 1 | 3 | 36 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 58 | 82 | 3 | 7 | 73 | 65 | T400-CF | 2 | 540 | 17280 | 2541 | 53502 | 2 | 2 | 54,072 |
| | | 10 | 20 | MV-22 | 8.0 | 160.0 | 100% | 160.0 | 50% | 50% | 0% | 80.00 | 80.00 | 0.00 | 1769 | 353 | 307 | 36 | 159 | 144 | 1769 | 353 | 307 | 36 | 159 | 144 | 0 | 0 | 0 | 0 | 0 | 0 | 3537 | 706 | 615 | 72 | 319 | 287 | | 2 | 2240 | 358400 | 52706 | 1109670 | 36 | 31 | 1,121,488 |

## Table D-12: Aircraft Emissions – Alternative 2 (continued)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ELECTRONIC WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Electronic Warfare Operations | 522 | 1 | 522 | FA-18I | 2.0 | 1044.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F414-GE | 2 | 10,338 | 10792872 | 1587187 | 33416636 | 1084 | 944 | 33,772,523 |
| Flare Exercise | 2200 | 0.9 | 1980 | F-15 | 3.0 | 5940.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F100-PW | 2 | 6196 | 36804240 | 5412388 | 113952422 | 3697 | 3220 | 115,166,015 |
| | | 0.06 | 132 | FA-18I | 3.0 | 396.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F414-GE | 2 | 10,338 | 4093848 | 602036 | 12675276 | 411 | 358 | 12,810,267 |
| | | 0.04 | 88 | SH-60 | 3.0 | 264.0 | 100% | 264.0 | 0% | 0% | 100% | 0.00 | 0.00 | 264.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1980 | 2028 | 174 | 127 | 1331 | 1198 | 1980 | 2028 | 174 | 127 | 1331 | 1198 | T700-GE | 2 | 1200 | 316800 | 46588 | 980869 | 32 | 28 | 391,315 |
| Chaff Exercise - Ship | 60 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chaff Exercise - Aircraft | 2200 | 0.9 | 1980 | F-15 | 3.0 | 5940.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F100-PW | 2 | 6196 | 36804240 | 5412388 | 113952422 | 3697 | 3220 | 115,166,015 |
| | | 0.06 | 132 | FA-18I | 3.0 | 396.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F414-GE | 2 | 10,338 | 4093848 | 602036 | 12675276 | 411 | 358 | 12,810,267 |
| | | 0.04 | 88 | SH-60 | 3.0 | 264.0 | 100% | 264.0 | 0% | 0% | 100% | 0.00 | 0.00 | 264.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1980 | 2028 | 174 | 127 | 1331 | 1198 | 1980 | 2028 | 174 | 127 | 1331 | 1198 | T700-GE | 2 | 1200 | 316800 | 46588 | 980869 | 32 | 28 | 391,315 |
| **MINE WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mine Laying - Aircraft | 4 | 0.5 | 2 | FA-18I | 0.5 | 1.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | F414-GE | 2 | 10,338 | 10338 | 1520 | 32008 | 1 | 1 | 32,349 |
| | | 0.5 | 2 | P-3 | 1.0 | 2.0 | 0% | 0.0 | 0% | 0% | 100% | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | T56-A-14 | 4 | 4,800 | 9600 | 1412 | 29723 | 1 | 1 | 30,040 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0.00 | 0.00 | 0 |
| Mine Neutralization - Explosive Ordnance | 20 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Limpet Mine Neutralization System/Shock Wave ... | 60 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **NAVAL SPECIAL WARFARE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Personnel I&E | 364 | 4 | 1456 | H-60 | 8.0 | 11648.0 | 100% | 11648.0 | 100% | 0% | 0% | 11648.00 | 0.00 | 0.00 | 87360 | 89457 | 7688 | 5591 | 58706 | 52835 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 87360 | 89457 | 7688 | 5591 | 58706 | 52835 | T700-GE | 2 | 1200 | 13977600 | 2055529 | 43277116 | 1404 | 1223 | 43,738,017 |
| | | 2 | 728 | MV-22 | 8.0 | 5824.0 | 100% | 5824.0 | 100% | 0% | 0% | 5824.00 | 0.00 | 0.00 | 128762 | 25700 | 22373 | 2609 | 11611 | 10450 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 128762 | 25700 | 22373 | 2609 | 11611 | 10450 | | 2 | 2240 | 13045760 | 1918494 | 40391975 | 1310 | 1142 | 40,822,149 |
| Parachute Insertion | 64 | 1 | 64 | C-130 | 4.0 | 256.0 | 100% | 256.0 | 100% | 0% | 0% | 256.00 | 0.00 | 0.00 | 2385 | 9400 | 541 | 461 | 4573 | 4116 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2385 | 9400 | 541 | 461 | 4573 | 4116 | T56-A-4: | 4 | 4,500 | 1152000 | 169412 | 3566795 | 116 | 101 | 3,604,782 |
| | | 1 | 64 | CH-46 | 4.0 | 256.0 | 100% | 256.0 | 100% | 0% | 0% | 256.00 | 0.00 | 0.00 | 5235 | 0 | 811 | 123 | 547 | 492 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5235 | 0 | 811 | 123 | 547 | 492 | T58-GE- | 2 | 1200 | 307200 | 45176 | 951145 | 31 | 27 | 961,275 |
| | | 1 | 64 | H-60 | 4.0 | 256.0 | 100% | 256.0 | 100% | 0% | 0% | 256.00 | 0.00 | 0.00 | 1920 | 1966 | 169 | 123 | 1290 | 1161 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1920 | 1966 | 169 | 123 | 1290 | 1161 | T700-GE | 2 | 1200 | 307200 | 45176 | 951145 | 31 | 27 | 961,275 |
| **OTHER** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Surface Ship Sonar | 42 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Submarine Sonar | 48 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Small Boat Attack | 27 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sub Navigation / Sub Nav Under Ice | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Precision Anchoring | 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Unmanned Aerial Vehicle | 350 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Intelligence, Surveillance, and Reconnaissanc | 44 | 1 | 44.0 | MQ-4C | 4.0 | 176.0 | 100% | 176.0 | 0% | 50% | 50% | 0.00 | 88.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 185 | 3418 | 58 | 312 | 54 | 48 | 0 | 0 | 0 | 0 | 0 | 0 | 185 | 3418 | 58 | 312 | 54 | 48 | AE3007I | 1 | 2,532 | 445632 | 65534 | 1379755 | 45 | 39 | 1,394,450 |
| Underwater Survey | 32 | 1 | 32 | SH-60B | 2.0 | 64.0 | 100% | 64.0 | 100% | 0% | 0% | 64.00 | 0.00 | 0.00 | 480 | 492 | 42 | 31 | 323 | 290 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 480 | 492 | 42 | 31 | 323 | 290 | T700-GE | 2 | 1200 | 76800 | 11294 | 237786 | 8 | 7 | 240,319 |
| Unmanned Underwater Vehicle Training | 64 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **TOTAL TRAINING (lbs per year)** | | | | | | | | | | | | | | | 452,105 | 303,735 | 64,331 | 20,310 | 135,394 | 121,855 | 28,764 | 34,044 | 4,023 | 1,994 | 15,015 | 13,513 | 61,211 | 913,723 | 8,847 | 25,306 | 407,937 | 367,144 | 542,080 | 1,251,503 | 77,202 | 47,609 | 558,346 | 502,512 | | | | 408,507,505 | 60,074,633 | 1,264,811,324 | 41,031 | 35,744 | 1,278,281,559 |
| **TOTAL TRAINING (tons per year)** | | | | | | | | | | | | | | | 226 | 152 | 32 | 10 | 68 | 61 | 14 | 17 | 2 | 1 | 8 | 7 | 31 | 457 | 4 | 13 | 204 | 184 | 271 | 626 | 39 | 24 | 279 | 251 | | | | 204,254 | 60,074,633 | 632,406 | 21 | 18 | 639,141 |

## Table D-13: Emissions from Ordnance – Alternative 2

| MEM Category | Location | Training MEM | Testing MEM | Emissions (lb/year) Training | | | | | | Emissions (lb/year) Testing | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | #/yr | #/yr | CO | NOx | VOC | SOx | PM10 | PM2.5 | CO | NOx | VOC | SOx | PM10 | PM2.5 |
| **BOMBS** | | | | | | | | | | | | | | | |
| Bombs (H-E) | MITT | 6,454 | 0 | 394,551.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Bombs (N-E) | MITT | 2,820 | 0 | 719.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **PROJECTILES** | | | | | | | | | | | | | | | |
| Small Caliber | MITT | 310,155 | 0 | 713.4 | 30.1 | 0.0 | 0.0 | 15.8 | 11.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Medium Caliber (H-E) | MITT | 23,020 | 4082 | 92.1 | 29.9 | 0.0 | 0.0 | 218.7 | 117.4 | 16.3 | 5.3 | 0.0 | 0.0 | 38.8 | 20.8 |
| Medium Caliber (N-E) | MITT | 309,275 | 0 | 804.1 | 30.0 | 0.0 | 0.0 | 43.3 | 37.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Large Caliber (H-E) | MITT | 6,757 | 240 | 864.9 | 1,081.1 | 0.0 | 0.0 | 64.9 | 50.3 | 30.7 | 38.4 | 0.0 | 0.0 | 2.3 | 1.8 |
| Large Caliber (N-E) | MITT | 24,540 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Missiles (H-E) | MITT | 258 | 20 | 7,900.9 | 9,178.1 | 0.0 | 0.0 | 15,943.1 | 15,943.1 | 612.5 | 711.5 | 0.0 | 0.0 | 1,235.9 | 1,235.9 |
| Missiles (N-E) | MITT | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rockets (H-E) | MITT | 4,100 | 16 | 3,813.0 | 23.0 | 0.0 | 0.0 | 1,640.0 | 1,189.0 | 14.9 | 0.1 | 0.0 | 0.0 | 6.4 | 4.6 |
| Rockets (N-E) | MITT | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **COUNTERMEASURES** | | | | | | | | | | | | | | | |
| Chaff | MITT | 18,204 | 0 | 1.1 | 2.8 | 0.0 | 0.0 | 5.1 | 4.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Flares | MITT | 17,600 | 0 | 1.0 | 2.7 | 0.0 | 0.0 | 5.0 | 4.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **TARGETS** | | | | | | | | | | | | | | | |
| Airborne targets | MITT | 16 | 0 | | | | | | | | | | | | |
| Surface targets | MITT | 240 | 0 | | | | | | | | | | | | |
| Expendable sub-surface targets | MITT | 261 | 0 | | | | | | | | | | | | |
| **TOTAL EMISSIONS (lbs per year)** | | | | 409,461 | 10,378 | 0 | 0 | 17,936 | 17,358 | 674 | 755 | 0 | 0 | 1,283 | 1,263 |
| **TOTAL EMISSIONS (tons per year)** | | | | 204.7 | 5.2 | 0.0 | 0.0 | 9.0 | 8.7 | 0.3 | 0.4 | 0.0 | 0.0 | 0.6 | 0.6 |

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# Appendix E: Estimated Marine Mammal and Sea Turtle Impacts from Exposure to Acoustic and Explosive Stressors Under Navy Training and Testing Activities

# Supplemental Environmental Impact Statement/

# Overseas Environmental Impact Statement

# Mariana Islands Training and Testing

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# APPENDIX E ESTIMATED MARINE MAMMAL AND SEA TURTLE IMPACTS FROM EXPOSURE TO ACOUSTIC AND EXPLOSIVE STRESSORS UNDER NAVY TRAINING AND TESTING ACTIVITIES

Navy training and testing activities would result in the incidental takes of marine mammals and sea turtles within the Study Area. This appendix provides the estimated number of marine mammal and sea turtle impacts. Specifically, estimated impacts are derived from the quantitative analysis for activities under Alternatives 1 and 2 that involve the use of acoustic or explosive stressors. The quantitative analysis takes into account Navy activities, marine species density layers, acoustic modeling, and other environmental parameters. A detailed explanation of the quantitative analysis is provided in the technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018). It is important to note that *impacts*, as discussed in this appendix, represent the estimated instances of take of marine mammals or sea turtles, not necessarily the number of individuals impacted (i.e., some marine mammals or sea turtles could be impacted several times, while others would not experience any impact). In addition, across training and testing activities, the seven-year total impacts in each table may be more or less than seven times the maximum impact in any year, because the level of certain activities may vary annually as described in Chapter 2 (Description of Proposed Action and Alternatives).

## E.1 ESTIMATED MARINE MAMMAL IMPACTS FROM SONAR AND OTHER TRANSDUCERS UNDER NAVY TRAINING AND TESTING ACTIVITIES

Table E-1 provides a summary of the estimated number of marine mammal impacts from exposure to sonar and other transducers used during Navy training and testing activities under Alternatives 1 and 2 over the course of one year.

**Table E-1: Estimated Marine Mammals Impacts per Year from Sonar Training and Testing Activities**

| Species | Alternative 1 – Minimum | | | Alternative 1 – Maximum | | | Alternative 2 – Maximum | | |
|---|---|---|---|---|---|---|---|---|---|
| | Behavioral Response | TTS | PTS | Behavioral Response | TTS | PTS | Behavioral Response | TTS | PTS |
| **Mysticetes** | | | | | | | | | |
| Blue whale* | 3 | 18 | 0 | 3 | 18 | 0 | 4 | 20 | 0 |
| Bryde's whale | 33 | 236 | 0 | 33 | 236 | 0 | 36 | 256 | 0 |
| Fin whale* | 4 | 19 | 0 | 4 | 19 | 0 | 5 | 20 | 0 |
| Humpback whale* | 46 | 387 | 0 | 46 | 387 | 0 | 51 | 419 | 0 |
| Minke whale | 8 | 78 | 0 | 8 | 78 | 0 | 9 | 85 | 0 |
| Omura's whale | 3 | 23 | 0 | 3 | 23 | 0 | 3 | 25 | 0 |
| Sei whale* | 15 | 125 | 0 | 15 | 125 | 0 | 17 | 135 | 0 |
| **Odontocetes** | | | | | | | | | |
| Blainville's beaked whale | 1,553 | 26 | 0 | 1,557 | 26 | 0 | 1,691 | 27 | 0 |
| Bottlenose dolphin | 104 | 21 | 0 | 104 | 21 | 0 | 116 | 21 | 0 |
| Cuvier's beaked whale | 600 | 4 | 0 | 600 | 4 | 0 | 642 | 4 | 0 |
| Dwarf sperm whale | 1,179 | 6,428 | 28 | 1,186 | 6,435 | 28 | 1,290 | 7,046 | 29 |
| False killer whale | 571 | 116 | 0 | 573 | 116 | 0 | 641 | 120 | 0 |
| Fraser's dolphin | 10,123 | 1,896 | 0 | 10,150 | 1,896 | 0 | 11,323 | 1,947 | 0 |
| Ginkgo-toothed beaked whale | 3,367 | 63 | 0 | 3,373 | 63 | 0 | 3,659 | 65 | 0 |
| Killer whale | 32 | 7 | 0 | 32 | 7 | 0 | 37 | 8 | 0 |
| Longman's beaked whale | 5,473 | 104 | 0 | 5,483 | 104 | 0 | 5,958 | 106 | 0 |

**Table E-1: Estimated Marine Mammals Impacts per Year from Sonar Training and Testing Activities (continued)**

| Species | Alternative 1 – Minimum | | | Alternative 1 – Maximum | | | Alternative 2 – Maximum | | |
|---|---|---|---|---|---|---|---|---|---|
| | Behavioral Response | TTS | PTS | Behavioral Response | TTS | PTS | Behavioral Response | TTS | PTS |
| Melon-headed whale | 2,059 | 489 | 0 | 2,064 | 489 | 0 | 2,305 | 508 | 0 |
| Pantropical spotted dolphin | 10,733 | 2,717 | 0 | 10,794 | 2,717 | 0 | 12,074 | 2,816 | 0 |
| Pygmy killer whale | 77 | 16 | 0 | 78 | 16 | 0 | 87 | 17 | 0 |
| Pygmy sperm whale | 463 | 2,594 | 11 | 465 | 2,596 | 11 | 509 | 2,840 | 11 |
| Risso's dolphin | 2,358 | 505 | 0 | 2,365 | 505 | 0 | 2,648 | 519 | 0 |
| Rough-toothed dolphin | 145 | 35 | 0 | 145 | 35 | 0 | 161 | 36 | 0 |
| Short-finned pilot whale | 874 | 172 | 0 | 876 | 172 | 0 | 987 | 177 | 0 |
| Sperm whale* | 183 | 11 | 0 | 184 | 11 | 0 | 192 | 11 | 0 |
| Spinner dolphin | 1,040 | 223 | 0 | 1,042 | 223 | 0 | 1,185 | 228 | 0 |
| Striped dolphin | 2,891 | 722 | 0 | 2,900 | 722 | 0 | 3,254 | 751 | 0 |

* ESA-listed species within the MITT Study Area

Notes: PTS = permanent threshold shift, TTS = temporary threshold shift

## E.2 ESTIMATED MARINE MAMMAL IMPACTS PER SEVEN-YEAR PERIOD FROM SONAR AND OTHER TRANSDUCERS UNDER NAVY TRAINING AND TESTING ACTIVITIES

Table E-2 provides a summary of the estimated number of marine mammal impacts from exposure to sonar and other transducers used during Navy training and testing activities under Alternatives 1 and 2 over the course of seven years.

**Table E-2: Estimated Marine Mammals Impacts per Seven-Year Period from Sonar Training and Testing Activities**

| *Species* | *Alternative 1 – 7-Year* | | | *Alternative 2 – 7-Year* | | |
|---|---|---|---|---|---|---|
| | *Behavioral Response* | *TTS* | *PTS* | *Behavioral Response* | *TTS* | *PTS* |
| ***Mysticetes*** | | | | | | |
| Blue whale* | 26 | 103 | 0 | 29 | 140 | 0 |
| Bryde's whale | 226 | 1,338 | 0 | 254 | 1,792 | 0 |
| Fin whale* | 30 | 100 | 0 | 34 | 139 | 0 |
| Humpback whale* | 318 | 2,199 | 0 | 358 | 2,933 | 0 |
| Minke whale | 56 | 452 | 0 | 62 | 590 | 0 |
| Omura's whale | 20 | 130 | 0 | 23 | 172 | 0 |
| Sei whale* | 105 | 708 | 0 | 118 | 947 | 0 |
| ***Odontocetes*** | | | | | | |
| Blainville's beaked whale | 10,117 | 117 | 0 | 11,844 | 187 | 0 |
| Bottlenose dolphin | 673 | 92 | 0 | 811 | 150 | 0 |
| Cuvier's beaked whale | 3,924 | 19 | 0 | 4,498 | 30 | 0 |
| Dwarf sperm whale | 8,274 | 37,761 | 126 | 9,030 | 49,298 | 203 |
| False killer whale | 3,700 | 528 | 0 | 4,487 | 841 | 0 |
| Fraser's dolphin | 64,858 | 8,401 | 0 | 79,242 | 13,627 | 0 |
| Ginkgo-toothed beaked whale | 21,937 | 280 | 0 | 25,627 | 452 | 0 |
| Killer whale | 209 | 32 | 0 | 255 | 54 | 0 |
| Longman's beaked whale | 35,630 | 477 | 0 | 41,731 | 743 | 0 |
| Melon-headed whale | 13,364 | 2,179 | 0 | 16,127 | 3,552 | 0 |
| Pantropical spotted dolphin | 69,701 | 12,367 | 0 | 84,487 | 19,707 | 0 |
| Pygmy killer whale | 499 | 71 | 0 | 609 | 116 | 0 |
| Pygmy sperm whale | 3,246 | 15,230 | 49 | 3,560 | 19,868 | 79 |
| Risso's dolphin | 15,223 | 2,288 | 0 | 18,535 | 3,629 | 0 |
| Rough-toothed dolphin | 943 | 161 | 0 | 1,127 | 251 | 0 |
| Short-finned pilot whale | 5,639 | 793 | 0 | 6,901 | 1,235 | 0 |
| Sperm whale* | 1,087 | 46 | 0 | 1,345 | 75 | 0 |
| Spinner dolphin | 6,747 | 970 | 0 | 8,292 | 1,598 | 0 |
| Striped dolphin | 18,723 | 3,257 | 0 | 22,776 | 5,250 | 0 |

* ESA-listed species within the MITT Study Area
Notes: PTS = permanent threshold shift, TTS = temporary threshold shift

## E.3 Estimated Marine Mammal Impacts from Explosives Under Navy Training and Testing Activities

Table E-3 provides a summary of the estimated number of marine mammal impacts from exposure to explosives used during Navy training and testing activities under Alternatives 1 and 2 over the course of one year.

**Table E-3: Estimated Marine Mammals Impacts per Year from Explosive Training and Testing Activities**

| Species | Alternative 1 – Minimum | | | | Alternative 1 – Maximum | | | | Alternative 2 – Maximum | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Behavioral Response | TTS | PTS | Injury | Behavioral Response | TTS | PTS | Injury | Behavioral Response | TTS | PTS | Injury |
| ***Mysticetes*** | | | | | | | | | | | | |
| Blue whale* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bryde's whale | 2 | 2 | 0 | 0 | 3 | 2 | 0 | 0 | 3 | 2 | 0 | 0 |
| Fin whale* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Humpback whale* | 5 | 2 | 0 | 0 | 6 | 2 | 0 | 0 | 7 | 4 | 0 | 0 |
| Minke whale | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| Omura's whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sei whale* | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 1 | 0 | 0 |
| ***Odontocetes*** | | | | | | | | | | | | |
| Blainville's beaked whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bottlenose dolphin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cuvier's beaked whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dwarf sperm whale | 57 | 89 | 17 | 0 | 58 | 92 | 18 | 0 | 64 | 100 | 20 | 0 |
| False killer whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fraser's dolphin | 4 | 5 | 1 | 0 | 4 | 5 | 1 | 0 | 4 | 5 | 1 | 0 |
| Ginkgo-toothed beaked whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Killer whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table E-3: Estimated Marine Mammals Impacts per Year from Explosive Training and Testing Activities (continued)**

| Species | Alternative 1 – Minimum | | | | Alternative 1 – Maximum | | | | Alternative 2 – Maximum | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Behavioral Response | TTS | PTS | Injury | Behavioral Response | TTS | PTS | Injury | Behavioral Response | TTS | PTS | Injury |
| Longman's beaked whale | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| Melon-headed whale | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Pantropical spotted dolphin | 4 | 2 | 1 | 0 | 4 | 2 | 1 | 0 | 5 | 3 | 1 | 0 |
| Pygmy killer whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pygmy sperm whale | 23 | 32 | 7 | 0 | 23 | 33 | 8 | 0 | 25 | 37 | 9 | 0 |
| Risso's dolphin | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| Rough-toothed dolphin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Short-finned pilot whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sperm whale* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spinner dolphin | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| Striped dolphin | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |

* ESA-listed species within the MITT Study Area
Notes: PTS = permanent threshold shift, TTS = temporary threshold shift

## E.4 Estimated Marine Mammal Impacts per Seven-Year Period from Explosives Under Navy Training and Testing Activities

Table E-4 provides a summary of the estimated number of marine mammal impacts from exposure to explosives used during Navy training and testing activities under Alternatives 1 and 2 over the course of seven years.

**Table E-4: Estimated Marine Mammals Impacts per Seven-Year Period from Explosive Training and Testing Activities**

| Species | Alternative 1 – 7-Year | | | | Alternative 2 – 7-Year | | | |
|---|---|---|---|---|---|---|---|---|
| | Behavioral Response | TTS | PTS | Injury | Behavioral Response | TTS | PTS | Injury |
| ***Mysticetes*** | | | | | | | | |
| Blue whale* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bryde's whale | 22 | 11 | 0 | 0 | 22 | 11 | 0 | 0 |
| Fin whale* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Humpback whale* | 38 | 19 | 0 | 0 | 39 | 20 | 0 | 0 |
| Minke whale | 8 | 0 | 0 | 0 | 8 | 0 | 0 | 0 |
| Omura's whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sei whale* | 11 | 0 | 0 | 0 | 11 | 3 | 0 | 0 |
| ***Odontocetes*** | | | | | | | | |
| Blainville's beaked whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bottlenose dolphin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cuvier's beaked whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dwarf sperm whale | 404 | 635 | 125 | 0 | 446 | 686 | 137 | 0 |
| False killer whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fraser's dolphin | 28 | 30 | 6 | 0 | 29 | 33 | 7 | 0 |
| Ginkgo-toothed beaked whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Killer whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Longman's beaked whale | 4 | 6 | 0 | 0 | 5 | 7 | 0 | 0 |

**Table E-4: Estimated Marine Mammals Impacts per Seven-Year Period from Explosive Training and Testing Activities (continued)**

| Species | Alternative 1 – 7-Year | | | | Alternative 2 – 7-Year | | | |
|---|---|---|---|---|---|---|---|---|
| | Behavioral Response | TTS | PTS | Injury | Behavioral Response | TTS | PTS | Injury |
| Melon-headed whale | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| Pantropical spotted dolphin | 28 | 17 | 5 | 0 | 29 | 18 | 6 | 0 |
| Pygmy killer whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pygmy sperm whale | 160 | 231 | 52 | 0 | 175 | 250 | 56 | 0 |
| Risso's dolphin | 4 | 0 | 0 | 0 | 5 | 4 | 0 | 0 |
| Rough-toothed dolphin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Short-finned pilot whale | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sperm whale* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spinner dolphin | 0 | 4 | 0 | 0 | 0 | 4 | 0 | 0 |
| Striped dolphin | 0 | 4 | 0 | 0 | 0 | 5 | 0 | 0 |

* ESA-listed species within the MITT Study Area

Notes: PTS = permanent threshold shift, TTS = temporary threshold shift

## E.5 Estimated Sea Turtle Impacts from Sonar and Other Transducers Under Navy Training and Testing Activities

Based on the quantitative analysis, no sea turtle impacts are anticipated from exposure to sonar and other transducers used during Navy training and testing activities under Alternatives 1 and 2 over the course of one year or seven years.

## E.6 Estimated Sea Turtle Impacts from Explosives Under Navy Training and Testing Activities

Table E-5 provides a summary of the estimated number of sea turtle impacts from exposure to explosives used during Navy training and testing activities under Alternatives 1 and 2 over the course of one year.

**Table E-5: Estimated Sea Turtle Impacts per Year from Explosive Training and Testing Activities**

| ***Species*** | ***Alternative 1 – Minimum*** | | | ***Alternative 1 – Maximum*** | | | ***Alternative 2 – Maximum*** | | |
|---|---|---|---|---|---|---|---|---|---|
| | ***TTS*** | ***PTS*** | ***Injury*** | ***TTS*** | ***PTS*** | ***Injury*** | ***TTS*** | ***PTS*** | ***Injury*** |
| ***Explosive Training and Testing Activities*** | | | | | | | | | |
| ***Family Cheloniidae (hardshell turtles)*** | | | | | | | | | |
| Green turtle* | 6 | 3 | 0 | 6 | 3 | 0 | 6 | 3 | 0 |
| Hawksbill turtle* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Loggerhead turtle* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Family Dermochelyidae (scuteless turtles)*** | | | | | | | | | |
| Leatherback turtle* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

* ESA-listed species within the MITT Study Area
Notes: PTS = permanent threshold shift, TTS = temporary threshold shift

## E.7 ESTIMATED SEA TURTLE IMPACTS PER SEVEN-YEAR PERIOD FROM EXPLOSIVES UNDER NAVY TRAINING AND TESTING ACTIVITIES

Table E-6 provides a summary of the estimated number of sea turtle impacts from exposure to explosives used during Navy training and testing activities under Alternatives 1 and 2 per seven-year period.

**Table E-6: Estimated Sea Turtle Impacts per Seven-Year Period from Explosive Training and Testing Activities**

| *Species* | *Alternative 1 – 7-Year* | | | *Alternative 2 – 7-Year* | | |
|---|---|---|---|---|---|---|
| | *TTS* | *PTS* | *Injury* | *TTS* | *PTS* | *Injury* |
| ***Explosive Training and Testing Activities*** | | | | | | |
| ***Family Cheloniidae (hardshell turtles)*** | | | | | | |
| Green turtle* | 40 | 20 | 0 | 40 | 20 | 0 |
| Hawksbill turtle* | 0 | 0 | 0 | 0 | 0 | 0 |
| Loggerhead turtle* | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Family Dermochelyidae (scuteless turtles)*** | | | | | | |
| Leatherback turtle* | 0 | 0 | 0 | 0 | 0 | 0 |

* ESA-listed species within the MITT Study Area
Notes: PTS = permanent threshold shift, TTS = temporary threshold shift

# REFERENCES

U.S. Department of the Navy. (2018). *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (Technical Report prepared by NUWC Division Newport, Space and Naval Warfare Systems Center Pacific, G2 Software Systems, and the National Marine Mammal Foundation). Newport, RI: Naval Undersea Warfare Center.

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# Appendix F: Training and Testing Activities Matrices

# Supplemental Environmental Impact Statement/
# Overseas Environmental Impact Statement
# Mariana Islands Training and Testing
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# APPENDIX F TRAINING AND TESTING ACTIVITIES MATRICES

This appendix contains three matrices. The first two matrices (Table F-1 and Table F-2) in this appendix list the training and testing activities that occur in the Mariana Islands Training and Testing Study Area and their associated stressors. The third matrix (Table F-3) lists the resources analyzed in this Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement and the stressors they are potentially affected by.

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**Table F-1: Stressors by Training Activity**

| Mariana Islands Training Activity | Biological Resources | | | | | | | | | | | | | | | | | | | Physical Resources | | | | | Human Resources[2] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Acoustic Stressors* | | | | *Explosives* | | *Energy Stressors* | | | *Physical Disturbance and Strike Stressors* | | | | | | *Entanglement Stressors* | | *Ingestion Stressors* | | *Air Quality Stressor* | *Sediments and Water Quality Stressors* | | | | *Cultural Resource Stressors* | | *Socioeconomic Stressors* | | | *Public Health & Safety Stressors* | | |
| | *Sonar & Other Transducers* | *Vessel Noise* | *Aircraft Noise* | *Weapons Noise* | *In-Air Explosions* | *In-Water Explosions* | *In-Air Electromagnetic Devices* | *In-Water Electromagnetic Devices* | *High Energy Lasers* | *Vessels & In-water Devices* | *Aircraft & Aerial Targets* | *Military Expended Material* | *Seafloor Devices* | *Ground Disturbance* | *Wildfires* | *Wires & Cables* | *Decelerators/Parachutes* | *Military Expended Materials – Munitions* | *Military Expended Materials – Other than Munitions* | *Criteria Air Pollutants* | *Explosives* | *Metals* | *Chemicals* | *Other Materials* [1] | *Explosives* [3] | *Physical Disturbance & Strike* [4] | *Accessibility* [5] | *Airborne Acoustics* [6] | *Physical Disturbance & Strike* [4] | *Underwater Energy* [7] | *In-Air Energy* [8] | *Physical Interactions* [9] |
| **Major Training Exercises** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Joint Expeditionary Exercise | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Joint Multi-Strike Group Exercise (decrease for Alt 1 only) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Marine Air Ground Task Force Exercise (Amphibious) – Battalion | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Air Warfare (AW)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Air Combat Maneuver (ACM) | | | ✓ | | | | ✓ | | | | ✓ | | | | | | | | | ✓ | | ✓ | | | | | | ✓ | ✓ | | | |
| Air Defense Exercise (ADEX) | | ✓ | ✓ | | | | ✓ | | | ✓ | ✓ | | | | | | | | | ✓ | | | | | | ✓ | | ✓ | ✓ | | | ✓ |
| Air Intercept Control (AIC) | | | ✓ | | | | | | | | ✓ | | | | | | | | | ✓ | | | | | | | | ✓ | ✓ | | | |
| Gunnery Exercise (Air-to-Air) Medium-Caliber GUNEX A-A | | | ✓ | ✓ | | | ✓ | | | | ✓ | ✓ | | | | | | ✓ | | ✓ | | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| Gunnery Exercise (Surface-to-Air) Large-Caliber GUNEX S-A | | ✓ | ✓ | ✓ | ✓ | | ✓ | | | ✓ | ✓ | ✓ | | | | | | ✓ | | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Gunnery Exercise (Surface-to-Air) Medium-Caliber GUNEX S-A | | ✓ | ✓ | ✓ | ✓ | | ✓ | | | ✓ | ✓ | ✓ | | | | | | ✓ | | ✓ | | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| Missile Exercise (Air-to-Air) MISSILEX A-A | | ✓ | ✓ | ✓ | ✓ | | ✓ | | | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| Missile Exercise (Surface-to-Air) MISSILEX S-A | | ✓ | ✓ | ✓ | ✓ | | ✓ | | | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| **Amphibious Warfare (AW)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Amphibious Rehearsal, No Landing | | ✓ | | | | | | | | ✓ | | | | | | | | | | ✓ | | | | | | ✓ | ✓ | | ✓ | | | ✓ |
| Amphibious Assault | | ✓ | ✓ | | | | | | | ✓ | ✓ | | | | | | | | | ✓ | | | | | | ✓ | ✓ | | ✓ | | | ✓ |

Legend: (blue) = Decrease in number of events from 2015 Final MITT EIS/OEIS; (orange) = Increase in number of events from 2015 Final MITT EIS/OEIS

**Table F-1: Stressors by Training Activity (continued)**

| *Mariana Islands Training Activity* | *Biological Resources* | | | | | | | | | | | | | | | | | | | *Physical Resources* | | | | | *Human Resources[2]* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Acoustic Stressors* | | | | *Explosives* | | *Energy Stressors* | | | *Physical Disturbance and Strike Stressors* | | | | | | *Entanglement Stressors* | | *Ingestion Stressors* | | *Air Quality Stressor* | *Sediments and Water Quality Stressors* | | | | *Cultural Resource Stressors* | | *Socioeconomic Stressors* | | | *Public Health & Safety Stressors* | | |
| | *Sonar & Other Transducers* | *Vessel Noise* | *Aircraft Noise* | *Weapons Noise* | *In-Air Explosions* | *In-Water Explosions* | *In-Air Electromagnetic Devices* | *In-Water Electromagnetic Devices* | *High Energy Lasers* | *Vessels & In-water Devices* | *Aircraft & Aerial Targets* | *Military Expended Material* | *Seafloor Devices* | *Ground Disturbance* | *Wildfires* | *Wires & Cables* | *Decelerators/Parachutes* | *Military Expended Materials – Munitions* | *Military Expended Materials – Other than Munitions* | *Criteria Air Pollutants* | *Explosives* | *Metals* | *Chemicals* | *Other Materials [1]* | *Explosives [3]* | *Physical Disturbance & Strike [4]* | *Accessibility [5]* | *Airborne Acoustics [6]* | *Physical Disturbance & Strike [4]* | *Underwater Energy [7]* | *In-Air Energy [8]* | *Physical Interactions [9]* |
| **Amphibious Warfare (AW) (Continued)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Amphibious Raid | | ✓ | ✓ | | | | | | | ✓ | ✓ | | | | | | | | | ✓ | | | | | | ✓ | ✓ | | ✓ | | | ✓ |
| Humanitarian Assistance/Disaster Relief Operations | | ✓ | ✓ | | | | ✓ | | | ✓ | ✓ | | | | | | | | | ✓ | | | | | | ✓ | ✓ | | ✓ | | | ✓ |
| Naval Surface Fire Support Exercise – Land-based target (Land) (increase Alt 2 only) | | ✓ | | ✓ | ✓ | | | ✓ | | ✓ | | | | | | | | | | ✓ | | | | | | | ✓ | ✓ | | | | ✓ |
| Noncombatant Evacuation Operation | | ✓ | ✓ | | | | ✓ | | | ✓ | ✓ | | | | | | | | | ✓ | | ✓ | ✓ | ✓ | | | ✓ | | ✓ | | | ✓ |
| Special Purpose Marine Air Ground Task Force Exercise | | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Unmanned Aerial Vehicle – Intelligence, Surveillance, and Reconnaissance | | | ✓ | | | | | | | | ✓ | | | | | | | | | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| **Anti-Submarine Warfare (ASW)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Torpedo Exercise (TORPEX) – Helicopter (increase Alt 2 only) | ✓ | ✓ | ✓ | | | | ✓ | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Torpedo Exercise (TORPEX) – Maritime Patrol Aircraft (increase Alt 2 only) | ✓ | | ✓ | | | | ✓ | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Torpedo Exercise (TORPEX) – Submarine | ✓ | ✓ | | | | | | | | ✓ | | ✓ | | | | ✓ | | | ✓ | | | ✓ | | | | ✓ | | | ✓ | ✓ | | ✓ |
| Torpedo Exercise (TORPEX) – Surface | ✓ | ✓ | | | | | ✓ | | | ✓ | | ✓ | | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Tracking Exercise (TRACKEX) – Helicopter | ✓ | | ✓ | | | | ✓ | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |

**Table F-1: Stressors by Training Activity (continued)**

| Mariana Islands Training Activity | *Biological Resources* | | | | | | | | | | | | | | | | | | | *Physical Resources* | | | | | *Human Resources*[2] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Acoustic Stressors* | | | | *Explosives* | | *Energy Stressors* | | | *Physical Disturbance and Strike Stressors* | | | | | | *Entanglement Stressors* | | *Ingestion Stressors* | | *Air Quality Stressor* | *Sediments and Water Quality Stressors* | | | | *Cultural Resource Stressors* | | *Socioeconomic Stressors* | | | *Public Health & Safety Stressors* | | |
| | *Sonar & Other Transducers* | *Vessel Noise* | *Aircraft Noise* | *Weapons Noise* | *In-Air Explosions* | *In-Water Explosions* | *In-Air Electromagnetic Devices* | *In-Water Electromagnetic Devices* | *High Energy Lasers* | *Vessels & In-water Devices* | *Aircraft & Aerial Targets* | *Military Expended Material* | *Seafloor Devices* | *Ground Disturbance* | *Wildfires* | *Wires & Cables* | *Decelerators/Parachutes* | *Military Expended Materials – Munitions* | *Military Expended Materials – Other than Munitions* | *Criteria Air Pollutants* | *Explosives* | *Metals* | *Chemicals* | *Other Materials*[1] | *Explosives*[3] | *Physical Disturbance & Strike*[4] | *Accessibility*[5] | *Airborne Acoustics*[6] | *Physical Disturbance & Strike*[4] | *Underwater Energy*[7] | *In-Air Energy*[8] | *Physical Interactions*[9] |
| **Anti-Submarine Warfare (ASW) (Continued)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tracking Exercise (TRACKEX) – Maritime Patrol Aircraft | ✓ | | ✓ | | | | ✓ | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Tracking Exercise (TRACKEX)– Submarine | ✓ | ✓ | | | | | | | | ✓ | | ✓ | | | | ✓ | | | | | | ✓ | | | | ✓ | | | ✓ | ✓ | | ✓ |
| Tracking Exercise (TRACKEX) – Surface | ✓ | ✓ | | | | | ✓ | ✓ | | ✓ | | ✓ | | | | ✓ | | | | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Small Joint Coordinated ASW Exercise (Multi-Sail/GUAMEX) | ✓ | ✓ | ✓ | | | | ✓ | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Electronic Warfare (EW)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Counter Targeting Chaff Exercise – Aircraft | | | ✓ | | | | | | | | ✓ | ✓ | | | | | | | ✓ | ✓ | | | | ✓ | | | | ✓ | | | | ✓ |
| Counter Targeting Chaff Exercise – Ship | | ✓ | | | | | | | | ✓ | | ✓ | | | | | | | ✓ | ✓ | | | | ✓ | | | ✓ | | | | | ✓ |
| Counter Targeting Flare Exercise – Aircraft | | | ✓ | | | | ✓ | | | | ✓ | ✓ | | | | | | | ✓ | ✓ | | ✓ | | ✓ | | | | ✓ | | | | ✓ |
| Electronic Warfare Operations | | ✓ | ✓ | | | | ✓ | | | ✓ | ✓ | | | | | | | | | ✓ | | | | | | | ✓ | ✓ | ✓ | | | ✓ |
| **Expeditionary Warfare** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Parachute Insertion | | ✓ | ✓ | | | | | | | ✓ | ✓ | | | | | | | | | ✓ | ✓ | | | ✓ | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| Personnel Insertion/Extraction | | ✓ | ✓ | | | | | | | ✓ | ✓ | | | | | | | | | ✓ | | | | | | ✓ | ✓ | | ✓ | | | ✓ |
| **Mine Warfare (MIW)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Civilian Port Defense | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Limpet Mine Neutralization System | | ✓ | | | | ✓ | | | | ✓ | | | | | | | | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |

**Table F-1: Stressors by Training Activity (continued)**

| *Mariana Islands Training Activity* | *Biological Resources* | | | | | | | | | | | | | | | | | | | *Physical Resources* | | | | | *Human Resources[2]* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Acoustic Stressors* | | | | *Explosives* | | *Energy Stressors* | | | *Physical Disturbance and Strike Stressors* | | | | | | *Entanglement Stressors* | | *Ingestion Stressors* | | *Air Quality Stressor* | *Sediments and Water Quality Stressors* | | | | *Cultural Resource Stressors* | | *Socioeconomic Stressors* | | | *Public Health & Safety Stressors* | | |
| | *Sonar & Other Transducers* | *Vessel Noise* | *Aircraft Noise* | *Weapons Noise* | *In-Air Explosions* | *In-Water Explosions* | *In-Air Electromagnetic Devices* | *In-Water Electromagnetic Devices* | *High Energy Lasers* | *Vessels & In-water Devices* | *Aircraft & Aerial Targets* | *Military Expended Material* | *Seafloor Devices* | *Ground Disturbance* | *Wildfires* | *Wires & Cables* | *Decelerators/Parachutes* | *Military Expended Materials – Munitions* | *Military Expended Materials – Other than Munitions* | *Criteria Air Pollutants* | *Explosives* | *Metals* | *Chemicals* | *Other Materials[1]* | *Explosives[3]* | *Physical Disturbance & Strike[4]* | *Accessibility[5]* | *Airborne Acoustics[6]* | *Physical Disturbance & Strike[4]* | *Underwater Energy[7]* | *In-Air Energy[8]* | *Physical Interactions[9]* |
| **Mine Warfare (MIW) (Continued)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mine Neutralization – Remotely Operated Vehicle Sonar (ASQ-235 [AQS-20], SLQ-48) | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Mine Countermeasure Exercise – Surface Ship Sonar (SQQ-32, MCM) | ✓ | ✓ | | | | | ✓ | | | ✓ | | | ✓ | | | | | | | ✓ | | | | | | | ✓ | | | ✓ | | ✓ |
| Mine Countermeasure – Towed Mine Neutralization | | ✓ | ✓ | | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | | | | | | | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Airborne Mine Countermeasure – Towed Mine Detection | ✓ | ✓ | ✓ | | | | | | | ✓ | ✓ | | ✓ | | | | | | | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Mine Countermeasure Exercise – Towed Sonar (AQS-20, LCS) | ✓ | ✓ | | | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | | | | | | | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Mine Laying | | ✓ | ✓ | | | | | | | | ✓ | ✓ | ✓ | | | | | | | ✓ | | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| Mine Neutralization – Explosive Ordnance Disposal | | ✓ | ✓ | | | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Submarine Mine Exercise | ✓ | | | | | | | | | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | | ✓ | | ✓ |
| Surface Ship Object Detection | ✓ | ✓ | | | | | | | | ✓ | | | ✓ | | | | | | | ✓ | | | | | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Underwater Demolition Qualification/Certification | | ✓ | ✓ | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| **Strike Warfare (STW)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bombing Exercise (Air-to-Ground) | | | ✓ | | | | | | | | ✓ | ✓ | | | | | | | | ✓ | | ✓ | | | ✓ | ✓ | | ✓ | | | | |
| Gunnery Exercise (Air-to-Ground) | | | ✓ | ✓ | | | | | | | ✓ | ✓ | | | | | | ✓ | | ✓ | | ✓ | | | ✓ | ✓ | | ✓ | | | | |
| Missile Exercise (MISSILEX) | | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ | | | | | | | | ✓ | | ✓ | | | ✓ | ✓ | | ✓ | | | | |

**Table F-1: Stressors by Training Activity (continued)**

| ***Mariana Islands Training Activity*** | *Biological Resources* | | | | | | | | | | | | | | | | | | | *Physical Resources* | | | | | *Human Resources*[2] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Acoustic Stressors* | | | | *Explosives* | | *Energy Stressors* | | | *Physical Disturbance and Strike Stressors* | | | | | | *Entanglement Stressors* | | *Ingestion Stressors* | | *Air Quality Stressor* | *Sediments and Water Quality Stressors* | | | | *Cultural Resource Stressors* | | *Socioeconomic Stressors* | | | *Public Health & Safety Stressors* | | |
| | *Sonar & Other Transducers* | *Vessel Noise* | *Aircraft Noise* | *Weapons Noise* | *In-Air Explosions* | *In-Water Explosions* | *In-Air Electromagnetic Devices* | *In-Water Electromagnetic Devices* | *High Energy Lasers* | *Vessels & In-water Devices* | *Aircraft & Aerial Targets* | *Military Expended Material* | *Seafloor Devices* | *Ground Disturbance* | *Wildfires* | *Wires & Cables* | *Decelerators/Parachutes* | *Military Expended Materials – Munitions* | *Military Expended Materials – Other than Munitions* | *Criteria Air Pollutants* | *Explosives* | *Metals* | *Chemicals* | *Other Materials* [1] | *Explosives* [3] | *Physical Disturbance & Strike* [4] | *Accessibility* [5] | *Airborne Acoustics* [6] | *Physical Disturbance & Strike* [4] | *Underwater Energy* [7] | *In-Air Energy* [8] | *Physical Interactions* [9] |
| **Surface Warfare (SUW)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bombing Exercise (Air-to-Surface) | | ✓ | ✓ | ✓ | | ✓ | | | | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Gunnery Exercise (Air-to-Surface) – Medium-Caliber | | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Gunnery Exercise (Air-to-Surface) – Small-Caliber | | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ | | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| Gunnery Exercise (Surface-to-Surface) Boat – Small- and Medium-Caliber | | ✓ | | ✓ | ✓ | | | | | ✓ | | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Gunnery Exercise (Surface-to-Surface) Ship – Large-Caliber | | ✓ | | ✓ | ✓ | ✓ | | | | ✓ | | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Gunnery Exercise (Surface-to-Surface) Ship – Small- and Medium-Caliber | | ✓ | | ✓ | ✓ | ✓ | ✓ | | | ✓ | | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Laser Targeting (at sea) | | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ | | | | | | | | | ✓ | | | | | | | ✓ | | ✓ | | ✓ | ✓ |
| Maritime Security Operations | | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | | | | ✓ | | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Missile Exercise (Air-to-Surface) MISSILEX | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Missile Exercise (Air-to-Surface) Rocket | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Missile Exercise (Surface-to-Surface) | | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Sinking Exercise | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Other Training Activities** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Direct Action (Tactical Air Control Party) | | ✓ | ✓ | | | | | | | ✓ | ✓ | | | | | | | | | ✓ | | | | | | | | | | | | |

**Table F-1: Stressors by Training Activity (continued)**

| Mariana Islands Training Activity | *Biological Resources* | | | | | | | | | | | | | | | | | | | *Physical Resources* | | | | | *Human Resources*[2] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Acoustic Stressors* | | | | *Explosives* | | *Energy Stressors* | | | *Physical Disturbance and Strike Stressors* | | | | | | *Entanglement Stressors* | | *Ingestion Stressors* | | *Air Quality Stressor* | *Sediments and Water Quality Stressors* | | | | *Cultural Resource Stressors* | | *Socioeconomic Stressors* | | | *Public Health & Safety Stressors* | | |
| | *Sonar & Other Transducers* | *Vessel Noise* | *Aircraft Noise* | *Weapons Noise* | *In-Air Explosions* | *In-Water Explosions* | *In-Air Electromagnetic Devices* | *In-Water Electromagnetic Devices* | *High Energy Lasers* | *Vessels & In-water Devices* | *Aircraft & Aerial Targets* | *Military Expended Material* | *Seafloor Devices* | *Ground Disturbance* | *Wildfires* | *Wires & Cables* | *Decelerators/Parachutes* | *Military Expended Materials – Munitions* | *Military Expended Materials – Other than Munitions* | *Criteria Air Pollutants* | *Explosives* | *Metals* | *Chemicals* | *Other Materials* [1] | *Explosives* [3] | *Physical Disturbance & Strike* [4] | *Accessibility* [5] | *Airborne Acoustics* [6] | *Physical Disturbance & Strike* [4] | *Underwater Energy* [7] | *In-Air Energy* [8] | *Physical Interactions* [9] |
| **Other Training Activities (Continued)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Intelligence, Surveillance, Reconnaissance | | ✓ | ✓ | | | | | | | ✓ | ✓ | | | | | ✓ | ✓ | | ✓ | | | | | | | | | ✓ | ✓ | ✓ | | ✓ |
| Precision Anchoring | | ✓ | | | | | | | | ✓ | | | ✓ | | | | | | | ✓ | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | | | ✓ |
| Search and Rescue at Sea | | ✓ | ✓ | | | | | | | ✓ | ✓ | ✓ | | | | | | | | ✓ | | | | | | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Small Boat Attack (increase for Alt 2 only) | | ✓ | | | | | | | | ✓ | | ✓ | | | | | | ✓ | ✓ | ✓ | | ✓ | | | | | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Submarine Navigation | ✓ | | | | | | | | | ✓ | | | | | | | | | | | | | | | | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Submarine Sonar Maintenance | ✓ | | | | | | | | | ✓ | | | | | | | | | | | | | | | | | | ✓ | | ✓ | | |
| Surface Ship Sonar Maintenance | ✓ | ✓ | | | | | ✓ | | | ✓ | | | | | | | | | | ✓ | | | | | | | | | | ✓ | | |
| Underwater Survey | | ✓ | | | | | | | | ✓ | | | | | | | | | | ✓ | | | | | | ✓ | ✓ | | | | | ✓ |
| Unmanned Aerial Vehicle Training and Certification | | ✓ | | | | | | | | ✓ | ✓ | ✓ | | | | | | | | ✓ | | | | | | | | ✓ | | | | |
| Unmanned Underwater Vehicle Training | ✓ | ✓ | | | | | | | | ✓ | | ✓ | ✓ | | | | | | | ✓ | | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

**Legend**: [blue] = Decrease in number of events from 2015 Final MITT EIS/OEIS; [orange] = Increase in number of events from 2015 Final MITT EIS/OEIS

[1] Other Materials include marine markers and flares, chaff, towed and stationary targets, and miscellaneous components of other expended objects
[2] Area of interest is U.S. Territorial Waters (seaward of the mean high water line to 12 nautical miles and any inshore waters)
[3] Vibration and shock waves from underwater explosions
[4] Physical disturbance and strike stressors resulting from in-water devices, military expended materials, seafloor devices, pile driving, and vibration from sonic booms in U.S. territorial waters (seaward of the mean high water line to 12 nautical miles).
[5] Availability of access on the ocean and in the air
[6] Loud noises from weapons firing, in-air explosions, and sonic booms
[7] Active sonar, underwater explosions, air guns, vessel movements, mine warfare training devices, and unmanned underwater systems
[8] Sources of electromagnetic energy and lasers
[9] Interaction of Navy or Marine Corps aircraft, vessels, and equipment with general public
Note: A check indicates training and/or testing event that trigger the stressor as it applies to the specific resource.

## Table F-2: Stressors by Testing Activity

| *Mariana Islands Testing Activity* | *Biological Resources* | | | | | | | | | | | | | | | | | | | *Physical Resources* | | | | | *Human Resources*[2] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Acoustic Stressors* | | | | *Explosives* | | *Energy Stressors* | | | *Physical Disturbance and Strike Stressors* | | | | | | *Entanglement Stressors* | | *Ingestion Stressors* | | *Air Quality Stressor* | *Sediments and Water Quality Stressors* | | | | *Cultural Resource Stressors* | | *Socioeconomic Stressors* | | | *Public Health & Safety Stressors* | | |
| | *Sonar & Other Transducers* | *Vessel Noise* | *Aircraft Noise* | *Weapons Noise* | *In Air Explosions* | *In Water Explosions* | *In-Air Electromagnetic Devices* | *In-Water Electromagnetic Devices* | *High Energy Lasers* | *Vessels & In-water Devices* | *Aircraft & Aerial Targets* | *Military Expended Material* | *Seafloor Devices* | *Ground Disturbance* | *Wildfires* | *Wires & Cables* | *Decelerators/Parachutes* | *Military Expended Materials – Munitions* | *Military Expended Materials – Other than Munitions* | *Criteria Air Pollutants* | *Explosives* | *Metals* | *Chemicals* | *Other Materials*[1] | *Explosives*[3] | *Physical Disturbance & Strike*[4] | *Accessibility*[5] | *Airborne Acoustics*[6] | *Physical Disturbance & Strike*[4] | *Underwater Energy*[7] | *In-Air Energy*[8] | *Physical Interactions*[9] |
| Legend | | | | | | | | | | | | | | | | | | = Decrease in number of events from 2015 Final MITT EIS/OEIS | | | | | | | = Increase in number of events from 2015 Final MITT EIS/OEIS | | | | | | | |
| **NAVAL AIR SYSTEMS COMMAND** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Anti-Submarine Warfare (ASW)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Anti-Submarine Warfare Torpedo Test | ✓ | | ✓ | | | | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft (Sonobuoys) | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| **Electronic Warfare (EW)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Intelligence, Surveillance, Reconnaissance ISR/EW Electronic Warfare Testing (previously named Broad Area Maritime Surveillance Testing – MQ-4C) | | | | | | | ✓ | | | | ✓ | | | | | | | | | ✓ | | | | | | | | ✓ | | | | ✓ |
| **Surface Warfare (SUW)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Air-to-Surface Missile Test | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| **NAVAL SEA SYSTEMS COMMAND** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Anti-Submarine Warfare (ASW)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Anti-Submarine Warfare Mission Package Testing | ✓ | ✓ | ✓ | | | | ✓ | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| At-Sea Sonar Testing | ✓ | | | | | | ✓ | ✓ | | | | ✓ | | | | ✓ | | | | ✓ | | ✓ | | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Torpedo (Explosive) Testing | ✓ | ✓ | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Torpedo (Non-explosive) Testing | ✓ | ✓ | ✓ | | | | ✓ | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Electronic Warfare (EW)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Radar and Other System Testing | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | ✓ | | | | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |

**Table F-2: Stressors by Testing Activity (continued)**

| *Mariana Islands Testing Activity* | *Biological Resources* | | | | | | | | | | | | | | | | | | | *Physical Resources* | | | | | *Human Resources*[2] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Acoustic Stressors* | | | | *Explosives* | | *Energy Stressors* | | | *Physical Disturbance and Strike Stressors* | | | | | | *Entanglement Stressors* | | *Ingestion Stressors* | | *Air Quality Stressor* | *Sediments and Water Quality Stressors* | | | | *Cultural Resource Stressors* | | *Socioeconomic Stressors* | | | *Public Health & Safety Stressors* | | |
| | *Sonar & Other Transducers* | *Vessel Noise* | *Aircraft Noise* | *Weapons Noise* | *In Air Explosions* | *In Water Explosions* | *In-Air Electromagnetic Devices* | *In-Water Electromagnetic Devices* | *High Energy Lasers* | *Vessels & In-water Devices* | *Aircraft & Aerial Targets* | *Military Expended Material* | *Seafloor Devices* | *Ground Disturbance* | *Wildfires* | *Wires & Cables* | *Decelerators/Parachutes* | *Military Expended Materials – Munitions* | *Military Expended Materials – Other than Munitions* | *Criteria Air Pollutants* | *Explosives* | *Metals* | *Chemicals* | *Other Materials* [1] | *Explosives* [3] | *Physical Disturbance & Strike* [4] | *Accessibility* [5] | *Airborne Acoustics* [6] | *Physical Disturbance & Strike* [4] | *Underwater Energy* [7] | *In-Air Energy* [8] | *Physical Interactions* [9] |
| **Mine Warfare (MIW)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mine Countermeasure and Neutralization Testing | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Surface Warfare** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Kinetic Energy Weapon Testing | | ✓ | | ✓ | ✓ | | ✓ | | | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | ✓ | | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| **Vessel Evaluation** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Undersea Warfare Testing | ✓ | ✓ | ✓ | | | | ✓ | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Other Testing Activities** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Simulant Testing | | ✓ | ✓ | | | | ✓ | | | ✓ | ✓ | | | | | | | | | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | | | | ✓ |
| **OFFICE OF NAVAL RESEARCH** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Acoustic and Oceanographic Research | | ✓ | | | | | | | | ✓ | | | ✓ | | | | | | | ✓ | | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Legend: [blue] = Decrease in number of events from 2015 Final MITT EIS/OEIS; [orange] = Increase in number of events from 2015 Final MITT EIS/OEIS

[1] Other Materials include marine markers and flares, chaff, towed and stationary targets, and miscellaneous components of other expended objects
[2] Area of interest is U.S. Territorial Waters (seaward of the mean high water line to 12 nautical miles and any inshore waters)
[3] Vibration and shock waves from underwater explosions.
[4] Physical disturbance and strike stressors resulting from in-water devices, military expended materials, seafloor devices, pile driving, and vibration from sonic booms in U.S. territorial waters (seaward of the mean high water line to 12 nautical miles).
[5] Availability of access on the ocean and in the air
[6] Loud noises from weapons firing, in-air explosions, and sonic booms
[7] Active sonar, underwater explosions, air guns, vessel movements, mine warfare training devices, and unmanned underwater systems
[8] Sources of electromagnetic energy and lasers
[9] Interaction of Navy or Marine Corps aircraft, vessels, and equipment with general public
Note: A check indicates training and/or testing events that trigger the stressor as it applies to the specific resource.

## Table F-3: Stressors by Resource

| ***Stressors vs. Resource*** | | *Biological Resources* | | | | | | | | | | | | | | | | | | | *Physical Resources* | | | | | *Human Resources*[2] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Acoustic Stressors* | | | | *Explosives* | | *Energy Stressors* | | | *Physical Disturbance and Strike Stressors* | | | | | | *Entanglement Stressors* | | *Ingestion Stressors* | | *Air Quality Stressor* | *Sediments and Water Quality Stressors* | | | | *Cultural Resource Stressors* | | *Socioeconomic Stressors* | | | *Public Health & Safety Stressors* | | |
| | | *Sonar & Other Transducers* | *Vessel Noise* | *Aircraft Noise* | *Weapons Noise* | *In Air Explosions* | *In Water Explosions* | *In-Air Electromagnetic Devices* | *In-Water Electromagnetic Devices* | *High Energy Lasers* | *Vessels & In-water Devices* | *Aircraft & Aerial Targets* | *Military Expended Material* | *Seafloor Devices* | *Ground Disturbance* | *Wildfires* | *Wires & Cables* | *Decelerators/Parachutes* | *Military Expended Materials – Munitions* | *Military Expended Materials – Other than Munitions* | *Criteria Air Pollutants* | *Explosives* | *Metals* | *Chemicals* | *Other Materials*[1] | *Explosives*[3] | *Physical Disturbance & Strike*[4] | *Accessibility*[5] | *Airborne Acoustics*[6] | *Physical Disturbance & Strike*[4] | *Underwater Energy*[7] | *In-Air Energy*[8] | *Physical Interactions*[9] |
| *Physical Resources* | Sediments and Water Quality | | | | | | | | | | | | | | | | | | | | | ✓ | ✓ | ✓ | ✓ | | | | | | | | |
| | Air Quality | | | | | ✓ | | | | | | | | | | | | | | | ✓ | | | | | | | | | | | | |
| *Biological Resources* | Marine Habitats | | | | | | ✓ | | | | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | | | | |
| | Marine Mammals | ✓ | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | | | | | | |
| | Sea Turtles | ✓ | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | | | | | | |
| | Marine Birds | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | | | | | | | | | | | | | |
| | Marine Vegetation | | | | | | ✓ | | | | ✓ | | ✓ | ✓ | | | | | | | | ✓ | ✓ | ✓ | ✓ | | | | | | | | |
| | Marine Invertebrates | ✓ | | | | | ✓ | | ✓ | | ✓ | | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | | | | | | |
| | Fish | ✓ | ✓ | | ✓ | | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | | | | | | |
| | Terrestrial | | | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | | |
| *Human Resources* | Cultural Resources | | | ✓ | | | ✓ | | | | | | ✓ | ✓ | | | | | | | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| | Socioeconomic Resources | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | |
| | Public Health and Safety | ✓ | | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | ✓ | ✓ | ✓ |

**Table F-3: Stressors by Resource (continued)**

| ***Stressors vs. Resource*** | *Biological Resources* | | | | | | | | | | | | | | | | | | | | | *Physical Resources* | | | | | *Human Resources*[2] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Acoustic Stressors* | | | | *Explosives* | | *Energy Stressors* | | | *Physical Disturbance and Strike Stressors* | | | | | | *Entanglement Stressors* | | *Ingestion Stressors* | | *Air Quality Stressor* | *Sediments and Water Quality Stressors* | | | | *Cultural Resource Stressors* | | *Socioeconomic Stressors* | | | *Public Health & Safety Stressors* | | |
| | *Sonar & Other Transducers* | *Vessel Noise* | *Aircraft Noise* | *Weapons Noise* | *In Air Explosions* | *In Water Explosions* | *In-Air Electromagnetic Devices* | *In-Water Electromagnetic Devices* | *High Energy Lasers* | *Vessels & In-water Devices* | *Aircraft & Aerial Targets* | *Military Expended Material* | *Seafloor Devices* | *Ground Disturbance* | *Wildfires* | *Wires & Cables* | *Decelerators/Parachutes* | *Military Expended Materials – Munitions* | *Military Expended Materials – Other than Munitions* | *Criteria Air Pollutants* | *Explosives* | *Metals* | *Chemicals* | *Other Materials* [1] | *Explosives* [3] | *Physical Disturbance & Strike* [4] | *Accessibility* [5] | *Airborne Acoustics* [6] | *Physical Disturbance & Strike* [4] | *Underwater Energy* [7] | *In-Air Energy* [8] | *Physical Interactions* [9] |

[1] Other Materials include marine markers and flares, chaff, towed and stationary targets, and miscellaneous components of other expended objects

[2] Area of interest is U.S. Territorial Waters (seaward of the mean high water line to 12 nautical miles and any inshore waters)

[3] Vibration and shock waves from underwater explosions.

[4] Physical disturbance and strike stressors resulting from in-water devices, military expended materials, seafloor devices, pile driving, and vibration from sonic booms in U.S. territorial waters (seaward of the mean high water line to 12 nautical miles).

[5] Availability of access on the ocean and in the air

[6] Loud noises from weapons firing, in-air explosions, and sonic booms

[7] Active sonar, underwater explosions, air guns, vessel movements, mine warfare training devices, and unmanned underwater systems

[8] Sources of electromagnetic energy and lasers

[9] Interaction of Navy or Marine Corps aircraft, vessels, and equipment with general public

Note: A check indicates training and/or testing events that trigger the stressor as it applies to the specific resource.

# Appendix G: Conceptual Framework for Assessing Effects on Biological Resources

# Supplemental Environmental Impact Statement/
# Overseas Environmental Impact Statement
# Mariana Islands Training and Testing
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There are no tables in this appendix.

# APPENDIX G Conceptual Framework for Assessing Effects on Biological Resources

The analysis of impacts on biological resources focused on the likelihood of encountering the stressor, the primary stimulus, response, and recovery of individual organisms. Where appropriate, the potential of a biological resource to overlap with a stressor was analyzed with consideration given to the specific geographic area (large marine ecosystems, open ocean areas, range complexes, operating areas, and other training and testing areas) in which the overlap could occur. Additionally, the differential impacts of training versus testing activities that introduce stressors to the resource were considered.

For each of the non-biological resources considered in this Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement, the methods are unique to each specific resource and are therefore described in each resource section. For Sediments and Water Quality, Air Quality, Cultural Resources, Socioeconomics, and for Public Health and Safety, see Section 3.0.1 (Overall Approach to Analysis).

## G.1 Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities

This conceptual framework describes the potential effects from exposure to acoustic and explosive activities and the accompanying short-term costs to the animal (e.g., expended energy or missed feeding opportunity). It then outlines the conditions that may lead to long-term consequences for the individual if the animal cannot fully recover from the short-term costs and how these in turn may affect the population. Within each biological resource section (e.g., marine mammals, birds, and fishes) the detailed methods to predict effects on 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 acoustic and explosive activities.

The categories of potential effects are listed below:

- ***Injury** and other non-auditory injury – Injury to organs or tissues of an animal*
- ***Hearing loss** – A noise-induced decrease in hearing sensitivity, which can be either temporary or permanent and may be limited to a narrow frequency range of hearing*
- ***Masking** – When the perception of a biologically important sound (i.e., signal) is interfered with by a second sound (i.e., noise)*
- ***Physiological stress** – An adaptive process that helps an animal cope with changing conditions; although, too much stress can result in physiological problems*
- ***Behavioral response** – A reaction ranging from very minor and brief changes in attentional focus, changes in biologically important behaviors, and avoidance of a sound source or area, to aggression or prolonged flight*

Figure G-1 is a flowchart that diagrams the process used to evaluate the potential effects to marine animals exposed to sound-producing activities. The shape and color of each box on the flowchart represents 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 following sections. For simplicity, sound is used here to include not only sound waves but also blast waves generated from explosive sources. Box A1, the Sound-Producing Activity, is the source of this stimuli and therefore the starting point in the analysis.

The first step in predicting whether an activity is capable of affecting a marine animal is to define the stimuli experienced by the animal. The stimuli include the overall level of activity, the surrounding acoustical environment, and characteristics of the sound when it reaches the animal.

Sounds emitted from a sound-producing activity (Box A1) travel through the environment to create a spatially variable sound field. The received sound at the animal (Box A2) determines the range of possible effects. The received sound can be evaluated in several ways, including number of times the sound is experienced (repetitive exposures), total received energy, or highest sound pressure level experienced.

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. There can be any number of individual sound sources in a given activity, each with its own unique characteristics. For example, a United States Department of the Navy training exercise may involve several ships and aircraft using several types of sonar. Environmental factors such as temperature and bottom type impact how sound spreads and attenuates through the environment. Additionally, independent of the sounds, the overall level of activity and the number and movement of sound sources are important to help predict the probable reactions.

The magnitude of the responses 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). Very high exposure levels close to explosives have the potential to cause injury. High-level, long-duration, or repetitive exposures may potentially cause some hearing loss. All perceived sounds may lead to behavioral responses, physiological stress, and masking. Many sounds, including sounds that are not detectable by the animal, could have no effect (Box A4).

### G.1.1 Injury

Injury (Box B1) refers to the direct injury of tissues and organs by shock or pressure waves impinging upon or traveling through an animal's body. Marine animals are well adapted to large, but relatively slow, hydrostatic pressures changes that occur with changing depth. However, injury may result from exposure to rapid pressure changes, such that the tissues do not have time to adequately adjust.

Therefore, injury is normally limited to relatively close ranges from explosions. Injury can be mild and fully recoverable or, in some cases, lead to mortality.

Injury includes both auditory and non-auditory injury. Auditory injury is the direct mechanical injury to hearing-related structures, including tympanic membrane rupture, disarticulation of the middle ear ossicles, and injury to the inner ear structures such as the organ of Corti and the associated hair cells. Auditory injury 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 injury is always injurious but can be temporary. One of the most common consequences of auditory injury is hearing loss.

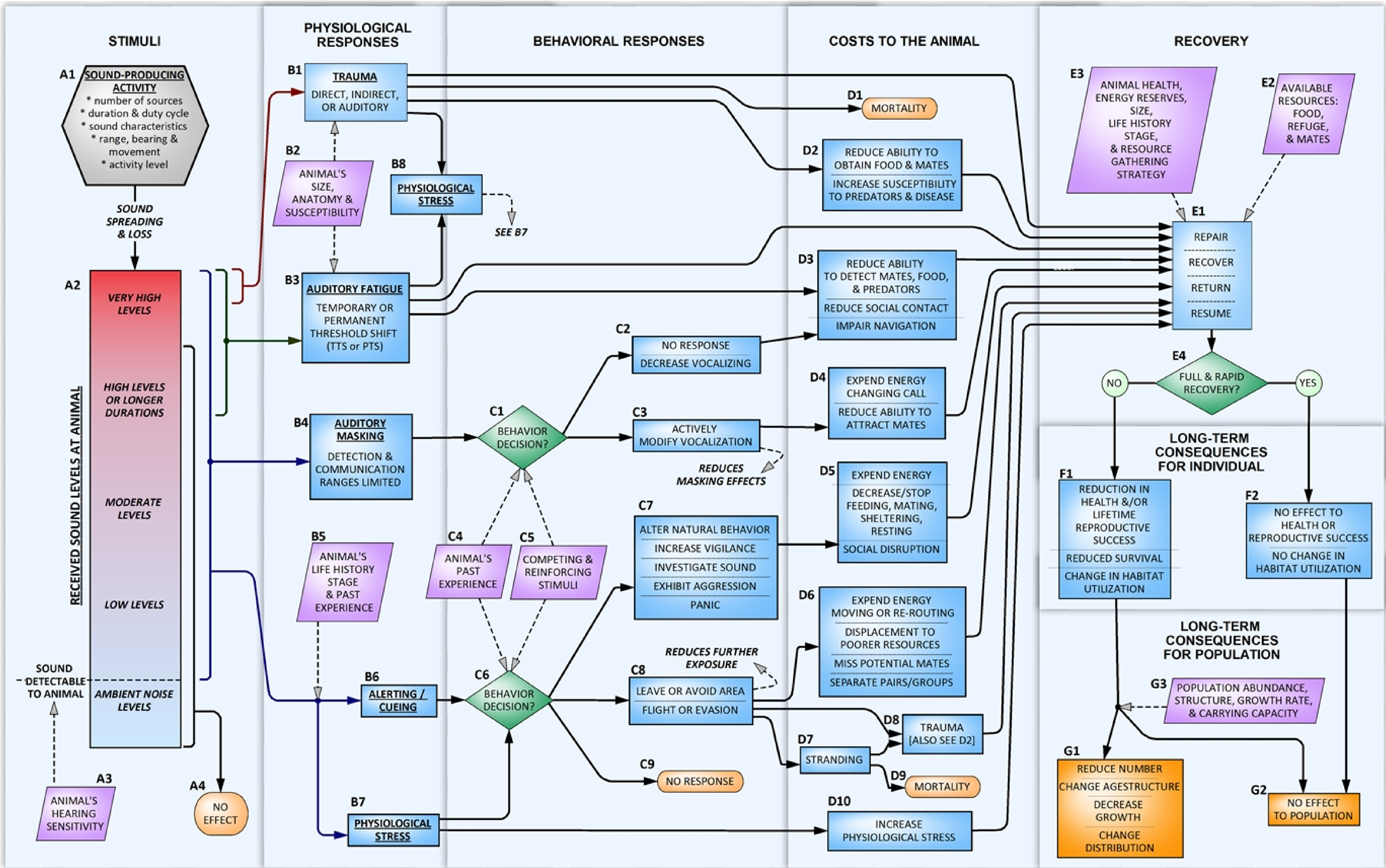


**Figure G-1: Flow Chart of the Evaluation Process of Sound-Producing Activities**

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Non-auditory injury 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 organs and tissues most sensitive to explosive injury. An animal's size and anatomy are important in determining its susceptibility to non-auditory injury (Box B2). Larger size indicates more tissue to protect vital organs. Therefore, larger animals should be less susceptible to injury 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 injury. The size, geometry, and material composition of a structure determine the frequency at which the object will resonate. 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 injury to breath-holding marine animals. Bubble formation and growth due to direct sound exposure have been hypothesized (Crum & Mao, 1996; Crum et al., 2005); however, the experimental laboratory conditions under which these phenomena were observed would not be replicated in the wild. Certain dive behaviors by breath-holding animals are predicted to result in conditions of blood nitrogen super-saturation, potentially putting an animal at risk for decompression sickness (Fahlman et al., 2014), although this phenomena has not been observed (Houser et al., 2009). In addition, animals that spend long periods of time at great depths are predicted to have super-saturated tissues that may slowly release nitrogen if the animal then spends a long time at the surface (i.e., stranding) (Houser et al., 2009).

Injury could increase the animal's physiological stress (Box B8), which feeds into the stress response (Box B7) and also increases the likelihood or severity of a behavioral response. Injury may reduce an animal's ability to secure food by reducing its mobility or the efficiency of its sensory systems, making the injured individual less attractive to potential mates, increasing an individual's chances of contracting diseases or falling prey to a predator (Box D2), or increasing an animal's overall physiological stress level (Box D10). Severe injury can lead to the death of the individual (Box D1).

Damaged tissues from mild to moderate injury may heal over time. The predicted recovery of direct injury is based on the severity of the injury, availability of resources, and characteristics of the animal. 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. 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.

### G.1.2 Hearing Loss

Hearing loss, also called a noise-induced threshold shift, is possibly the most studied type of effect from sound exposures to animals. Hearing loss manifests itself as loss in hearing sensitivity across part of an animal's hearing range, which is dependent upon the specifics of the noise exposure. Hearing loss may be either PTS or TTS. 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 G-2 shows one hypothetical threshold shift that completely recovers, a TTS, and one that does not completely recover, leaving some PTS.

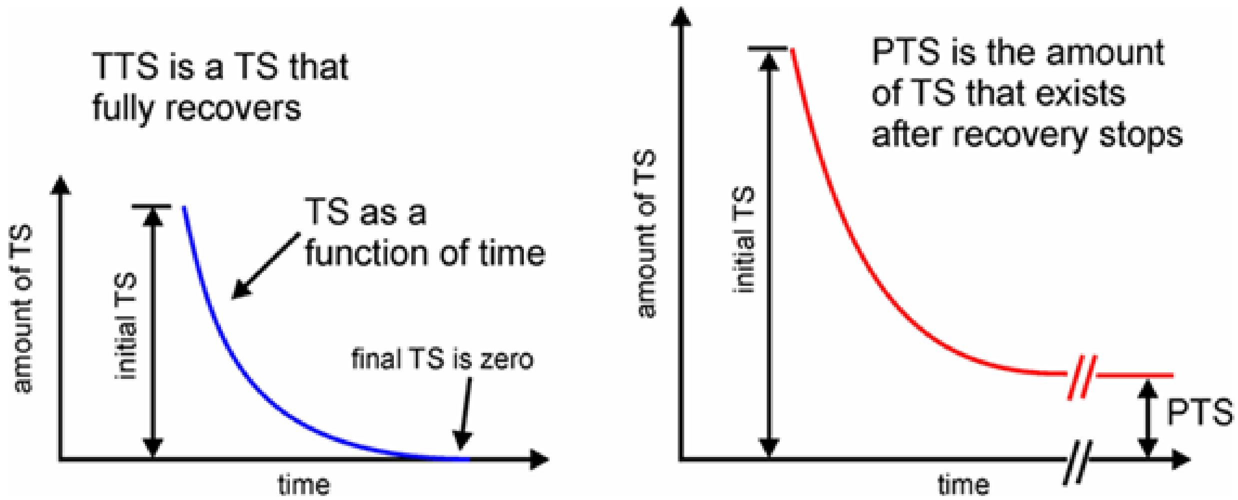


**Figure G-2: Two Hypothetical Threshold Shifts**

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 hearing loss. The amplitude, frequency, duration, and temporal pattern of the sound exposure are important parameters for predicting the potential for hearing loss over a specific portion of an animal's hearing range. Duration is particularly important because hearing loss increases with prolonged exposure time. Longer exposures with lower sound levels can cause more threshold shift than a shorter exposure using the same amount of energy overall. The frequency of the sound also plays an important role. Experiments show that animals are most susceptible to hearing loss (Box B3) within their most sensitive hearing range. Sounds outside of an animal's audible frequency range do not cause hearing loss.

The mechanisms responsible for hearing loss may consist of a variety of mechanical and biochemical processes in the inner ear, including physical damage or distortion of the tympanic membrane (not including tympanic membrane rupture which is considered auditory injury), physical damage or distortion of the cochlear hair cells, hair cell death, changes in cochlear blood flow, and swelling of cochlear nerve terminals (Henderson et al., 2006; Kujawa & 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).

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 measured two minutes after exposure) will recover with no apparent permanent effects; however, terrestrial mammal studies revealed that larger amounts of threshold shift can result in permanent neural degeneration, despite the hearing thresholds returning to normal (Kujawa & Liberman, 2009). The amounts of threshold shift induced by Kujawa and Liberman (2009) were described as being "at the limits of reversibility." It is unknown whether smaller amounts of threshold shift can result in similar neural degeneration, or if effects would translate to other species such as marine animals.

Hearing loss can increase an animal's physiological stress (Box B8), which feeds into the stress response (Box B7). Hearing loss increase the likelihood or severity of a behavioral response and increase an animal's overall physiological stress level (Box D10). Hearing loss reduces the distance over which animals can communicate and detect other biologically important sounds (Box D3). Hearing loss could also be inconsequential for an animal if the frequency range affected is not critical for that animal to hear within, or the hearing loss is of such short duration (e.g., a few minutes) that there are no costs to the individual.

Small to moderate amounts of hearing loss may recover over a period of minutes to days, depending on the amount of initial threshold shift. Severe noise-induced hearing loss may not fully recover, resulting in some amount of PTS. An animal whose hearing does not recover quickly and fully could suffer a reduction in lifetime reproductive success. An animal with 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.

### G.1.3 Masking

Masking occurs if the noise from an activity interferes with an animal’s ability to detect, understand, or recognize biologically relevant sounds of interest (Box B4). In this context noise refers to unwanted or unimportant sounds that mask an animal’s ability to hear sounds of interest. Sounds of interest include those from conspecifics such as offspring, mates, and competitors; 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. The probability of masking increases as the noise and sound of interest increase in similarity and the masking noise increases in level. The frequency, received level, and duty cycle of the noise determines the potential degree of auditory masking. Masking only occurs during the sound exposure.

A behavior decision (either conscious or instinctive) 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 experiences can be important in determining the behavioral response when dealing with masking (Box C4). 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) such as the presence of predators, prey, or potential mates.

An animal may exhibit a passive behavioral response when coping with 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, masking will continue, depending on the acoustic stimuli.

An animal may actively compensate for 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.

If masking impairs an animal’s ability to hear biologically important sounds (Box D3) it could reduce an animal's ability to communicate with conspecifics or reduce opportunities to detect or attract more distant mates, gain information about their physical environment, or navigate. An animal that modifies its vocalization in response to masking could also incur a cost (Box D4). Modifying vocalizations may cost the animal energy, 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 & Ripmeester, 2007). Masking may also lead to no measurable costs for an animal. Masking could be of short duration or intermittent such that biologically important sounds that are continuous or repeated are received by the animal between masking noise.

Masking only occurs when the sound source is operating; therefore, direct masking effects stop immediately upon cessation of the sound-producing activity. Masking could have long-term consequences for individuals if the activity was continuous or occurred frequently enough.

### G.1.4 Physiological Stress

Marine animals naturally experience physiological stress as part of their normal life histories. 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. Sound-producing activities have the potential to cause additional stress. However, too much of a stress response can be harmful to an animal, resulting in physiological dysfunction.

If a sound is detected (i.e., heard or sensed) by an animal, a stress response can occur (Box B7). 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), and the animal's life history stage (e.g., juvenile or adult, breeding or feeding season), and past experience with the stimuli (Box B5). 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. 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 & Dierauf, 2001) or increase the response via sensitization. Additionally, if an animal suffers injury or hearing loss, a physiological stress response will occur (Box B8).

The generalized stress response is characterized by a release of hormones (Reeder & Kramer, 2005) and other chemicals (e.g., stress markers) such as reactive oxidative compounds associated with noise-induced hearing loss (Henderson et al., 2006). Stress hormones include 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 classically used as an indicator of a stress response and to characterize the magnitude of the stress response (Hennessy et al., 1979).

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.

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 any behavioral response. Regardless of whether the animal displays a behavioral response, this tolerated stress could incur a cost to the animal. Reactive oxygen compounds produced during normal physiological processes are generally counterbalanced by enzymes and antioxidants; however, excess stress can lead to damage of lipids, proteins, and nucleic acids at the cellular level (Berlett & Stadtman, 1997; Sies, 1997; Touyz, 2004).

Frequent physiological stress responses may accumulate over time increasing an animal's chronic stress level. Each component of the stress response is variable in time, and stress hormones return to baseline levels at different rates. Elevated chronic stress levels are usually a result of a prolonged or repeated disturbance. Chronic elevations in the stress levels (e.g., cortisol levels) may produce long-term health consequences that can reduce lifetime reproductive success.

### G.1.5 Behavioral Reactions

Behavioral responses fall into two major categories: alterations in natural behavior patterns and avoidance. These types of reactions are not mutually exclusive, and 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. The total number of vehicles and platforms involved, the size of the activity area, the distance between the animal and activity, and the duration of the activity are important considerations when predicting the initial behavioral responses.

A physiological stress response (Box B7) such as an annoyance or startle reaction, or cueing or alerting (Box B6) may cause an animal to make a behavior decision (Box C6). Any exposure that produces an injury or hearing loss is also assumed to produce a stress response (Box B7) and increase the severity or likelihood of a behavioral reaction. Both an animal's 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).

An animal's past experiences can be important in determining what behavior decision it may make when dealing with a stress response (Box C4). Habituation is the process by which an animal learns to ignore or tolerate stimuli over some period and return to a normal behavior pattern, perhaps after being exposed to the stimuli with no negative consequences. Sensitization is when an animal becomes more sensitive to a set of stimuli over time, perhaps as a result of a past, negative experience that could result in a stronger behavioral response.

Other stimuli (Box C5) present in the environment can influence an animal's behavioral response. These stimuli may be conspecifics or predators in the area or the drive to engage in a natural behavior. Other stimuli can also reinforce the behavioral response caused by acoustic stimuli. For example, the awareness of a predator in the area coupled with the sound-producing activity may elicit a stronger reaction than the activity alone would have.

An animal may reorient, become more vigilant, or investigate if it detects a sound-producing activity (Box C7). These behaviors all require the animal to divert attention and resources, therefore slowing or stopping their presumably beneficial natural behavior. This can be a very brief diversion, or an animal may not resume its natural behaviors until after the activity has concluded. An animal may choose to leave or avoid an area where a sound-producing activity is taking place (Box C8). A more severe form of this comes in the form of flight or evasion. Avoidance of an area can help the animal avoid further effects by avoiding or reducing further exposure. An animal may also choose not to respond to a sound-producing activity (Box C9).

An animal that alters its natural behavior in response to stress or an auditory cue may slow or cease its natural behavior and instead expend energy reacting to the sound-producing activity (Box D5). 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.

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). The amount of energy expended depends on the severity of the behavioral response. Missing potential mates can result in delaying reproduction. Groups could be separated during a severe behavioral response such as flight and 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 injury (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 injury is likely to occur to an animal that strands (Box D8). Injury 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 may die (Box D9).

### G.1.6 Long-Term Consequences

The potential long-term consequences from behavioral responses are difficult to discern. Animals displaced from their normal habitat due to an avoidance reaction may return over time and resume their natural behaviors. This is likely to depend upon 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 the new baseline; conversely, species that are more sensitive may not return, or return but not resume use of the habitat in the same manner. For example, an animal may return to an area to feed but no longer rest in that area. Long-term abandonment or a change in the utilization of an area by enough individuals can change the distribution of the population. Frequent disruptions to natural behavior patterns may not allow an animal to recover between exposures, which increase the probability of causing long-term consequences to individuals.

The magnitude and type of effect and the speed and completeness of recovery (i.e., return to baseline conditions) must be considered in predicting long-term consequences to the individual animal (Box E4). The predicted recovery of the animal (Box E1) is based on the cost to the animal from any reactions, behavioral or physiological. Available resources fluctuate by season, location, and year and can play a major role in an animal's rate of recovery (Box E2). Recovery can occur more quickly if plentiful food resources, many potential mates, or refuge or shelter is available. 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 takes place will likely recover more quickly.

Animals that recover quickly and completely are unlikely to 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 use the environment; or they could die (Box F1). These long-term consequences to the individual can lead to consequences for the population (Box G1); although, 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.

Long-term consequences to individuals can translate into consequences for populations dependent upon population abundance, structure, growth rate, and carry capacity. 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, its 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 consequences on a few individuals may not be affected overall. Populations that exist well below their carrying capacity may suffer greater consequences from any lasting consequences 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.

## G.2 Conceptual Framework for Assessing Effects from Energy-Producing Activities

### G.2.1 Stimuli

#### G.2.1.1 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). High-energy and low-energy lasers were considered for analysis. Low-energy lasers (e.g., targeting systems, detection systems, laser light detection and ranging) do not pose a risk to organisms (Swope, 2010) and, therefore, will not be discussed further. Radar was also considered for analysis and was determined not to pose a risk to biological resources.

#### G.2.1.2 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 and the relative location of the resource with respect to the source was considered. For example, the greatest potential electromagnetic energy exposure is at the source, where intensity is greatest and the greatest potential for high energy laser exposure is at the ocean's surface, where high-energy laser intensity is greatest. All light energy, including laser light, entering the ocean becomes absorbed and scattered at a rate that is dependent on the frequency of the light. For most laser applications, the energy is rapidly reduced as the light penetrates the ocean.

#### G.2.1.3 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 and radar particularly considered those species known to occur at or above the surface of the ocean.

### G.2.2 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 are available to analyze potential impacts on organisms from exposure to high energy lasers. For all but the highest-energy lasers, the greatest laser-related concern for marine species is damage to an organism's ability to see.

### G.2.3 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.

## G.3 Conceptual Framework for Assessing Effects from Physical Disturbance or Strike

### G.3.1 Stimuli

#### G.3.1.1 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. For example, 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, whereas a larger organism could potentially be struck by an object since it may not be displaced by the movement of the water. 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).

#### G.3.1.2 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.

#### G.3.1.3 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.

#### G.3.1.4 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.

### G.3.2 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.

### G.3.3 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.

## G.4 Conceptual Framework for Assessing Effects from Entanglement

### G.4.1 Stimuli

#### G.4.1.1 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.

#### G.4.1.2 Physical Features of the Resource

The physical makeup of the organism itself is also considered when evaluating the risk of entanglement. Some species, by their size or physical features, are more susceptible to entanglement than others. For example, more rigid bodies with protruding snouts (e.g., hammerhead shark) or large, rigid fins (e.g., humpback whale) would have an increased risk of entanglement when compared to species with smoother, streamlined bodies such as lamprey or eels.

#### G.4.1.3 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.

#### G.4.1.4 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.

#### G.4.1.5 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). A defense response by some large whales (when encountering rope) is to spin, thereby entangling themselves further in the “object.” This makes selecting for non-looping and lower breaking strength in objects such as ropes very important. 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.

### G.4.2 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.

### G.4.3 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.

## G.5 Conceptual Framework for Assessing Effects from Ingestion

### G.5.1 Stimuli

#### G.5.1.1 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.

#### G.5.1.2 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.

#### G.5.1.3 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 munitions 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 or entangled in floating kelp. 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.

#### G.5.1.4 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).

### G.5.2 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.

### G.5.3 Long-Term Consequences to the Individual and Population

The 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.

## G.6 Conceptual Framework for Assessing Effects from Secondary Stressors

This conceptual framework describes the potential effects to marine species exposed to stressors indirectly through impacts on habitat and prey availability (e.g., sediment or water quality, and physical disturbance). Stressors from United States Department of the Navy training and testing activities could pose indirect impacts on marine biological resources via indirect effects to habitat or to prey. These include indirect impacts from (1) explosives, explosives byproducts and unexploded munitions, (2) metals, (3) chemicals, and (4) transmission of disease and parasites. The methods used to determine secondary stressors on marine resources are presented below. Once a category of primary stressor has been analyzed to determine how a marine biological resource is impacted, an analysis follows of how a secondary stressor is potentially impacting a marine resource. After the secondary stressors are identified, a determination on the significance of the secondary impact is made. The same criteria to determine the level of significance for primary impacts are used for secondary stressors. In addition, it is possible for a significant primary impact to produce a beneficial indirect impact. For example, sinking exercises could generate a significant impact on the seafloor and surrounding habitats, while causing a potential beneficial secondary impact by creating hard-bottom habitat for invertebrates, producing a food source for fishes, and creating structural refuges for other biological resources.

### G.6.1 Secondary Stressors

#### G.6.1.1 Impacts on Habitat

Primary impacts defined in each marine resource section were used to develop a conceptual model to predict the potential secondary stressors on each habitat or resource. This conceptual model incorporated factors such as the co-occurrence of stressors in space and time, the impacts or assessment endpoints of individual stressors (e.g., habitat alteration, changes in animal behavior or physiology, injury, mortality, or changes in human use), and the duration and intensity of the impacts of individual stressors. For example, a secondary stressor from a munitions strike could be habitat degradation. The primary impact or stressor is the actual strike on the habitat such as the seafloor, with the introduction of military expended materials, munitions, and fragments inducing further habitat degradation.

Secondary stressors can also induce additive impacts on habitats. These types of impacts are also determined by summing the individual stressors with identical and quantifiable assessment endpoints. For example, if one stressor disturbed 0.25 square nautical miles ($NM^2$) of benthic habitat, a second stressor disturbed 0.5 $NM^2$, and all other stressors did not disturb benthic habitat, then the total benthic habitat disturbed would be 0.75 $NM^2$. For stressors with identical but not quantifiable assessment endpoints, potential additive impacts were qualitatively evaluated using available scientific knowledge and best professional judgment. Other habitat impacts such as underwater detonations were assessed by size of charge (net explosive weight), charge radius, height above the seafloor, substrate types in the area, and equations linking all these factors. The analysis also considered that impacts of underwater explosions vary with the bottom substrate type and that the secondary impacts would also be variable among substrate types.

#### G.6.1.2 Impacts on Prey Availability

Assessing the impacts of secondary stressors on prey availability falls into two main areas over different temporal scales: the cost to an individual over a relatively short amount of time (short-term) and the cost to an individual or population over a longer period of time (long-term).

### G.6.2 Immediate Response and Costs to the Individual

After a primary impact was identified, an analysis of secondary stressors on that resource was initiated. This analysis examined whether indirect impacts would occur after the initial (primary) impact and at what temporal scale that secondary stressor would affect the resource (short-term or long-term). An assessment was then made as to whether the secondary stressor would impact an individual or a population. For example, an underwater explosion could impact a single resource such as a fish or multiple other species in the food web (e.g., prey species such as plankton). The analysis also took into consideration whether the primary impact affected more than an individual or single species. For example, a prey species that would be directly injured or killed by an explosive blast could draw in predators or scavengers from the surrounding waters that would feed on those organisms, and in turn could be more directly susceptible to being injured or killed by subsequent explosions. For purposes of this analysis, indirect impacts on a resource did not require trophic transfer (e.g., bioaccumulation) in order to be observed. It is important to note that the terms "indirect" and "secondary" describe how the impact may occur in an organism or its ecosystem and does not imply reduced severity of environmental consequences.

### G.6.3 Long-Term Consequences to the Individual and Population

Long-term consequences of secondary stressors on an individual or population are often difficult to determine. Once a primary impact is identified, the severity of that impact helps to determine the temporal scale at which the secondary stressor can be measured. For most marine resources, the abundance of prey species near a detonation point would be diminished for a short period (weeks to months) before being repopulated by animals from adjacent waters. In some extreme cases, recovery of the habitat or prey resources could occur over a relatively long time frame (months to years). It is important to note that indirect impacts often differ among resources, spatial, and temporal scales.

# REFERENCES

Berlett, B. S., and E. R. Stadtman. (1997). Protein oxidation in aging, disease, and oxidative stress. *The Journal of Biological Chemistry, 272*(33), 20313–20316.

Crum, L., and Y. Mao. (1996). Acoustically enhanced bubble growth at low frequencies and its implications for human diver and marine mammal safety. *The Journal of the Acoustical Society of America, 99*(5), 2898–2907.

Crum, L., M. Bailey, J. Guan, P. Hilmo, S. Kargl, and T. Matula. (2005). 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.

Fahlman, A., P. L. Tyack, P. J. O. Miller, and P. H. Kvadsheim. (2014). How man-made interference might cause gas bubble emboli in deep diving whales. *Frontiers in Physiology, 5*(13), 1–6.

Henderson, D., E. C. Bielefeld, K. C. Harris, and B. H. Hu. (2006). The role of oxidative stress in noise-induced hearing loss. *Ear & Hearing, 27*, 1–19.

Hennessy, M. B., J. P. Heybach, J. Vernikos, and S. Levine. (1979). Plasma corticosterone concentrations sensitively reflect levels of stimulus intensity in the rat. *Physiology and Behavior, 22*, 821–825.

Houser, D. S., L. A. Dankiewicz-Talmadge, T. K. Stockard, and P. J. Ponganis. (2009). Investigation of the potential for vascular bubble formation in a repetitively diving dolphin. *The Journal of Experimental Biology, 213*, 52–62.

Kujawa, S. G., and M. C. Liberman. (2009). Adding insult to injury: Cochlear nerve degeneration after "temporary" noise-induced hearing loss. *Journal of Neuroscience, 29*(45), 14077–14085.

Normandeau, E., T. Tricas, and A. Gill. (2011). *Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species*. Camarillo, CA: U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific Outer Continental Shelf Region.

Reeder, D. M., and K. M. Kramer. (2005). Stress in free-ranging mammals: Integrating physiology, ecology, and natural history. *Journal of Mammalogy, 86*(2), 225–235.

Sies, H. (1997). Physiological society symposium: Impaired endothelial and smooth muscle cell function in oxidative stress: Oxidants and antioxidants. *Experimental Physiology, 82*, 291–295.

Slabbekoorn, H., and E. A. Ripmeester. (2007). Birdsong and anthropogenic noise: Implications and applications for conservation. *Molecular Ecology, 17*(1), 72–83.

St. Aubin, D. J., and L. A. Dierauf. (2001). Stress and Marine Mammals. In L. A. Dierauf & F. M. D. Gulland (Eds.), *Marine Mammal Medicine* (2nd ed., pp. 253–269). Boca Raton, FL: CRC Press.

Swope, B. (2010). *Laser System Usage in the Marine Environment: Applications and Environmental Considerations*. San Diego, CA: Space and Naval Warfare Systems Command 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.

# Appendix H: Acoustic and Explosive Concepts

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There are no tables in this appendix.

# APPENDIX H ACOUSTIC AND EXPLOSIVE CONCEPTS

This section introduces basic principles and terminology for acoustics and explosives to help the reader understand the analyses presented in this Supplemental Environmental Impact Statement (SEIS)/Overseas EIS (OEIS). This section briefly explains the transmission of sound and explosive energy; introduces some of the basic mathematical formulas used to describe propagation; and defines acoustical terms, abbreviations, and units of measurement. The difference between transmission of sound in water and in air is also discussed. Finally, it discusses methods used to analyze what animals may hear.

A number of other sources provide a more extensive background on acoustics and explosives than presented in this overview and are recommended for further inquiry. These include, but are not limited to

- *Marine Mammals and Noise* (Richardson et al., 1995) for a general overview
- *Principles of Underwater Sound* (Urick, 1983), *Fundamentals of Acoustical Oceanography* (Medwin & Clay, 1998), and *Principles of Marine Bioacoustics* (Au & Hastings, 2008) for comprehensive explanations of underwater acoustics

## H.1 Terminology

The following terms are used in this document when discussing sound and the attributes of a sound source.

### H.1.1 Sound

Sound is produced when an elastic medium (such as air or water) is set into motion, typically 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. The result is a mechanical disturbance (the "sound wave") that moves away from the source and propagates at a medium-dependent speed (the "sound speed"). 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. As the particles of the medium move back and forth they create small changes about the original values of the medium density, pressure, and temperature.

Sound may be described by both physical and subjective attributes. Physical attributes, such as sound amplitude and frequency, may be directly measured. Subjective (or sensory) attributes like loudness depend on an animal's perception of sound. Physical attributes of a sound at a particular point are usually obtained by measuring pressure changes as sound waves pass.

### H.1.2 Signal versus Noise

When sound is purposely created to convey information, communicate, or obtain information about the environment, it is often referred to as a signal. Examples of sounds that could be considered signals are sonar pings, marine mammal vocalizations and echolocation clicks, tones used in hearing experiments, and small sonobuoy explosions used for submarine detection.

Noise is undesired sound (American National Standards Institute, 1994). Sounds produced by naval aircraft and vessel propulsion are considered noise because they represent possible inefficiencies and increased detectability. Whether a sound is perceived as noise often depends on the receiver (i.e., the animal or system that detects the sound). For example, small explosives and sonar used to generate sounds that can locate an enemy submarine produce signals that are useful to Sailors engaged in anti-submarine warfare, but are assumed to be noise when detected by marine mammals.

The combination of all sounds at a particular location, whether these sources are located near or far, is ambient noise (American National Standards Institute, 1994). Ambient noise includes natural sources, such as sound from crashing waves, rain, and animals (e.g., snapping shrimp), and anthropogenic sources, such as seismic surveys and vessel noise.

### H.1.3 Frequency and Wavelength

Frequency is the physical attribute most closely associated with the subjective attribute "pitch"; the higher the frequency, the higher the pitch. Frequency is defined by the number of oscillations in the sound pressure or particle motion per second. One hertz (Hz) is equal to one oscillation per second, and one kilohertz (kHz) is equal to 1,000 oscillations per second. Human hearing generally spans the frequency range from 20 Hz to 20 kHz. The frequency range of a sound is called its bandwidth.

Pure tones have energy at a constant, single frequency. Complex tones contain energy at multiple, discrete frequencies, rather than a single frequency. 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, but at lower amplitudes. Some sources may also emit subharmonics; however, these are typically many orders of magnitude less powerful than at the center frequency. Sounds with large bandwidth ("broadband" sounds) have energy spread across many frequencies.

In this document, sounds are generally described as either low- (less than 1 kHz), mid- (1 kHz–10 kHz), high- (10 kHz–100 kHz), or very high- (greater than 100 kHz) frequency. Hearing ranges of marine animals (e.g., fish, birds, sea turtles, 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. Acoustic impact analyses must therefore focus not only on the sound amplitude (i.e., pressure or particle motion, see Section H.1.4, Sound Amplitude), but on the sound frequency and the hearing capabilities of the species being considered.

The wavelength of a sound is the distance between wave peaks. Wavelength decreases as frequency increases. The frequency multiplied by the wavelength equals the speed of sound in a medium, as shown in this equation:

$$\text{Frequency } (s^{-1}) \text{ x wavelength (m) = sound speed (m/s)}$$

The approximate speed of sound in sea water is 1500 m/s and in air is 340 m/s, although speed varies depending on environmental conditions (e.g., pressure, temperature, and, in the case of sea water, salinity; see Section H.3.1 (Speed of Sound).

### H.1.4 Sound Amplitude

Sound amplitude is the physical attribute most closely associated with the subjective attribute loudness. Amplitude is related to the amount that the medium particles oscillate about their original positions and can be thought of as the "strength" of a sound (as the amplitude increases, the loudness also increases). As the sound wave travels, the particles of the medium oscillate but do not actually travel with the wave. The result is a mechanical disturbance (i.e., the sound wave) that propagates away from the sound source.

Sound amplitude is typically characterized by measuring the acoustic pressure or particle motion (see Section H.2, Sound Metrics).

### H.1.5 Impulsive versus Non-Impulsive Sounds

Although no standard definitions exist, sounds may be broadly categorized as impulsive or non-impulsive. Impulsive sounds have short durations, rapid rise-times, broad frequency content, and high peak sound pressures. Impulsive sounds are often produced by processes involving a rapid release of energy or mechanical impacts (Hamernik & Hsueh, 1991). Explosions, air guns, weapon firing, and impact pile driving are examples of impulsive sound sources analyzed in this document. In contrast, sonars, vessel operation, vibratory pile driving, and underwater transducers lack the characteristics of impulsive sources and are thus examples of non-impulsive sound sources. Non-impulsive sounds can be essentially continuous, such as machinery noise, or intermittent, such as sonar pings.

### H.1.6 Acoustic Impedance

Acoustic impedance is a property of the propagation medium (air, water, or tissue) that can be simply described as the opposition to flow of a pressure wave. Acoustic impedance is a function of the density and speed of sound in a medium. Sound transmits more readily through materials of similar acoustic impedance, such as water and animal tissue. When sound waves encounter a medium with different acoustic impedance (for example, an air-water interface), they reflect and refract (see Sections H.3.3.3, Refraction, and H.3.3.4, Reflection and Multipath Propagation), creating more complex propagation conditions. For example, sound traveling in air (low impedance) encountering the water surface (high impedance) will be largely reflected, preventing most sound energy in the air from being transmitted into the water. The impedance difference at the tissue-air interface in animals with gas-containing organs also makes these areas susceptible to damage when exposed to the shock wave near an explosion, since the transmission from high-impedance to low-impedance can result in large motion at the boundary.

### H.1.7 Duty Cycle

Duty cycle describes the portion of time that a sound source actually generates sound. It is defined as the percentage of time during which a sound is generated over a total operational time period. For example, if a sonar source produces a one-second ping once every 10 seconds, the duty cycle is 10 percent. Duty cycles vary among different acoustic sources; in general, a low duty cycle could be considered 20 percent or less and a high duty cycle 80 percent or higher.

### H.1.8 Resonance

Resonance occurs when an object is vibrated at a frequency near its "natural frequency" or resonant frequency. The resonant frequency can be considered the preferred frequency at which an object will oscillate at a greater magnitude than when exposed to other frequencies. In this document, resonance is considered in relation to the size of an air bubble or air cavity in an animal that is exposed to high pressure waves and the potential for injury. The natural frequencies of dolphin and beluga lungs near the surface are about 36 Hz and 30 Hz, respectively (Finneran, 2003), the natural frequency of lungs of a large whale would be lower, while the natural frequency of small air bubbles would be much higher. Resonant frequencies would tend to increase as an animal dives, since the increased water pressure would compress an air-filled structure and reduce its size.

## H.2 Sound Metrics

The sound metrics described here are used in this document to quantify exposure to a sound or explosion.

### H.2.1 Pressure

Sound pressure is the incremental variation in a medium's static pressure as a sound wave travels through it. Sound pressure is typically expressed in units of pascals (Pa) (1 Pa = N/m$^2$ = 10 µbar = 1.45×10$^{-4}$ psi), although explosive overpressure may also be described in pounds per square inch (psi).

Various sound pressure metrics are illustrated in Figure H-1 for (a) a non-impulsive sound (a pure tone in this illustration) and (b) an impulsive sound. As shown in Figure H-1, the non-impulsive sound has a relatively gradual rise in pressure from static pressure (the ambient pressure without the added sound), while the impulsive sound has a near-instantaneous rise to a high peak pressure. The peak pressure shown on both illustrations is the maximum absolute value of the instantaneous sound pressure during a specified time interval ("zero-to-peak" or "peak"), which accounts for the values of peak pressures below the static (ambient) pressure (American National Standards Institute, 2013). "Peak-to-peak" pressure is the difference between the maximum and minimum sound pressures. The root-mean-square (rms) value is often used to describe the average sound pressure level of sounds, and sound pressure levels provided in this EIS/OEIS are root-mean-square values unless otherwise specified. 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 rms sound pressure for a given sound, especially where pressure levels vary significantly, as during an impulsive sound exposure. If the analysis duration includes a significant portion of the waveform after the sound pressure has returned to zero, the rms pressure would be relatively low. If the analysis duration includes only the highest pressures of the impulsive exposure, the rms value would be comparatively high. For this reason, it is important to specify the duration used to calculate the rms pressure for impulsive sounds.

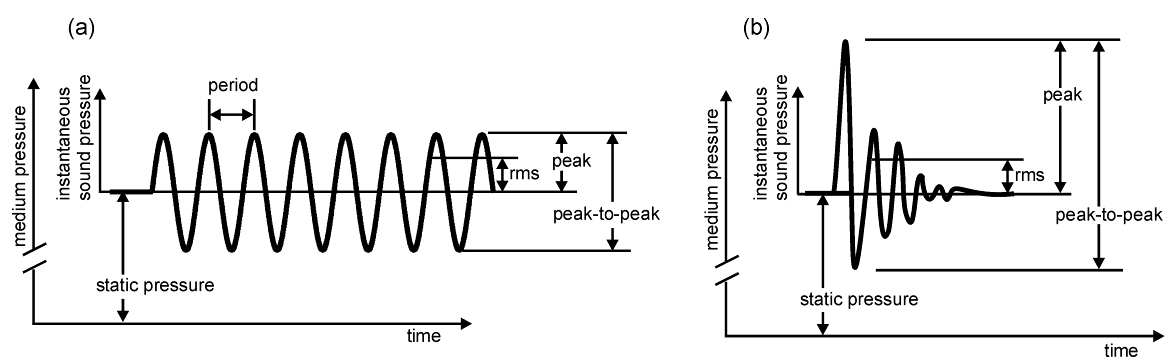



**Figure H-1: Various Sound Pressure Metrics for a Hypothetical (a) Pure Tone (Non-Impulsive) and (b) Impulsive Sound**

### H.2.2 Sound Pressure Level

The most common sound level metric is sound pressure level (SPL). Because many animals can detect very large pressure ranges and judge the relative loudness of sounds by the ratio of the sound pressures (a logarithmic behavior), SPL is described by taking the logarithm of the ratio of the sound pressure to a reference pressure. Use of a logarithmic scale compresses the wide range of measured pressure values into a more useful scale.

Sound pressure levels are normally expressed in decibels. A decibel is 1/10 of a bel, a unit of level when the logarithm is to the base ten and the quantities concerned are proportional to power (American National Standards Institute, 2013). Sound pressure level in decibels is calculated as follows:

$$SPL = 20\log_{10}\left(\frac{P}{P_{ref}}\right)$$

where P is the sound pressure and $P_{ref}$ is the reference pressure. Unless stated otherwise, the pressure P is the rms value of the pressure (American National Standards Institute, 2013). In some situations, SPL is calculated for the peak pressure rather than the rms pressure. On the occasions when rms pressure is not used, the pressure metric will be stated (e.g., peak SPL means an SPL calculated using the peak pressure rather than the rms pressure).

When a value is presented in decibels, it is important to also specify the value and units of the reference quantity. Normally the numeric value is given, followed by the text "re," meaning "with reference to," and the numeric value and unit of the reference quantity. For example, a pressure of 1 Pa, expressed in decibels with a reference of 1 micropascal (µPa), is written 120 dB re 1 µPa. The standard reference pressures are 1 µPa for water and 20 µPa for air. The reference pressure for air, 20 µPa, is the approximate lowest threshold of human hearing. It is important to note that because of the differences in reference units, the same sound pressures would result in different SPL values for each medium (the same sound pressure measured in water and in air would result in a higher SPL in water than in air, since the in-air reference is larger). Therefore, sound pressure levels in air and in water should never be directly compared.

### H.2.3 Sound Exposure Level

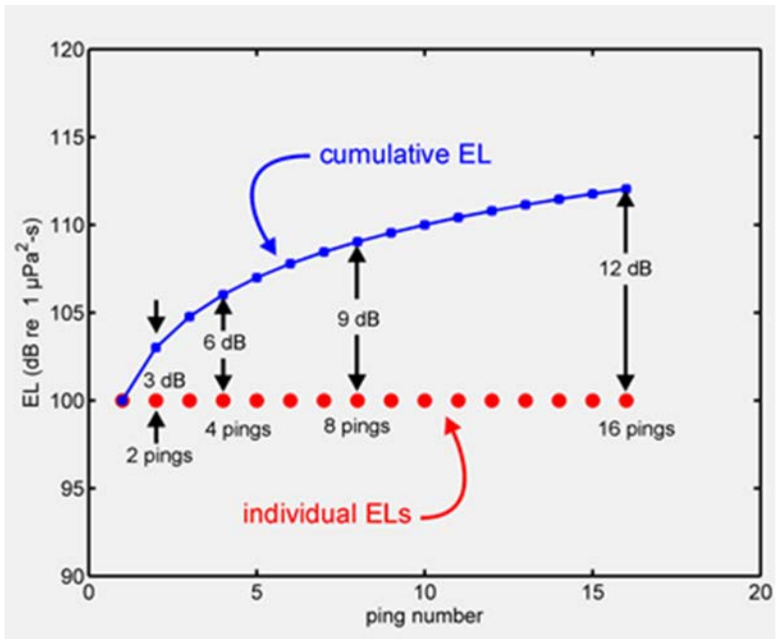
Sound exposure level (SEL) can be thought of as a composite metric that represents both the SPL of a sound and its duration. Individual time-varying noise events (e.g., a series of sonar pings or an impulsive sound) have two main characteristics: (1) a sound pressure that changes throughout the event and (2) a period of time during which the source is exposed to the sound. SEL can be provided for a single exposure (i.e., a single sonar ping or single explosive detonation) or for an entire acoustic event (i.e., multiple sonar pings or multiple explosive detonations). Cumulative SEL provides a measure of the net exposure of the entire acoustic event, but it does not directly represent the sound level heard at any given time. SEL 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 micropascal squared seconds (re 1 µPa$^2$-s) for sounds in water and dB re (20 micropascal) squared seconds [dB re (20 µPa)$^2$-s] for sounds in air.

Some rules of thumb for SEL are as follows:

- The numeric value of SEL is equal to the SPL of a 1-second sound that has the same total energy as the exposure event. If the sound duration is 1 second, SPL and SEL have the same numeric value (but not the same reference quantities). For example, a 1 second sound with an SPL 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 SPL changes, SEL will change by the same number of decibels as the SPL.

- If the SPL is held constant and the duration (T) changes, SEL will change as a function of $10\log_{10}(T)$:
  - $10\log_{10}(10) = 10$, so increasing duration by a factor of 10 raises SEL by 10 dB.
  - $10\log_{10}(0.1) = -10$, so decreasing duration by a factor of 10 lowers SEL by 10 dB.
  - Since $10\log_{10}(2) \approx 3$, so doubling the duration increases SEL by 3 dB.
  - $10\log_{10}(1/2) \approx -3$, so halving the duration lowers SEL by 3 dB.

Figure H-2 illustrates the summation of energy for a succession of sonar pings. In this hypothetical case, each ping has the same duration and SPL. 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.

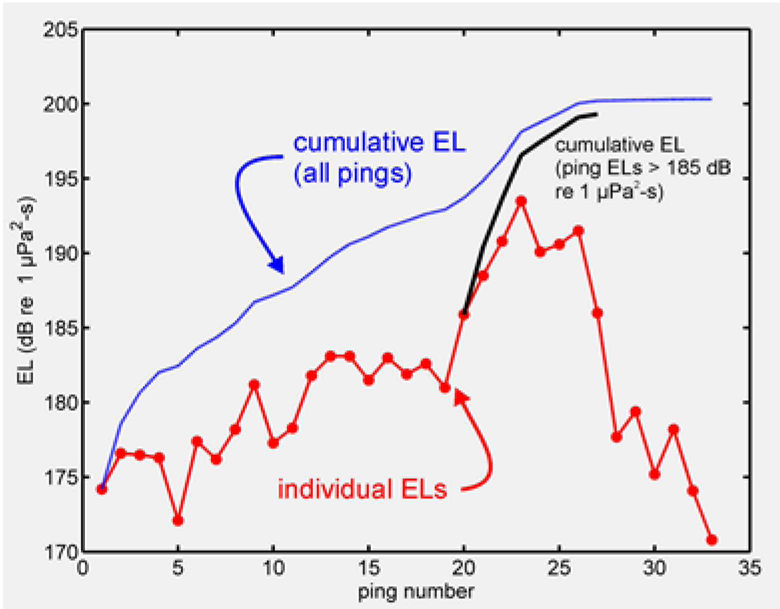



*Note: EL = Exposure Level (i.e., Sound Exposure Level)*

**Figure H-2: Summation of Acoustic Energy from a Hypothetical, Intermittently Pinging, Stationary Sound Source**

After the first ping, the cumulative SEL is 100 dB re 1 µPa$^2$-s. Since each ping has the same duration and SPL, 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 H-3 shows a more realistic example where the individual pings do not have the same SPL 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 SPL from each ping increased, causing the SEL of each ping to increase. After the source passed the hydrophone, the received SPL 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 H-3, 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).




*Note: EL = Exposure Level (i.e., Sound Exposure Level)*

**Figure H-3: Cumulative Sound Exposure Level under Realistic Conditions with a Moving, Intermittently Pinging Sound Source**

### H.2.4 Particle motion

The particles of a medium (e.g., water or air) oscillate around their original position as a sound wave passes. This motion is quantified using average displacement (m or dB re 1pm), velocity (m/s or dB re 1 nm/s$^2$), and acceleration (m/s$^2$ or dB re 1 μm/s$^2$) of the particles (Nedelec et al., 2016). Note that particle velocity is not the same as sound speed, which is how fast a sound wave moves through a medium. Particle motion is directional, whereas pressure measurement is not (Nedelec et al., 2016).

Far from a sound source and without any boundaries that could cause wave interference, particle velocity is directly proportional to sound pressure. Closer to a sound source, particle velocity begins to increase relative to sound pressure. Because this phenomenon is related to wavelength, it may be relevant only when very close to sound sources with extremely low frequencies.

### H.2.5 Impulse

Impulse is a metric used to describe the pressure and time component of a pressure wave. Impulse is typically only considered for high energy exposures to impulsive sources, such as exposures close to explosives. Specifically, positive impulse is the time integral of the initial peak positive pressure with units of Pascal-seconds (Pa-s). Impulse is a measured quantity that is distinct from the term “impulsive,” which is not a measurement term, but rather describes a type of sound (see Section H.1.5, Impulsive versus Non-Impulsive Sounds).

## H.3 Predicting How Sound Travels

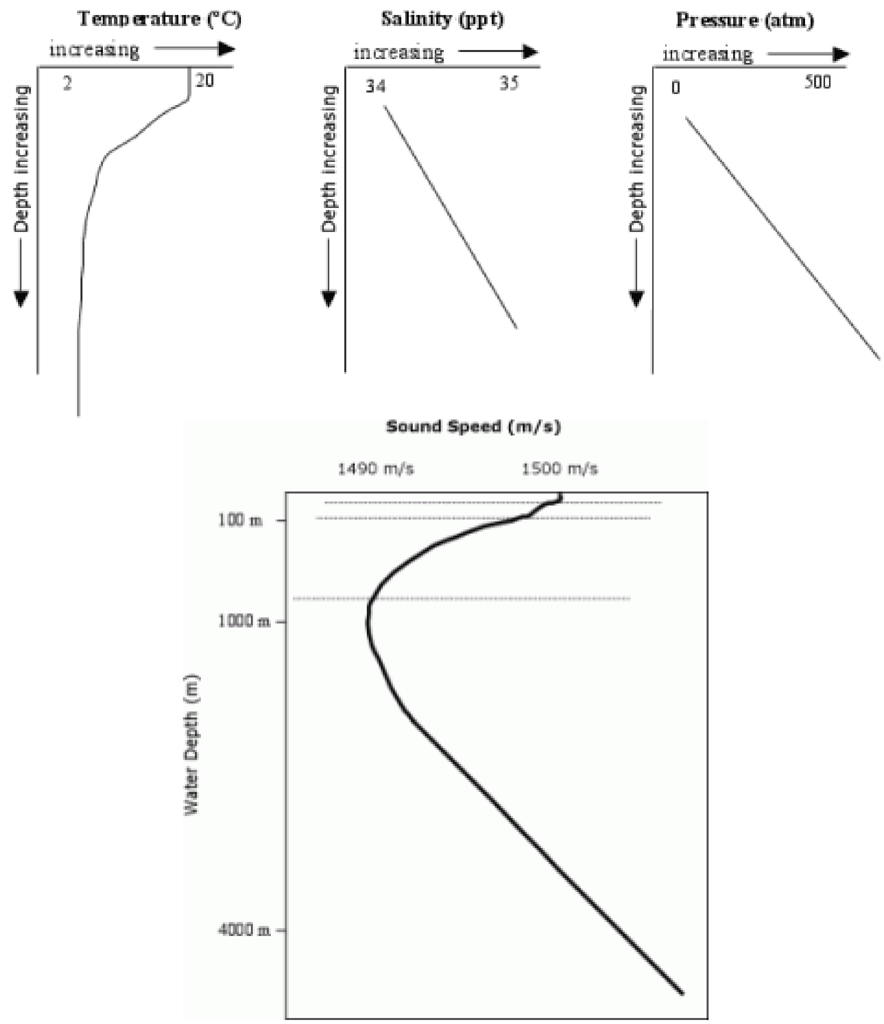
While the concept of a sound wave traveling from its source to a receptor is relatively simple, sound propagation is quite complex because of the simultaneous presence of numerous sound waves of different frequencies and source levels, and other phenomena such as reflections of sound waves and subsequent 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 [see technical report *Quantitative Analysis for Estimating Acoustic and Explosive Impacts to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017a)].

### H.3.1 Speed of Sound

The speed of sound is not affected by the SPL or frequency of the sound, but rather depends wholly on characteristics of the medium through which it is passing (e.g., the density and the compressibility). Sound travels faster through a medium that is harder to compress. For example, water is more difficult to compress than air, and sound travels approximately 340 m/s in air and 1,500 m/s in seawater.

The speed of sound in air is primarily influenced by temperature, relative humidity, and pressure, because these factors affect the density and compressibility of air. Generally, the speed of sound in air increases as air temperature increases.

The speed of sound in seawater also increases with increasing temperature and, to a lesser degree, with increasing hydrostatic pressure and salinity. Figure H-4 shows an example of how these attributes can change with depth. In seawater, temperature has the most important effect on sound speed for depths less than about 300 m. Below 1,500 m, the increasing 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 velocity profile.




Source: Diogou (2014)

**Figure H-4: Sound Velocity Profile (Sound Speed) Is Related to Temperature, Salinity, and Hydrostatic Pressure of Seawater**

### H.3.2 Source Directivity

Most sonar and other active acoustic sources do not radiate sound in all directions. Rather, they emit sounds over a limited range of angles, in order to focus sound energy on a specific area or object of interest. The specific angles are sometimes given as horizontal or vertical beam width. Some sources can be described qualitatively as "forward-looking," when sound energy is radiated in a limited direction in front of the source, or "downward-looking," when sound energy is directed toward the bottom.

### H.3.3 Transmission Loss

As a sound wave passes through a medium, the sound level decreases with distance from the sound source. This phenomenon is known as transmission loss (TL). The transmission loss is used to relate the source SPL (SL), defined as the SPL produced by a sound source at a distance of one meter, and the received SPL (RL) at a particular location, as follows:

$$RL = SL - TL$$

The main contributors to transmission loss are as follows (Urick, 1983):

- Geometric spreading of the sound wave as it propagates away from the source
- Sound absorption (conversion of sound energy into heat)
- Scattering, diffraction, multipath interference, and boundary effects

### H.3.3.1 Geometrical Spreading Loss

Spreading loss is a geometric effect representing regular weakening of a sound wave as it spreads out from a source. 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.

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. An example of spherical spreading loss is shown in Figure H-5. As spherical propagation continues, the sound energy is distributed over an ever-larger area following the inverse square law: the pressure 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 pressure of the sound to one-fourth of its initial value; tripling the distance results in one-ninth of the original pressure, and so on. Since the surface area of a sphere is $4\pi r^2$, where r is the sphere radius, the change in SPL with distance r from the source is proportional to the radius squared. This relationship is known as the spherical spreading law. The transmission loss for spherical spreading between two locations is:

$$TL = 20 \log_{10} (r_2/r_1)$$

where $r_1$ and $r_2$ are distances from the source. Spherical spreading results in a 6 dB reduction in SPL for each doubling of distance from the sound source. For example, calculated transmission loss for spherical spreading is 40 dB at 100 m and 46 dB at 200 m.

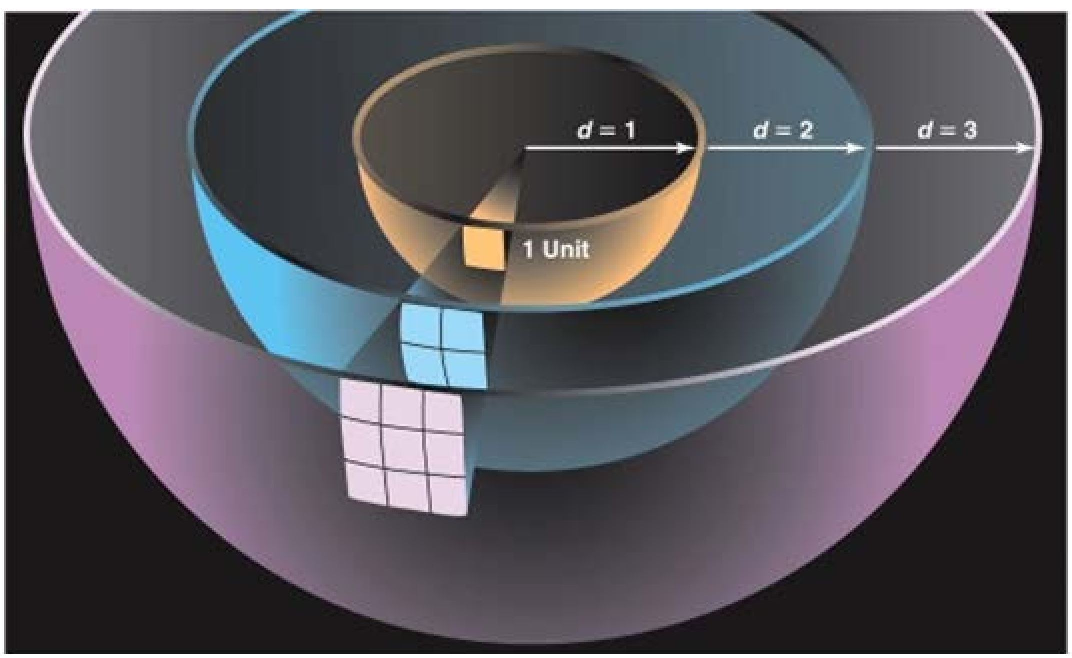



**Figure H-5: Graphical Representation of the Inverse Square Relationship in Spherical Spreading**

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:

$$TL = 10\log_{10}(r_2/r_1)$$

Cylindrical spreading is an approximation of sound propagation in a water-filled channel with horizontal dimensions much larger than the depth. Cylindrical spreading predicts a 3 dB reduction in SPL for each doubling of distance from the source. For example, calculated transmission loss for cylindrical spreading is 30 dB at 1,000 m and 33 dB at 2,000 m.

The cylindrical and spherical spreading equations above represent two simple hypothetical cases. In reality, geometric spreading loss is more spherical near a source and more cylindrical with distance, and is better predicted using more complex models that account for environmental variables, such as the Navy Acoustic Effects Model [see technical report *Modeling and Quantitative Analysis of Acoustic and Explosive Impacts to Marine Species due to Navy Training and Testing Activities* (DON 2017)].

However, when conducting simple spreading loss calculations in near shore environments, "practical spreading loss" can be applied, where:

$$TL = 15\log_{10}(r_2/r_1)$$

Practical spreading loss accounts for other realistic losses in the environment, such as absorption and scattering, which are not accounted for in geometrical spreading.

#### H.3.3.2 Absorption

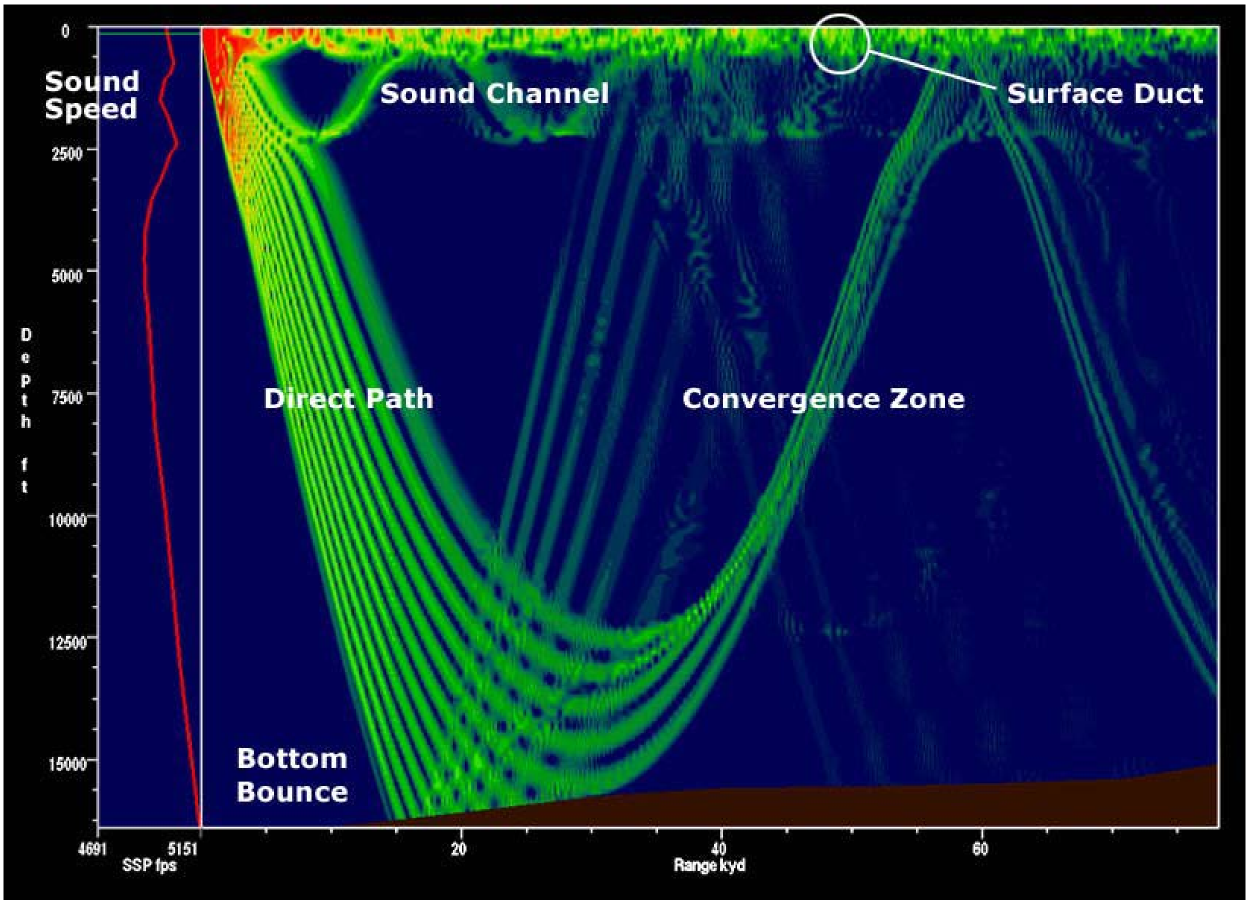
Absorption is the conversion of acoustic energy to kinetic energy in the particles of the propagation medium (Urick, 1983). Absorption is directly related to sound frequency, with higher frequencies having higher rates of absorption. Absorption rates range from 0.07 dB/km for a 1 kHz sound to about 30 dB/km for a 100 kHz sound. Therefore, absorption is the cause of a significant amount of attenuation for high and very high frequency sound sources, reducing the distance over which these sources may be perceived compared to mid- and low-frequency sound sources with the same source level.

#### H.3.3.3 Refraction

When a sound wave propagating in a medium encounters a second medium with a different density (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). 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 properties of the medium change enough to cause a variation in the sound speed. 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).

As discussed in Section H.3.1 (Speed of Sound), the sound speed in the ocean primarily depends on hydrostatic pressure (i.e., depth) and temperature. 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 commercial shipping noise (Figure I-6). Sources located within this surface duct can have their sounds trapped, but sources located below this layer would have their sounds refracted downward. The deep sound channel, or sound frequency and ranging (SOFAR) channel, is another duct that exists where sound speeds are slowest deeper in the water column (600–1,200 m depth at the mid-latitudes).

Similarly, the path of sound will bend toward regions of lower sound speed in air. Air temperature typically decreases with altitude, meaning sounds produced in air tend to bend skyward. When an atmospheric temperature inversion is present, air is cooler near the earth's surface. In inversion conditions, sound waves near the earth's surface will tend to refract downward.




*Note: 1 kiloyard (kyd) = 0.9 km*

**Figure H-6: Sound Propagation Showing Multipath Propagation and Conditions for Surface Duct**

### H.3.3.4 Reflection and Multipath Propagation

In multipath propagation, sound may not only travel a direct path (with no reflection) from a source to a receiver, but also be reflected from the surface or bottom multiple times before reaching the receiver (Urick, 1983). Reflection is shown in Figure H-6 at the seafloor (bottom bounce) and at the water surface. 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.

Reflection plays an important role in the pressures observed at different locations in the water column. Near the bottom, the direct path pressure wave may sum with the bottom-reflected pressure wave, increasing the exposure. Near the surface, however, the surface-reflected pressure wave may destructively interfere with the direct path pressure wave, "cutting off" the wave and reducing exposure (called the Lloyd mirror effect). This can cause the sound level to decrease dramatically within the top few meters of the water column.

#### H.3.3.5 Diffraction, Scattering, and Reverberation

Diffraction, scattering, and reverberation are examples of what happens when sound waves interact with obstacles in the propagation path.

Diffraction may be thought of as the change of direction of a sound wave as it passes around an obstacle. Diffraction depends on the size of the obstacle and the sound frequency. The wavelength of the sound must be larger than the obstacle for notable diffraction to occur. If the obstacle is larger than the wavelength of sound, an acoustic shadow zone will exist behind the obstacle where the sound is unlikely to be detected. Common examples of diffraction 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, gas bubbles due to waves, and marine life) in the path of a sound wave causes scattering as these inhomogeneities reradiate incident sound in a variety of directions (Urick, 1983). Reverberation refers to the prolongation of a sound, after the source has stopped emitting, caused by multiple reflections at water boundaries (surface and bottom) and scattering.

#### H.3.3.6 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. Sound waves reflected from the sea surface experience a phase reversal. When the surface-reflected waves interact with the direct path waves near the surface, a destructive interference pattern is created in which the received pressure approaches zero.

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. As sound travels into the seafloor it reflects off of these different density layers in complex ways. For sources in contact with the bottom, such as during pile driving or bottom-placed explosives, a ground wave is produced that travels through the bottom sediment and may refract back into the water column.

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 (constructive interference), resulting in an increased sound pressure near the sea bottom. Soft bottoms such as mud or sediment absorb sound waves and reduce the level in the water column overall.

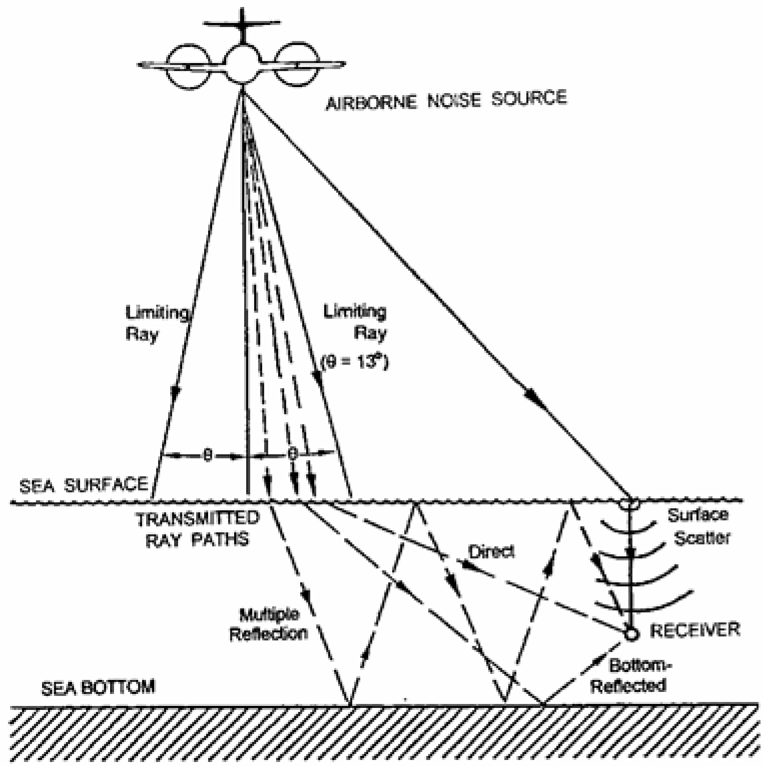
#### H.3.3.7 Air-Water Interface

Sound from aerial sources such as aircraft and weapons firing may be transmitted into the water under certain conditions. 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 sections 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.

When sound waves in air meet the water surface, the sound can either be transmitted across the air-water boundary or reflected off the water surface. When sound waves meet the water at a perpendicular angle (e.g., straight down from an in-air source to a flat water surface), the sound waves are both transmitted directly across the water surface in the same direction of travel and reflected 180° back toward the original direction of travel. This can create a localized condition at the water surface where the incident and reflected waves sum, doubling the in-air overpressure (+ 6 dB). As the incident angle of the in-air sound wave changes from perpendicular, this phenomenon is reduced, ultimately reaching the angle where sound waves are parallel to the water surface and there is no surface reflection.

The sound that enters the water is refracted due to the difference in sound velocity between air and water, as shown in Figure H-7. As the angle of the in-air incident wave moves away from perpendicular, the direction of travel of the underwater refracted waves becomes closer to parallel to the water surface. When the incident angle is reached where the underwater refracted sound wave is parallel to the water surface, all of the sound is reflected back into the air and no sound enters the water. This occurs at an angle of about 13-14°. As a result, most of the acoustic energy transmitted into the water through a relatively narrow cone extending vertically downward from the in-air source. The width of the footprint would be a function of the source altitude. Lesser amounts of sound may enter the water outside of this cone due to surface scattering (e.g., from water surface waves that can vary the angle of incidence over an area) and as evanescent waves that are only present very near the surface.




Source: Richardson et al. 1995

**Figure H-7: Characteristics of Sound Transmission through the Air-Water Interface**

If a sound wave is ideally transmitted into water (that is, with no surface transmission loss, such as due to foamy, wave conditions that could decrease sound entering the water), the sound pressure level underwater is calculated by changing the pressure reference unit from 20 µPa in air to 1 µPa in water. For a sound with the same pressure in air and water, this calculation results in a +26 dB sound pressure level in water compared to air. For this reason, sound pressure levels in water and sound pressure levels in air should never be directly compared.

## H.4 Auditory Perception

Animals with an eardrum or similar structure, including mammals, birds, and reptiles, directly detect the pressure component of sound. Some marine fish also have specializations to detect pressure changes, although most invertebrates and many marine fish do not have anatomical structures that enable them to detect the pressure component of sound and are only sensitive to the particle motion component of sound. This difference in acoustic energy sensing mechanisms limits the range at which these animals can detect most sound sources analyzed in this document. This is because far from a sound source (i.e., in the far field), particle velocity and sound pressure are directly proportional. But close to a source (i.e., in the near field), particle velocity increases relative to sound pressure and may become more detectable to certain animals. As sound frequency increases, the wavelength becomes shorter, resulting in a smaller near field.

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 amplitude is described by the SPL, calculated by taking the logarithm of the ratio of the sound pressure to a reference pressure (see

Section H.2.2, Sound Pressure Level). Use of a logarithmic scale compresses the wide range of pressure values into a more usable numerical scale. On the decibel scale, the smallest audible sound in air (near total silence) to a human is 0 dB re 20 µPa. If the sound intensity increases by a factor of 10, the SPL would increase to 10 dB re 20 µPa. If the sound intensity increases by a factor of 100, the SPL would increase to 20 dB re 20 µPa, and if the sound intensity increases by a factor of 1000, the SPL would be 30 dB re 20 µPa. A quiet conversation has an SPL of about 50 dB re 20 µPa, while the threshold of pain is around 120–140 dB re 20 µPa.

As described in Section H.2.2 (Sound Pressure Level), SPLs under water differ from those in air because they rely on different reference pressures in their calculation; therefore, the two should never be directly compared.

While sound pressure and frequency are physical measure of the sound, loudness is a subjective attribute that varies with not only sound pressure but also other attributes of the sound, such as frequency. For example, a human listener would perceive a 60 dB re 20 µPa sound at 2 kHz to be louder than a 60 dB re 20 µPa sound at 50 Hz, even though the SPLs are identical. This effect is most noticeable at lower sound pressure levels; however, at very high sound pressure levels, the difference in perceived loudness at different frequencies becomes smaller.

To account for differences in hearing sensitivity at various frequencies, acoustic risk analyses commonly use auditory weighting functions—mathematical functions that adjust (or “weight”) received sound levels across sound frequency based on how the listener’s sensitivity or susceptibility to sound changes at different frequencies. For humans, the most common weighting function is called “A-weighting” (see Figure H-8). A-weighted sound levels are specified in units of “dBA” (A-weighted decibels). For example, if the unweighted received level of a 500 Hz tone at a human receiver was 90 dB re 20 µPa, the A-weighted sound level would be 90 dB – 3 dB = 87 dBA because the A-weighting function amplitude at 500 Hz is -3 dB. Many measurements of sound in air appear as A-weighted decibels in the literature because the intent of the authors is to assess noise impacts on humans.

The auditory weighting concept can be applied to other species. 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. Auditory weighting functions were developed for marine mammals and sea turtles and are used to assess acoustic impacts. For more information on weighting functions and their derivation for this analysis see technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis* (U.S. Department of the Navy, 2017b).

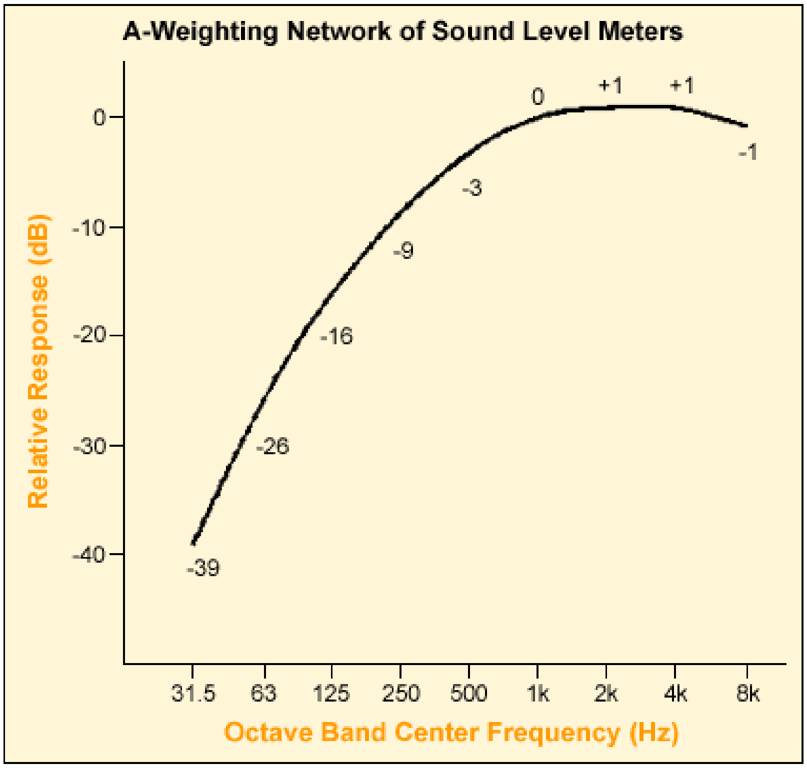



**Figure H-8: A-weighting for Human Hearing of Sounds in Air (OSHA). The Numbers along the Curve Indicate How a Received Sound Level Would Be Adjusted at that Frequency.**

## H.5 Explosives

Explosive materials used in Navy testing and training activities are either (1) "high explosives," sometimes referred to as HE, which means that the explosive material has a very fast rate of detonation (exceeding the speed of sound), or (2) low explosives, which exhibit a relatively slow burn, or deflagration, such as black powder. Because low explosives are typically used in small quantities and have less destructive power, the below discussion focuses on high explosives.

This rate of detonation of a high explosive is highly supersonic, producing a high pressure, steep instantaneous shock wave front travelling through the explosive material. This shock front is produced by the supersonic expansion of the explosive products, but as the shock front travels away from the immediate area of the detonation, it begins to behave as an acoustic wave front travelling at the speed of sound.

The near-instantaneous rise from ambient to an extremely high peak pressure is what makes the explosive shock wave potentially damaging. The area under this positive pressure duration is calculated as the positive impulse.

The positive pressure produced by an explosion is also referred to as the overpressure. As the shock front passes a location, the positive pressure exponentially decays, as shown in Figure H-9. As the shock front travels away from the detonation, the waveform is stretched – the peak pressure decreases while the positive duration increases. The reduction in peak pressure reduces the rate at which the positive impulse is received. Both the reduction in peak pressure and stretching of the positive impulse reduce the potential for injury. In addition, absorption losses of higher frequencies over distance results in a softening of the shock front, such that the rise to peak pressure is no longer near-instantaneous.

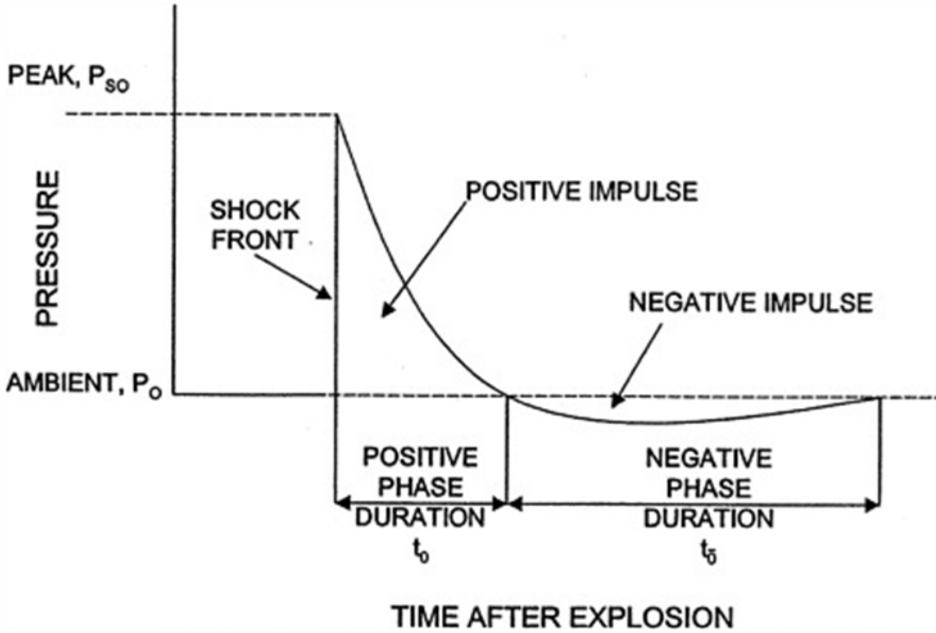



**Figure H-9: Impulse Shown as a Function of Pressure over Duration at a Specific Location**

The peak pressure experienced by a receptor (i.e., an animal) is a function of the explosive material, the net explosive weight, and the distance from the charge. Net explosive weight is a way to classify and compare quantities of different explosive compounds. The net explosive weight for a charge is the energetic equivalent weight of trinitrotoluene (TNT). In general, shock wave effects near an explosive charge increase in proportion to the cube root of the explosive weight (Young, 1991). For example, shock wave impacts will double when the explosive charge weight is increased by a factor of eight (i.e., cube root of eight equals two). This relationship is known as the similarity principle, and the corresponding similitude equations allow for prediction of various explosive metrics for a given charge weight and material.

The similitude equations allow for a simple prediction of peak pressure in a uniform free field environment, and sources are provided below for using these equations for estimating explosive effects in air and in water. However, at longer distances or in more complex environments with boundaries and variations in the propagation medium, explosive propagation modeling is preferred.

### H.5.1 Explosions in Air

Explosions in air produce an initial blast front that propagates away from the detonation. When pressure waves from an explosion in air meet the water surface, the pressure wave can be transmitted across the air-water boundary and reflected off the water surface. When pressure waves in air meet the water at a perpendicular angle (e.g., straight down from an in-air source to a flat water surface), the sound waves are both transmitted directly across the water surface in the same direction of travel and reflected 180° back toward the original direction of travel. For acoustic waves, this can create a localized condition at the water surface where the incident and reflected waves sum, doubling the in-air overpressure (+ 6 dB). For shock waves with high incident pressures travelling at supersonic speeds, the reflection from the water surface depends on the angle of incidence and the speed of the shock wave, and the reflected shock wave pressure can be greater than the incident shock wave pressure (Kinney & Graham, 1985; Swisdak, 1975).

In certain explosive geometries, depending on the size of the explosive and its height of detonation, a combined shock wave, called a Mach stem, can be created by the summing of the direct and reflected shock waves at larger angles of incidence (Kinney & Graham, 1985). In instances where this specific geometry does not occur, only the direct path wave is experienced because there is no surface reflection (waves are parallel to or angled away from the water surface, such as would occur when an explosive is detonated at the water surface), or separate direct and reflected pressure waves may be experienced.

#### H.5.1.1 Fragmentation

Missiles, rockets, projectiles, and other cased weapons will produce casing fragments upon detonation. These fragments may be of variable size and are ejected at supersonic speed from the detonation. The casing fragments will be ejected at velocities much greater than debris from any target due to the proximity of the casing to the explosive material. Unlike detonations on land targets, detonations during Navy training and testing would not result in other propelled materials such as crater debris.

Fragment density can be simply assumed to follow an inverse-square law with distance, in which the possibility of fragment strike is reduced by the square of the distance from the original detonation point. The forces of gravity and drag will further reduce the likelihood of strike with increasing distance than is accounted for in the inverse-square relationship (Zaker, 1975). The possible area of strike risk at any given distance from the detonation point is limited to the surface area of produced fragments, with drag and gravity reducing the number of produced fragments that travel to greater distances.

### H.5.2 Explosions in Water

At the instant of explosion underwater, gas byproducts are generated at high pressure and temperature, creating a bubble. The heat causes a certain amount of water to vaporize, adding to the volume of the bubble. This action immediately begins to force the water in contact with the blast front in an outward direction, creating an intense, supersonic pressure shock wave. As the high-pressure wave travels away from the source, it slows to the speed of sound and acts like an acoustic wave similar to other impulsive sources that lack a strong shock wave (e.g., air guns). Explosions have the greatest amount of energy in lower frequencies below 500 Hz, although energy is present in frequencies exceeding 10 kHz (Urick, 1983). The higher frequency components exhibit more attenuation with distance due to absorption (see Section H.3.3.2, Absorption).

The shock wave caused by an explosion in deeper water may be followed by several bubble pulses in which the explosive byproduct gases expand and contract, with correlated high and low pressure oscillations. These bubble pulses lack the steep pressure front of the initial explosive pulse, but the first bubble pulse may still contribute to the total energy released at frequencies below 100 Hz (Urick, 1983). Subsequent bubble pulses contribute little to the total energy released during the explosion (Urick, 1983). If the detonation occurs at or just below the surface, a portion of the explosive power is released into the air and a pulsating gas bubble is not formed.

The pressure waves from an explosive can constructively add or destructively cancel each other in ocean environments with multi-path propagation, as described for acoustic waves in Section H.3.3.3 (Refraction) and Section H.3.3.4 (Reflection and Multipath Propagation). The received impulse is affected by the depth of the charge and the depth of the receiving animal. Pressure waves from the detonation may travel directly to the receiver or be reflected off the water surface before arriving at the receiver. If a charge is detonated closer to the surface or if an animal is closer to the surface, the time between the initial direct path arrival and the following surface-reflected tension wave arrival is reduced, resulting in a steep negative pressure cut-off of the initial direct path positive impulse exposure. Two animals at similar distances from a charge, therefore, may experience the same peak pressure but different levels of impulse at different depths.

# REFERENCES

American National Standards Institute. (1994). *ANSI S1.1-1994 (R 2004) American National Standard Acoustical Terminology*. New York, NY: The Acoustical Society of America.

American National Standards Institute. (2013). *Acoustical Terminology*. Melville, NY: The Acoustical Society of America.

Au, W., and M. Hastings. (2008). *Principles of Marine Bioacoustics*. New York, NY: Springer-Verlag.

Diogou, N. (2014). *Talk about the weather*. Retrieved from http://blogs.oregonstate.edu/bioacoustics/2014/10/21/talk-weather/.

Eller, A. I., and R. C. Cavanagh. (2000). *Subsonic Aircraft Noise At and Beneath the Ocean Surface: Estimation of Risk for Effects on Marine Mammals*. McLean, VA: United States Air Force Research Laboratory.

Finneran, J. J. (2003). Whole-lung resonance in a bottlenose dolphin (*Tursiops truncatus*) and white whale (*Delphinapterus leucas*). *The Journal of the Acoustical Society of America, 114*(1), 529–535.

Hamernik, R. P., and K. D. Hsueh. (1991). Impulse noise: Some definitions, physical acoustics and other considerations. *The Journal of the Acoustical Society of America, 90*(1), 189–196.

Kinney, G. F., and K. J. Graham. (1985). *Explosive Shocks in Air* (2nd ed.). New York, NY: Springer-Verlag.

Kinsler, L. E., A. R. Frey, A. B. Coppens, and J. V. Sanders. (1982). *Fundamentals of Acoustics* (3rd ed.). New York, NY: John Wiley & Sons.

Laney, H., and R. C. Cavanagh. (2000). *Supersonic Aircraft Noise At and Beneath the Ocean Surface: Estimation of Risk for Effects on Marine Mammals* (AFRL-HE-WP-TR-2000-0167). McLean, VA: United States Air Force Research Laboratory.

Medwin, H., and C. Clay. (1998). *Fundamentals of Acoustical Oceanography*. San Diego, CA: Academic Press.

Nedelec, S. L., J. Campbell, A. N. Radford, S. D. Simpson, and N. D. Merchant. (2016). Particle motion: The missing link in underwater acoustic ecology. *Methods in Ecology and Evolution, 7*(7), 836–842.

Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thomson. (1995). *Marine Mammals and Noise*. San Diego, CA: Academic Press.

Swisdak, M. M. (1975). *Explosion Effects and Properties Part I – Explosion Effects in Air*. Silver Spring, MD: White Oak Laboratory, Naval Surface Weapons Center.

U.S. Department of the Navy. (2017a). *Quantitative Analysis for Estimating Acoustic and Explosive Impacts to Marine Mammals and Sea Turtles*. Newport, RI: Space and Naval Warfare System Command, Pacific and Naval Undersea Warfare Cente.

U.S. Department of the Navy. (2017b). *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*. San Diego, CA: Space and Naval Warfare System Command, Pacific.

Urick, R. J. (1983). *Principles of Underwater Sound, Principles of Underwater Sound for Engineers* (3rd ed.). Los Altos Hills, CA: Peninsula Publishing.

Young, G. A. (1991). *Concise Methods for Predicting the Effects of Underwater Explosions on Marine Life*. Silver Spring, MD: Naval Surface Warfare Center.

Young, R. W. (1973). Sound pressure in water from a source in air and vice versa. *The Journal of the Acoustical Society of America, 53*(6), 1708–1716.

Zaker, T. A. (1975). *Fragment and Debris Hazards*. Washington, DC: U.S. Department of Defense Explosives Safety Board.

# Appendix I: Geographic Mitigation Assessment

# Supplemental Environmental Impact Statement/
# Overseas Environmental Impact Statement
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# APPENDIX I GEOGRAPHIC MITIGATION ASSESSMENT

## I.1 Introduction

As described in Chapter 5 (Mitigation), the United States (U.S.) Department of the Navy (Navy) will implement at-sea procedural mitigation, at-sea geographic mitigation, and terrestrial mitigation to avoid or reduce potential impacts on environmental and cultural resources from training and testing activities proposed in the Mariana Islands Training and Testing (MITT) Supplemental Environmental Impact Statement (SEIS)/Overseas Environmental Impact Statement (OEIS) Proposed Action. The purpose of this appendix is to present an assessment of the potential geographic mitigation (i.e., mitigation implemented seasonally or year-round within defined at-sea mitigation areas) that the Navy considered to reduce or avoid impacts on marine mammals and sea turtles in the Study Area. The goals of developing geographic mitigation in this appendix are (1) in combination with procedural mitigation, to effect the least practicable adverse impact on marine mammal species or stocks and their habitat, and (2) to ensure that the Proposed Action does not jeopardize the continued existence of endangered or threatened species.

This appendix includes background information on the areas that the Navy is proposing as geographic mitigation areas, information on the marine mammals and sea turtles known to occur in each area, and an assessment of the effectiveness and practicality of implementing mitigation. A summary of the mitigation areas that the Navy proposes to implement under Alternative 1 or Alternative 2 of the Proposed Action as a result of the assessments presented in this appendix is also included in Section 5.4 (At-Sea Mitigation Areas to be Implemented). The Navy will work collaboratively with the appropriate regulatory agencies to finalize its mitigation areas through the consultation and permitting processes and will coordinate with the National Marine Fisheries Service (NMFS) to finalize the geographic mitigation analyzed in this appendix. Final mitigation measures will be documented in the Navy Record of Decision, NMFS Marine Mammal Protection Act (MMPA) Final Rule and Letter of Authorization, and the Endangered Species Act (ESA) Biological Opinions as applicable.

## I.2 Geographic Mitigation Development Process

See Chapter 5 (Mitigation) for general information on the Navy's mitigation development process, including definitions of mitigation terminology, background information pertinent to the overall process, and information about the mitigation effectiveness and practicality criteria. This section presents information specific to assessing and developing geographic mitigation for marine mammals and sea turtles in the Study Area.

The Navy considered areas suggested by the public, governmental agencies, and non-governmental organizations during the public involvement process. The Navy also considered additional areas that were informed by Navy-funded studies.

MFS has not identified Biologically Important Areas for marine mammals in the MITT Study Area (Ferguson et al., 2015b; Van Parijs et al., 2015). Data informing geographic mitigation area development and assessment included the operational information described in Section 5.2.4 (Practicality of Implementation), the best available science discussed in Chapter 3 (Affected Environment and Environmental Consequences), published literature, and marine species monitoring and density data. The Navy operational community (i.e., leadership from the aviation, surface, subsurface, and special warfare communities; leadership from the research and acquisition community; and training and testing experts), environmental planners, and scientific experts provided input on the effectiveness and practicality of mitigation.

The Navy used a comprehensive qualitative method to analyze potential geographic mitigation that considered a biological assessment of how a potential time and area limitation on Navy activities would benefit the species or stock and its habitat (e.g., Does a certain area support important biological functions? Would mitigation in that area result in an avoidance or reduction of impacts?) in the context of the stressors of concern in the specific area, and an operational assessment of the practicality of implementation (e.g., including an assessment of the specific importance of that area for training and testing).

### I.2.1 Identification by the Navy of Areas to Consider for Potential Geographic Mitigation

Navy scientists derived the geographic boundaries and applicable timeframes (i.e., seasonal or year-round) for potential areas based on a review of the best available science. The Navy evaluated marine mammal and sea turtle sighting and satellite tag data to identify locations where species appeared to concentrate, the timeframes of apparent concentrations, and documented behaviors from available reports and publications (Ampela et al., 2014; Fulling et al., 2011; Hill et al., 2015a; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016a; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2017b; Hill et al., 2018a; Hill et al., 2018b; Hill et al., 2018c; Jones & Van Houtan, 2014a; Jones & Van Houtan, 2014b; Jones et al., 2015; Jones & Martin, 2016; Klinck et al., 2015; Klinck et al., 2016; Ligon et al., 2011; Martien et al., 2014; Martin & Jones, 2016; Martin et al., 2018; Munger et al., 2014; Munger et al., 2015; National Marine Fisheries Service, 2018; Nieukirk et al., 2016; Norris et al., 2015; Norris et al., 2014; Norris et al., 2017; Oleson et al., 2015; Summers et al., 2017; Summers et al., 2018; Tetra Tech Inc., 2014; U.S. Department of the Navy, 2013, 2018b; Uyeyama, 2014; Yack et al., 2016). Area boundaries were generally drawn with straight lines and simple shapes, with the goal that these areas would be relatively easy for operators to plot if they were carried forward for implementation.

The Navy named each area considered according to a nearby geographic feature. A list of the areas identified by the Navy as potential mitigation areas and their applicable resource protection focus and timeframe is provided in Table I-1. A map showing the location of each area identified as a potential mitigation area is shown in Figure I-1.

**Table I-1: Navy-Identified Potential Geographic Mitigation Areas**

| ***Habitat Considered*** | ***Protection Focus*** | ***Applicable Timeframe*** |
|---|---|---|
| Marpi Reef Area | Humpback whales | Seasonal (December–April) |
| | Marine mammals | Year-round |
| Chalan Kanoa Reef Area | Humpback whales | Seasonal (December–April) |
| | Marine mammals and sea turtles | Year-round |
| Agat Bay Nearshore Area | Spinner dolphins and sea turtles | Year-round |
| North Guam Offshore Area | Marine mammals | Year-round |
| Ritidian Point Offshore Area | Marine mammals | Year-round |
| Tumon Bay Offshore Area | Marine mammals | Year-round |

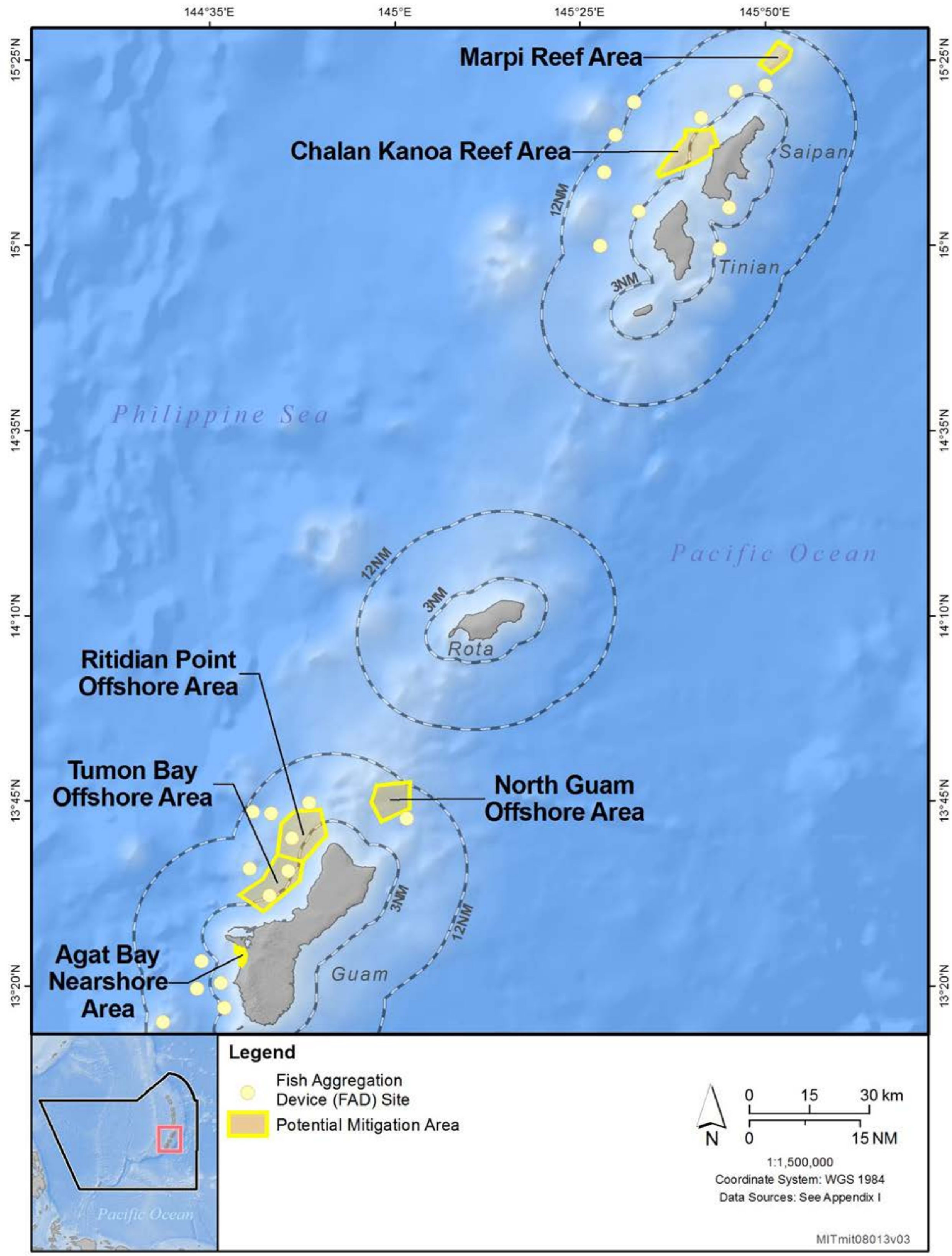


**Figure I-1: Navy-Identified Potential Geographic Mitigation Areas**

### I.2.2 Assessing Mitigation Effectiveness

The first step in assessing the potential geographic mitigation areas was to use the best available science to determine if implementing geographic mitigation would effectively help the Navy avoid or reduce potential impacts associated with the Proposed Action on marine mammals or sea turtles. This appendix focuses on avoiding or reducing potential impacts from the stressors that have the highest potential for injurious impacts on marine mammals and sea turtles. Therefore, the Navy focused its assessment on hull-mounted mid-frequency active sonar and in-water explosives. The Navy considered a geographic mitigation area to be biologically effective if it met the following criteria:

- **The mitigation area is a key area of biological importance:** The best available science suggests that the mitigation area is particularly important to one or more species of marine mammals or sea turtles for a biologically important life process (e.g., foraging, migration, reproduction); and
- **The mitigation will result in an avoidance or reduction of impacts:** Implementing the mitigation will likely avoid or reduce potential impacts on species, stocks, or populations of marine mammals or sea turtles based on data describing their seasonal occurrence and distribution, spatial density, and behaviors in the Study Area. Furthermore, implementing the mitigation would not shift or transfer adverse impacts from one species to another (e.g., to a more vulnerable or sensitive species).

While this appendix focuses on marine mammals and sea turtles, geographic mitigation may provide potential benefits to other marine resources known to occur in each area, such as marine invertebrates and fishes. Additional information on the Navy's mitigation effectiveness criteria is presented in Section 5.2.2 (At-Sea Mitigation Area Development).

### I.2.3 Assessing Practicality of Implementation

In the next step of the mitigation assessment process, the Navy operational community conducted an extensive and comprehensive analysis to determine how and to what degree the implementation of geographic mitigation areas would impact planning, scheduling, and conducting safe training and testing activities as described under the Proposed Action. Conducting the proposed training and testing activities is necessary for the Navy to fulfill its Title 10 requirements, ensuring naval forces are ready to execute the range of military operations required by operational Commanders. The Navy considered a mitigation measure to be practical to implement if it met all criteria discussed in Section 5.2.4 (Practicality of Implementation) for safety, sustainability, and mission requirements.

## I.3 Geographic Mitigation Assessment – Areas Proposed for Implementation

The Navy determined that three of the six potential geographic mitigation areas met the criteria presented in Section I.2.2 (Assessing Mitigation Effectiveness) and Section I.2.3 (Assessing Practicality of Implementation). These three areas (the Marpi Reef, Chalan Kanoa Reef, and Agat Bay Geographic Mitigation Areas) are described in this appendix as proposed mitigation areas. The three other potential mitigation areas considered in this appendix did not meet the Navy's criteria because, based on the available data, the areas are not key areas of biological importance to any marine mammal or sea turtle species.

The discussion for each of the proposed geographic mitigation areas includes a physical description of the area, details on how and why the area was identified, information on Navy training and testing activities potentially occurring in the area, and a mitigation assessment. The mitigation assessment uses information presented in Sections 3.4 (Marine Mammals) and 3.5 (Sea Turtles) to assess the effectiveness of geographic mitigation in reducing or avoiding impacts on these resources, and uses information presented in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Training and Testing Activities Descriptions) to assess practicality of implementation and impacts on the effectiveness of military readiness activities. The Navy considers both the potential benefit to resources and the practicality of implementing the mitigation when determining which areas were proposed as geographic mitigation areas. Additional information on the three proposed mitigation areas and the three potential mitigation areas is contained in the administrative record for this SEIS/OEIS.

### I.3.1 Proposed Geographic Mitigation Area - Marpi Reef

The Marpi Reef Mitigation Area is located approximately 11 kilometers (km) north of Saipan at its closest point and covers approximately 31 square kilometers ($km^2$). As shown in Figure I-2, this is an observed area of concentration and reproductive behavior for humpback whales based on sightings documented during a broad area line transect survey in 2007 (Fulling et al., 2011) and during non-systematic small boat surveys occurring from 2010 through 2018 (HDR, 2011; HDR EOC, 2012; Hill et al., 2014; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Hill et al., 2018c; Ligon et al., 2011). Navy scientists reviewed these sighting data using a Geographic Information System, and a boundary was drawn to encompass the area of known concentration at Marpi Reef.

#### I.3.1.1 Resources within the Marpi Reef Geographic Mitigation Area

The Marpi Reef Mitigation Area was developed based on the seasonal presence of humpback whales; however, other biological resources have been observed or are expected to be present at Marpi Reef, including other marine mammals, sea turtles, invertebrates including corals, and fishes. Those resources are discussed in detail in the following sections of this SEIS/OEIS: Section 3.4 (Marine Mammals), Section 3.5 (Sea Turtles), Section 3.8 (Marine Invertebrates), and Section 3.9 (Fishes).

As shown in Table I-2, five marine mammal species have been documented in the Marpi Reef Area either through sightings or satellite tag detections (Fulling et al., 2011; HDR, 2011; HDR EOC, 2012; Hill et al., 2014; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Hill et al., 2018c; Ligon et al., 2011). Species documented in the Marpi Reef Area include humpback whale, spinner dolphin, bottlenose dolphin, short-finned pilot whale, and false killer whale. Sea turtles have not been reported in the Marpi Reef Area.

### Table I-2: Marine Mammals Documented Within the Proposed Marpi Reef Geographic Mitigation Area

| Common Name | 2007 | 2010 | 2011 | 2012 | 2013 | 2014 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|
| Humpback whale | S | | | | | | S | S | S |
| Spinner dolphin | S | S | S | S | S | S | S | S | S |
| Bottlenose dolphin | | | | | S+T | | | S | S |
| Short-finned pilot whale | | | | | S+T | S+T | S+T | S | |
| False killer whale | | | | | T | | | | |

Notes: S = One or more sightings during a survey in the area; T = one or more satellite tag detections; S+T = one or more sightings and satellite tag detections in a given year; empty cells indicate no documented occurrence of the species in the given year; years not shown indicate that no surveys were conducted in the area in that year.

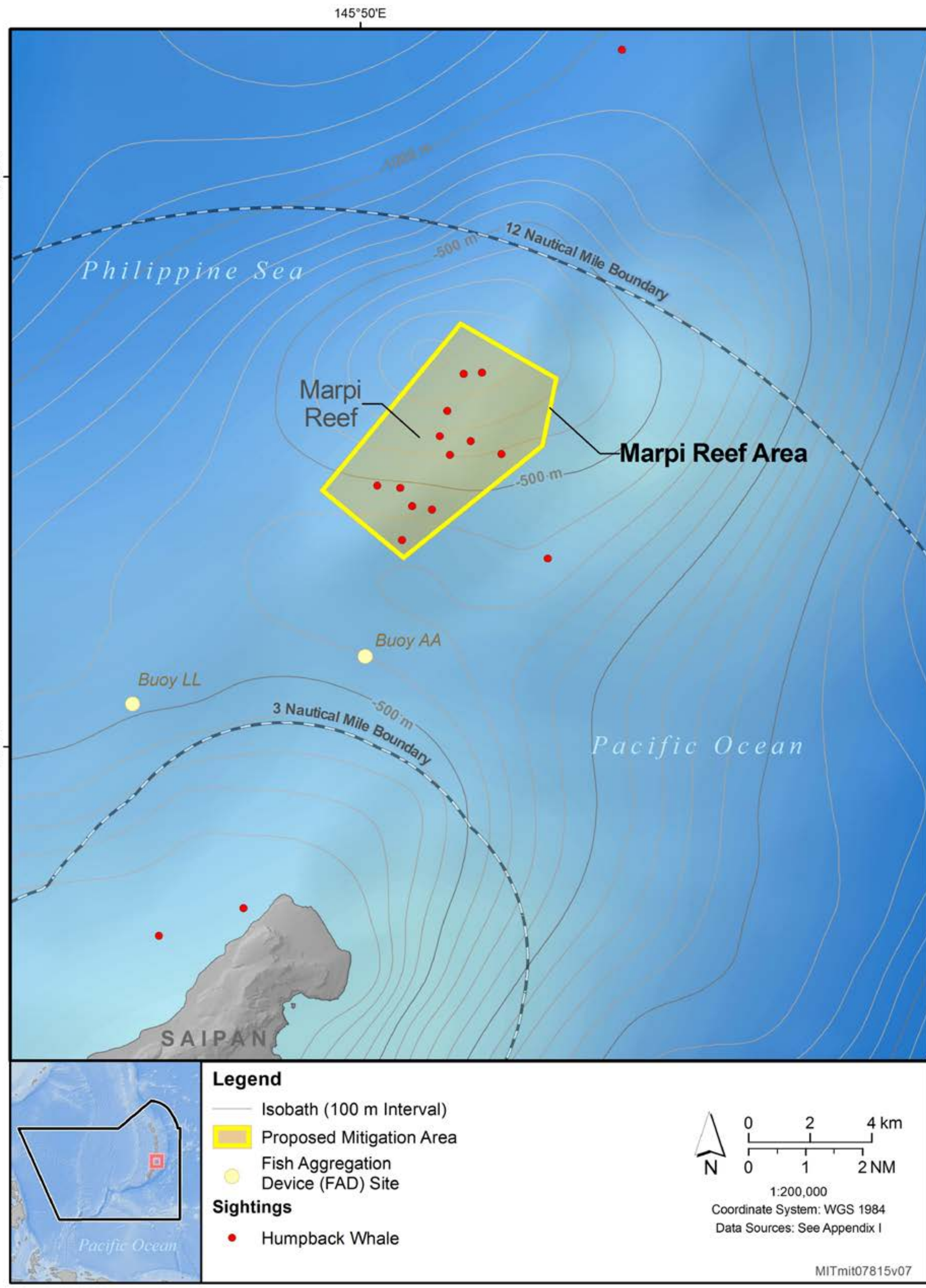


**Figure I-2: Proposed Marpi Reef Geographic Mitigation Area**

#### I.3.1.1.1 Marine Mammals

##### I.3.1.1.1.1 Humpback Whales

While all species of marine mammals described in this SEIS/OEIS could occur at Marpi Reef, the Marpi Reef Geographic Mitigation Area was specifically developed to avoid or reduce potential impacts on seasonally-present humpback whales engaged in reproductive behaviors (e.g., breeding, birthing, and nursing).

Humpback whales have been observed during four surveys in the vicinity of Saipan, in relatively small numbers, with multiple sightings documented within the proposed Marpi Reef Geographic Mitigation Area (Fulling et al., 2011; Hill et al., 2015a; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Oleson & Hill, 2010b).

Humpback whales have occasionally been observed seasonally during winter and spring (December-April) throughout the Mariana Islands by local fisherman, dive-tour operators, and during marine mammal surveys (Hill et al., 2015a; Hill et al., 2016a; U.S. Department of the Navy, 2005a; Uyeyama, 2014). Humpback whales have been sighted during surveys in the vicinity of Saipan in the months of February and March (Fulling et al., 2011; Hill et al., 2015a; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b). It remains unclear if humpback whales are simply transiting through the Study Area or use portions of the Study Area as a wintering location (Hill et al., 2016a). Given the species' absence in the waters off Saipan, Tinian, and Guam during any of the surveys that occurred between February 2010 and April 2014 (Hill et al., 2015a), their seasonal presence may be variable in the Mariana Islands even in the vicinity of Marpi Reef.

In the 2007 survey of the region, there were eight humpback whales observed in the proposed Marpi Reef Geographic Mitigation Area, but no calves were observed (Fulling et al., 2011). The next surveys to encounter humpback whales in the Mariana Islands occurred from February 26 to March 8, 2015, when four mother-calf pairs and four other individual humpback whales were observed at Chalan Kanoa Reef (Hill et al., 2015a; Hill et al., 2016b). During the subsequent NMFS Mariana Archipelago Cetacean Survey two months later (May 8 to June 6, 2015), survey transects sampling all the Mariana Islands out to 50 NM from shore detected no humpback whales visually or acoustically in the Mariana Islands (Hill et al., 2018c; Oleson, 2017). Humpback whales were observed at Marpi Reef again in 2016; eight humpback whales were sighted on March 2, including two mother-calf pairs, and on March 10 six humpback whales were sighted, also including two mother-calf pairs (Hill et al., 2017a). At Marpi Reef in 2017, a total of 21 humpback whales were sighted over two days of effort, but no calves were observed (Hill et al., 2018b). For the broader area around Saipan, humpback whales were encountered in the 2017 surveys off Marpi Reef, Chalan Kanoa Reef, or off the northwest side of Saipan between the two reefs. Sightings included mother-calf pairs, one accompanied by an escort, and other humpbacks in competitive groups (Hill et al., 2018b). Humpback whales engaged in reproductive activities or in the company of calves are generally found at or near the surface and therefore more readily observable from survey vessels, so it is unlikely that humpbacks were present and were unobserved.

In 2007 and in all subsequent surveys, all age classes of humpbacks have been observed in the Mariana Islands, including calves (Fulling et al., 2011; Hill et al., 2015a; Hill et al., 2016a; Hill et al., 2018b; Hill et al., 2018c). These surveys have documented behaviors (e.g., escorting, competitive groups) consistent with known humpback whale reproductive activities in other locations (Gabriele et al., 2017; Pack et al., 2017; U.S. Department of Commerce et al., 2015), and in 2018 NMFS confirmed that the waters around

Saipan are a newly identified "breeding location" for humpback whales (National Oceanic and Atmospheric Administration, 2018).

Based on a compendium of all observations, humpback whales have been sighted in the Study Area from January through March (U.S. Department of the Navy, 2005b; Uyeyama, 2014), and male humpback songs have been recorded from December through April (Hill et al., 2017a; Klinck et al., 2016; Munger et al., 2014; Norris et al., 2014; Oleson et al., 2015). Except for the potential presence of a few individual humpback whales at any time during the year or when migrating to or from summer feeding areas in the North Pacific, humpback whales will most likely occur in the vicinity of the Mariana Islands in relatively shallow waters during the December to April timeframe. For the purposes of establishing geographic mitigation and based on a conservative approach extending beyond the time periods for sightings in the Mariana Islands (Fulling et al., 2011; Hill et al., 2016a; Hill et al., 2017a; Hill et al., 2017b; Hill et al., 2018b; Hill et al., 2018c), humpback whales are assumed to be seasonally present from December through April in the proposed Marpi Reef Geographic Mitigation Area.

#### I.3.1.1.1.2 Spinner Dolphins

In 2017, spinner dolphins were sighted at Marpi Reef in group sizes that ranged between 25 and 110 individuals (Hill et al., 2018b). Spinner dolphins have been the most commonly encountered marine mammal species in small boat surveys since 2010 (Hill et al., 2018b; Hill et al., 2018c). As shown in Table I-2, spinner dolphins have been sighted in every year that a survey of the Marpi Reef Area has occurred, present in the months of at least February through September (Fulling et al., 2011; HDR, 2011; HDR EOC, 2012; Hill et al., 2014; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Ligon et al., 2011). Spinner dolphin behaviors observed most often at this location include milling or approaches to the survey boat to bow-ride (Hill et al., 2018b). The behaviors of these animals and their common occurrence throughout the Mariana Islands suggest that the proposed Marpi Reef Geographic Mitigation Area is of no particular biological importance for this species.

#### I.3.1.1.1.3 Bottlenose Dolphins

Bottlenose dolphins were sighted in the Marpi Reef Area in 2013, 2017, and 2018, in groups of two to eight individuals. A satellite tag was deployed on a bottlenose dolphin off Aguijan in 2013, and that individual moved through the Marpi Reef Geographic Mitigation Area and continued north to waters south of Sarigan (Hill et al., 2014), which is a distance of approximately 200 km. This is consistent with findings from other bottlenose dolphin tagging efforts in the Mariana Islands (Hill et al., 2013b; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b) indicating that bottlenose dolphins are wide-ranging across the Mariana Islands. During the 2017 encounter, it was noted the bottlenose dolphins were interacting with the humpback whales and short-finned pilot whales that were also present at Marpi Reef (Hill et al., 2018b). The wide-ranging movements of these animals suggest that no specific islands or areas in the Mariana Islands are of any particular biological importance for this species.

#### I.3.1.1.1.4 Short-Finned Pilot Whales

Short-finned pilot whales were sighted and detected via satellite tag in the Marpi Reef Area from 2013 through 2017 (Hill et al., 2013b; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b). During the 2017 survey, a pod of approximately 35 short-finned pilot whales was observed interacting with bottlenose dolphins and humpback whales (Hill et al., 2018b). Satellite tag location data for short-finned pilot whales indicate that these animals also range widely across the

Mariana Islands and that no specific islands or areas in the Mariana Islands are of any particular biological importance for this species.

##### I.3.1.1.1.5 False Killer Whales

False killer whales have not been sighted within the Marpi Reef Area during any surveys. In 2013, satellite tags were deployed on four false killer whales off Rota in pods with a group size ranging from 15 to 17 individuals (Hill et al., 2013b). Only one of these four tagged individuals moved north and through the Marpi Reef Area, but all four individuals traveled in excess of 200 NM from their initial tag detection locations off Rota (Hill et al., 2013b). The wide-ranging movements provided by these tag data indicate no particular islands or areas of importance for the species in the Mariana Islands.

#### I.3.1.1.2 Sea Turtles

Sea turtles could be present in the vicinity of the Marpi Reef Area (Martin & Jones, 2016; Martin et al., 2016; Martin et al., 2018; U.S. Department of the Navy, 2018b). Sea turtles have not been sighted within the boundaries of the proposed Marpi Reef Geographic Mitigation Area during any of the surveys conducted to date (HDR, 2011, 2012; HDR EOC, 2012; Hill et al., 2011; Hill et al., 2013a; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Ligon et al., 2011; Oleson & Hill, 2010b) and have not transited through the area based on the satellite tag detections recorded since 2013 (Jones & Van Houtan, 2014b; Jones et al., 2015; Jones & Martin, 2016; Martin & Jones, 2016; Martin et al., 2016; Martin et al., 2018).

The available data indicate that the proposed Marpi Reef Geographic Mitigation Area does not meet the Navy's criteria as a key area of biological importance for sea turtles.

### I.3.1.2 Navy Training and Testing Activities – Marpi Reef Area

The Marpi Reef Area is a low-use area for Navy training and testing activities. Explosive munitions have not been used in this area, nor has sonar use been reported in this area. However, transiting vessels could engage in training or testing activities within this area using sonar or explosives while implementing of procedural mitigation measures and following Standard Operating Procedures to ensure public safety.

### I.3.1.3 Mitigation Assessment – Proposed Marpi Reef Geographic Mitigation Area

#### I.3.1.3.1 Biological Assessment – Marpi Reef

NMFS has concluded that the waters around Saipan are a newly identified "breeding location" for humpback whales (National Oceanic and Atmospheric Administration, 2018). Based on the non-systematic survey data described above indicating that humpback whales, including mother-calf pairs, are seasonally present on a non-annual basis in the Marpi Reef Area, the area may be of biological importance to humpback whales for biologically important life processes associated with reproduction (e.g., breeding, birthing, and nursing) for part of the year. Marpi Reef is one of only two locations in the Study Area where reproductive activities have been repeatedly, although not always annually, observed. Additional data would help refine frequency of occurrence in terms of oceanographic variability, validate re-sightings of the same individuals as a percent of a humpback whale DPS, and determine if actual residency time for mother-calf pairs at Marpi Reef is significant or not. This is different from others areas in the Pacific, such as Hawaii or the U.S. West Coast, where datasets of 30–40 years are available and where far larger numbers of animals engaged in biologically important life processes have been observed. However, in consideration of the scientific data that is available at this time for the Study Area and in order to be conservative to the resource (i.e., over-protective) the Navy considers that this area does meet its criteria as an area of biological importance for humpback whale reproductive behaviors. The data do not indicate that the Marpi Reef Area is of any particular importance for other marine mammal species that may occur there.

As detailed in Section 3.4.2 (Environmental Consequences) of this SEIS/OEIS and based on the discussion above, the proposed Navy training and testing activities described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Training and Testing Activities Descriptions) are not expected to result in long-term consequences to any marine species present in the Marpi Reef Area. Geographic mitigation limiting training and testing activities would likely reduce or avoid potential impacts on marine mammals present in the Marpi Reef Area in the event that naval forces conduct training or testing activities using hull-mounted mid-frequency active sonar or in-water explosives.

#### I.3.1.3.2 Practicality of Geographic Mitigation – Proposed Marpi Reef Geographic Mitigation Area

Access to a variety of bathymetric features, including shallow areas, is critical to support realistic Anti-Submarine Warfare training and testing activities using sonar. Areas with shallow depths are limited in the Mariana Archipelago; therefore, the Navy has determined that it would be imprudent to limit the use of sonar at the Marpi Reef Area.

The Navy has access to established, nearshore training and testing areas for the use of explosive munitions; therefore, the Navy has determined that it would be practical to avoid using explosives in the proposed Marpi Reef Geographic Mitigation Area.

#### I.3.1.3.3 Summary – Proposed Marpi Reef Geographic Mitigation Area

As a result of the assessment of the Marpi Reef Area, the Navy is proposing to implement geographic mitigation and to report sonar use as described in Table I-3. Geographic mitigation would reduce or avoid impacts to any marine mammals or sea turtles present in the event a ship does transit through the area and mission requirements necessitate using active sonar while conducting a training or testing activity. Given that the Marpi Reef may be an area for humpback whale reproductive behaviors, the Navy has developed special reporting requirements, similar to those employed in the Hawaiian Humpback Whale Sanctuary, specifically for the use of MF1 surface ship hull-mounted mid-frequency active sonar, which will aid the Navy and NMFS in continuing to analyze potential impacts of training and testing in this area.

Based on current operational projections and the availability of other similar, suitable training and testing locations in the Study Area, the Navy has determined that it would be practical to avoid using explosives in the Marpi Reef Area year round under the Proposed Action. Such geographic mitigation would ensure that marine mammals are not exposed to explosives in this area, which is thought to be particularly important for humpback whale reproductive behaviors. The Navy does need to retain some degree of capability to potentially conduct active sonar in the limited shallow, nearshore waters of the MITT Study Area, including Marpi Reef, to ensure transiting vessels can meet critical training and testing requirements for MF1 surface ship hull-mounted mid-frequency active sonar.

## Table I-3: Proposed Mitigation Within the Marpi Reef Geographic Mitigation Area

| *Mitigation Area Description* |
|---|
| **<u>Stressor or Activity</u>**<br>MF1 surface ship hull-mounted mid-frequency active sonar<br>In-water explosives |
| **<u>Identified Resource Protection Focus</u>**<br>Humpback whales; seasonally present<br>Marine mammals; potentially present year-round |
| **<u>Mitigation Area Requirements</u>**<br>Seasonal (December–April): The Navy will report the total hours of MF1 surface ship hull-mounted mid-frequency active sonar used in this area in its annual training and testing activity reports submitted to NMFS.<br>Year-round: Prohibition on the use of in-water explosives<br><br>Should national security present a requirement to use in-water explosives that could potentially result in the take of marine mammals during training or testing, naval units will obtain permission from the appropriate designated Command authority prior to commencement of the activity. The Navy will provide NMFS with advance notification of an event involving the use of in-water explosives and include information about the event in its annual activity reports submitted to NMFS. The designated Command authority will base such authorization on the unique characteristics of the area from a military readiness perspective, taking into account the importance of the area for humpback whales and the need to avoid adverse impacts to the maximum extent practicable. Furthermore, the Command authority conducting the activity will provide specific direction to operational units on required mitigation prior to conducting training or testing using in-water explosives in this area. |

### I.3.2 Proposed Geographic Mitigation Area – Chalan Kanoa Reef

The Chalan Kanoa Reef[1] includes exposed fringing reef, reef flats exposed at low tide, nearshore shallow waters (less than 20 meters in depth), and a portion of Saipan Harbor. The area extends to approximately 2 km off the west coast of Saipan and covers approximately 80 $km^2$, as shown in Figure I-3. This area was developed to encompass the relative concentration of total marine mammal sightings and tag detections as observed and documented between 2007 and 2018, which included seasonal (in February and March) humpback whale sightings documented during non-systematic small boat surveys occurring in 2015 through March 2018 (Fulling et al., 2011; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Hill et al., 2018c; Oleson & Hill, 2010b). Navy scientists reviewed the locations of sightings and tag detections using a Geographic Information System, and delineated a boundary to encompass the area of highest concentration at Chalan Kanoa Reef with a particular emphasis on including humpback whale sightings.

[1] Chalan Kanoa Reef is also known as "CK Reef," "Double Reef," or "6-Mile Reef" (Hill et al., 2015a).

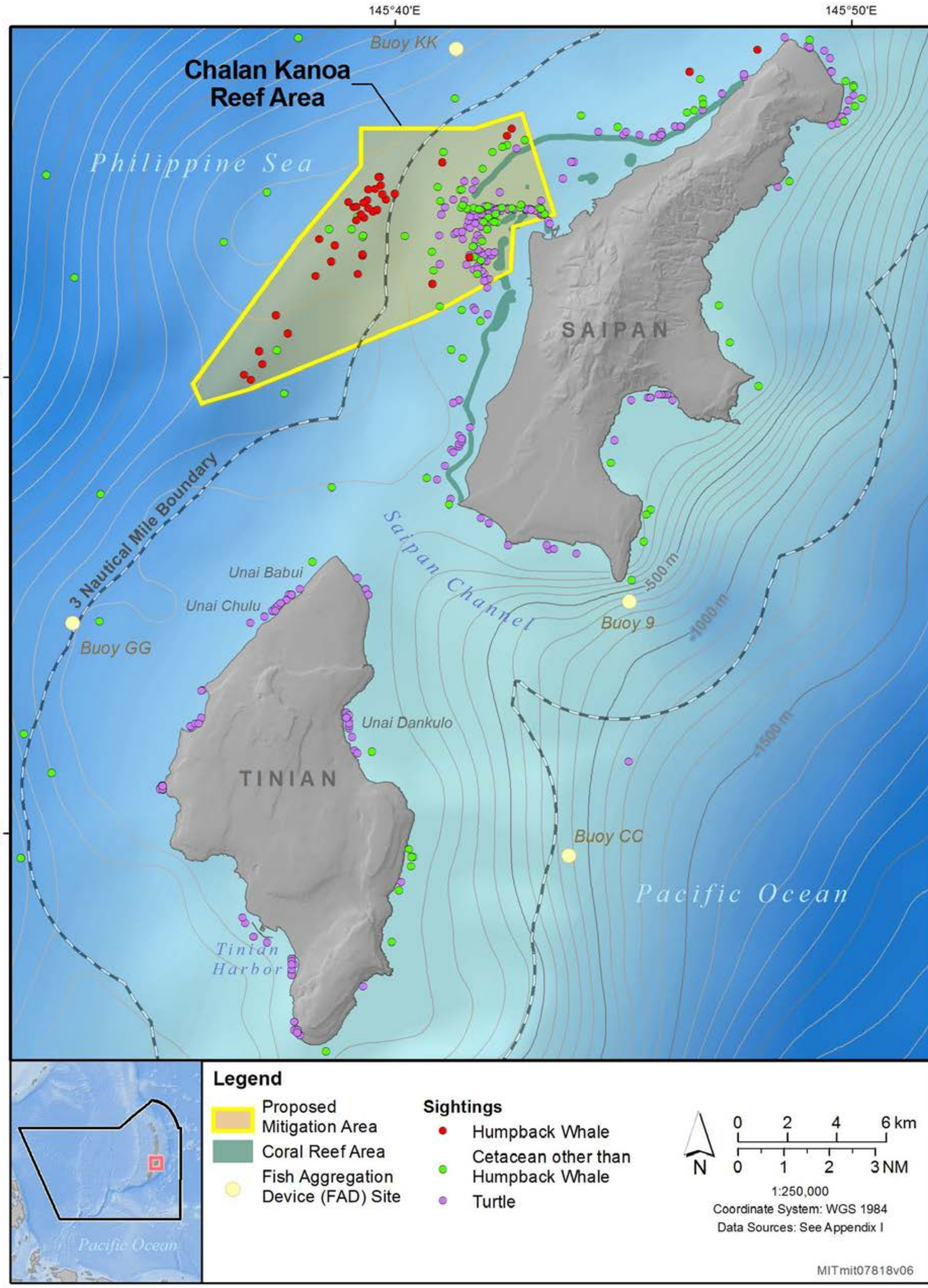


**Figure I-3: Proposed Chalan Kanoa Reef Geographic Mitigation Area**

### I.3.2.1 Resources within the Chalan Kanoa Reef Geographic Mitigation Area

The Chalan Kanoa Reef Geographic Mitigation Area was developed based on the seasonal presence of humpback whales, observed behaviors associated with reproduction, and sightings and tag detections of other marine mammals and sea turtles. Other biological resources have been observed or are expected to be present at Chalan Kanoa Reef, including corals, other invertebrates, and fishes. These resources are discussed in detail in the following sections of this SEIS/OEIS: Section 3.4 (Marine Mammals), Section 3.5 (Sea Turtles), Section 3.8 (Marine Invertebrates), and Section 3.9 (Fishes). Seven marine mammal species have been sighted or detected via satellite tag in the area: humpback whale, spinner dolphin, bottlenose dolphin, short-finned pilot whale, false killer whale, rough-toothed dolphin, and pygmy killer whale (Table I-4). Sea turtles have also been sighted in the Chalan Kanoa Reef Mitigation Area, but not all observations identified the specific species. Based on sea turtle surveys conducted throughout the Mariana Islands, the most likely species observed were green sea turtles and hawksbill sea turtles (Martin et al., 2016; U.S. Department of the Navy, 2014a).

**Table I-4: Marine Mammals and Sea Turtles Documented Within the Proposed Chalan Kanoa Reef Mitigation Area**

| Common Name | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|
| Humpback whale | | | | | | S | S | S | S |
| Spinner dolphin | S | | S | S | S | | S | S | S |
| Bottlenose dolphin | | | | S+T | S+T | S | | S | |
| Short-finned pilot whale | | | | T | T | | T | | |
| False killer whale | | | | T | | | | | |
| Rough-toothed dolphin | | | | S+T | | | | | S |
| Pygmy killer whale | | | | | | S | | | |
| Sea Turtle | | | S | S | | | | S | |

Notes: S = One or more sightings during a survey in the area; T = one or more satellite tag detections; S+T = one or more sightings and satellite tag detections in a given year; empty cells indicate no documented occurrence of the species in the given year; years not shown indicate that no surveys were conducted in the area in that year.

#### I.3.2.1.1 Marine Mammals

Surveys and satellite tag data have documented the presence of seven marine mammal species in the proposed Chalan Kanoa Reef Geographic Mitigation Area (Fulling et al., 2011; Hill et al., 2015a; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Oleson & Hill, 2010b). However, the Navy assumes all species of marine mammals known to occur in the Mariana Islands could potentially be present, if only briefly, in the offshore portion of the Chalan Kanoa Reef Mitigation Area. It is unlikely marine mammals other than spinner dolphins would be present in the shallow waters landward of the fringing reef, in Saipan Harbor, or the channel leading to the harbor. Spinner dolphins have been sighted within these inshore areas, likely using them as resting areas, consistent with behavior documented in similar habitats (Hill et al., 2015b; Hill et al., 2017a; Hill et al., 2018b).

#### I.3.2.1.1.1 Humpback Whales

Humpback whales have been observed during four surveys in the vicinity of Saipan in relatively small numbers, and multiple sightings have been documented within the proposed Chalan Kanoa Reef Geographic Mitigation Area in 2015 and 2017 (Fulling et al., 2011; Hill et al., 2015a; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Oleson & Hill, 2010b). Four encounters with humpback whales during surveys in the vicinity of Saipan occurred in February and March (Fulling et al., 2011; Hill et al., 2015a; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b). Hill et al. (2016b; 2017b) proposed that humpback whales use the Mariana Islands as a wintering location, but given the species' absence during surveys in the waters off Saipan, Tinian, and Guam in February 2010 and in April 2014 (Hill et al., 2015a), their seasonal presence may be variable in the Mariana Islands.

In 2015 small boat surveys conducted over a nine-day period a total of 12 humpback whales were encountered in the proposed Chalan Kanoa Reef Geographic Mitigation Area, including four mother-calf pairs (Hill et al., 2015a). In 2016, two humpbacks, a single mother-calf pair, were sighted in the area. The mother that was detected and photographed in 2007 at Marpi Reef (Fulling et al., 2011) was identified in the Chalan Kanoa Reef Geographic Mitigation Area in 2016 by matching patterns observed on her flukes with those in the photographs (Hill et al., 2016b). In a 2017 survey, nine humpback whales, including two mother-calf pairs, were documented during three encounters in the Chalan Kanoa Reef Geographic Mitigation Area (Hill et al., 2018b). Three of the nine whales had been identified during previous surveys in the vicinity of the Chalan Kanoa Reef (Hill et al., 2018b). As detailed in the discussion of the proposed Marpi Reef Geographic Mitigation Area (Section I.3.1.1.1.1, Humpback Whales), NMFS has confirmed that the waters around Saipan are a newly identified breeding location for humpback whales (National Oceanic and Atmospheric Administration, 2018). For purposes of geographic mitigation and based on a conservative approach exceeding the time periods for sightings in the Mariana Islands (Fulling et al., 2011; Hill et al., 2015a; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Oleson & Hill, 2010b), humpback whales are assumed to be seasonally present from December through April in the Chalan Kanoa Mitigation Area.

#### I.3.2.1.1.2 Spinner Dolphins

Spinner dolphins are the most commonly encountered species in small boat surveys and have been sighted in the proposed Chalan Kanoa Reef Geographic Mitigation Area during every survey that has been conducted in the area, except during the winters of 2011 and 2015 (HDR EOC, 2012; Hill et al., 2011; Hill et al., 2013a; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b). During small boat surveys, group sizes in the Chalan Kanoa Reef Geographic Area have ranged from as few as seven individuals in a pod to as many as 124 in the largest group observed. Milling behavior and slow travel were the most commonly observed behaviors and indicate spinner dolphin resting behavior, as documented in other locations (Tyne et al., 2015).

#### I.3.2.1.1.3 Bottlenose Dolphins

Small groups of bottlenose dolphins were routinely sighted in the years 2013, 2015, and 2017 in the Chalan Kanoa Reef Geographic Mitigation Area. In 2013, there were two sightings of bottlenose dolphins on the same day, a pod of three and a pod of six (Hill et al., 2013b). In 2015, a single individual was sighted in the area (Hill et al., 2016b). In February 2017, a pod of four bottlenose dolphins was sighted, and in May a pod of six was observed in the Chalan Kanoa Geographic Reef Area (Hill et al., 2018b). Satellite tags on two bottlenose dolphins deployed in the Marpi Reef Area during 2017 documented the extensive travel by these animals (and likely their accompanying pods). The animals traveled from within the proposed Chalan Kanoa Reef Geographic Area, south to waters off Tinian, north past Saipan to Marpi Reef, and then farther north with a final tag detection approximately 85 km west of Farallon de Medinilla (FDM) (Hill et al., 2018b). Although these satellite tracking data are limited, they indicate that the Chalan Kanoa Reef Geographic Mitigation Area is only a small portion of the range these tagged individuals (and their accompanying pods) use in the Study Area.

#### I.3.2.1.1.4 Short-finned Pilot Whales

Short-finned pilot whales have not been visually sighted in the Chalan Kanoa Reef Geographic Mitigation Area. However, individuals initially tagged off Guam, Rota, and Tinian with satellite tags were detected within the Chalan Kanoa Geographic Mitigation Reef Area in 2013, 2014, and 2016. The animals ranged widely in the Mariana Islands from waters south of Guam and north to at least as far as FDM (Hill et al., 2013b; Hill et al., 2014; Hill et al., 2017a). Through 2017, there have been 17 satellite tags deployed on short-finned pilot whales in the Mariana Islands; these individuals were in groups ranging in size from 15 to 48 animals (Hill et al., 2013b; Hill et al., 2014; Hill et al., 2017a). The wide-ranging movements of these animals suggest that no specific islands or areas in the Mariana Islands are of any particular biological importance for this species.

#### I.3.2.1.1.5 False Killer Whales

False killer whales have not been sighted within the Chalan Kanoa Reef Mitigation Area during any surveys. In 2013, satellite tags were deployed on four false killer whales off Rota in groups ranging in size from 15 to 17 individuals (Hill et al., 2013b). Two of the four tagged animals moved north and through the Chalan Kanoa Reef Mitigation Area, and all four individuals traveled in excess of 200 NM from their initial tag detection locations off Rota (Hill et al., 2013b). The wide-ranging movements of these animals suggest that no specific islands or areas in the Mariana Islands are of any particular biological importance for this species.

#### I.3.2.1.1.6 Rough-toothed Dolphins

In 2013, a pod of four rough-toothed dolphins was sighted in the Chalan Kanoa Reef Geographic Mitigation Area (Hill et al., 2013b). Five days prior to the sighting, a satellite tag was deployed on a rough-toothed dolphin in a group of six individuals off Aguijan (Hill et al., 2013b). The tagged animal moved north from the deployment location over an 11-day period and transited through the Chalan Kanoa Reef Geographic Mitigation Area to waters north of Saipan, at which point the transmissions ended. In total, the animal covered a distance of approximately 65 km. It is not known whether the tagged animal remained with the five other dolphins. The distance traveled by this individual, and possibly the group, coupled with the lack of other occurrence data, suggests that the Chalan Kanoa Reef Geographic Mitigation Area is not of any particular importance for rough-toothed dolphins in the Mariana Islands.

#### I.3.2.1.1.7 Pygmy Killer Whales

In March 2015, a pod of six pygmy killer whales was sighted in the Chalan Kanoa Reef Geographic Mitigation Area interacting with two adult humpback whales (Hill et al., 2016b). The only other sighting of pygmy killer whales in the vicinity of Saipan was a 2011 encounter with a pod of 11 approximately 2 NM from the proposed Marpi Reef Geographic Mitigation Area (Hill et al., 2011). The limited sighting data from the surveys at the Chalan Kanoa Reef indicate that the Chalan Kanoa Reef Geographic Mitigation Area is not of any particular importance for pygmy killer whales in the Mariana Islands.

#### I.3.2.1.2 Sea Turtles

All species of sea turtles could be present in the proposed Chalan Kanoa Reef Geographic Mitigation Area; although as discussed in Section 3.5 (Sea Turtles), the species most likely to be present are green sea turtles and hawksbill sea turtles, based on documented sightings the Mariana Islands (Martin & Jones, 2016; Martin et al., 2016; Martin et al., 2018; Summers et al., 2017; U.S. Department of the Navy, 2018a). Loggerhead and leatherback sea turtles are known to pass through the Study Area during migration, and olive ridley sea turtles are expected to be rare throughout the year in all waters in the Study Area (U.S. Department of the Navy, 2018).

Sea turtle sightings shown in Figure I-3 were recorded during surveys conducted in the vicinity of the Chalan Kanoa Reef (not necessarily within the boundaries of the proposed Chalan Kanoa Geographic Mitigation Area) from 2009 through the spring of 2017 (HDR, 2011, 2012; HDR EOC, 2012; Hill et al., 2011; Hill et al., 2013a; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Jones & Martin, 2016; Ligon et al., 2011; Martin & Jones, 2016; Martin et al., 2016; Martin et al., 2018; Oleson & Hill, 2010b; Summers et al., 2017; U.S. Department of the Navy, 2018b). The concentration of sightings of sea turtles (almost certainly all green and hawksbill sea turtles) in nearshore waters of the Chalan Kanoa Reef (Figure I-3) demonstrates that the area, including portions of the proposed Chalan Kanoa Geographic Mitigation Area, is used by sea turtles; however, the reef is not the only location where sea turtles are known to concentrate off Saipan. Summers et al. (2017) assessed population demographics and habitat-use for green and hawksbill sea turtles off Tinian, Saipan, and Rota using a mark-recapture study. They captured 493 green and 36 hawksbill turtles between August 2006 and February 2014 and noted long-term residency and high site fidelity among both species at the locations surveyed. Refer to Section 3.5 (Sea Turtles) and the Navy Marine Species Density Database Technical Report for the MITT Study Area (U.S. Department of the Navy, 2018b) for additional information regarding the general distribution of sea turtles in the Study Area, including in the vicinity of the Chalan Kanoa Reef Geographic Mitigation Area.

### I.3.2.2 Navy Training and Testing Activities – Chalan Kanoa Reef

The Chalan Kanoa Reef is a low-use area for Navy training and testing activities. Explosive munitions have not been used in this area, nor has sonar use been reported in this area. However, transiting vessels could engage in training or testing activities within this area using sonar or explosives while implementing procedural mitigation measures and following Standard Operating Procedures to ensure public safety.

### I.3.2.3 Mitigation Assessment – Proposed Chalan Kanoa Reef Geographic Mitigation Area

#### I.3.2.3.1 Biological Assessment – Chalan Kanoa Reef

Based on sea turtle sightings in the area, the Navy assumes that sea turtles may use the Chalan Kanoa Reef Geographic Mitigation Area for foraging; however, the available data (Martin & Jones, 2016; Martin et al., 2016; Martin et al., 2018; Summers et al., 2017; U.S. Department of the Navy, 2018a) do not indicate that the Chalan Kanoa Reef Geographic Mitigation Area is unique or particularly important for a biologically important process (e.g., foraging), and therefore the proposed mitigation area does not meet the Navy's criteria as a key area of biological importance for sea turtles.

NMFS has concluded that the waters around Saipan are a newly identified "breeding location" for humpback whales (National Oceanic and Atmospheric Administration, 2018). Based on the non-systematic survey data described above indicating that humpback whales, including mother-calf pairs, are seasonally present in the Chalan Kanoa Reef Area, the area may be of biological importance to humpback whales for biologically important life processes associated with reproduction (e.g., birthing, nursing, and breeding) for part of the year. Chalan Kanoa Reef is one of only two locations in the study area where reproductive activities have been repeatedly, although not always annually, observed. Additional data would help refine frequency of occurrence in terms of oceanographic variability, validate re-sightings of the same individuals as a percent of a humpback whale DPS, and determine if actual residency time for mother-calf pairs at Chalan Kanoa Reef is significant or not. This is different from others areas in the Pacific such as Hawaii or the U.S. West Coast, where datasets of 30–40 years are available and where far larger number of animals engaged in biologically important life process have been observed. However, in consideration of the scientific data that is available at this time for the MITT study area and in order to be conservative to the resource (i.e., over-protective), the Navy considers this area does meet its criteria as an area of biological importance for humpback whale reproductive behaviors. The data do not indicate that the Chalan Kanoa Reef Area is of any particular importance for other marine mammal species that may occur there.

As detailed in Section 3.4.2 (Environmental Consequences) of this SEIS/OEIS and based on the discussion above, the proposed Navy training and testing activities as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Training and Testing Activities Descriptions) are not expected to result in long-term consequences to any marine resources present in the Chalan Kanoa Reef. Geographic mitigation would reduce or avoid impacts to any marine mammals present in the Chalan Kanoa Reef in the event that naval forces conduct training or testing activities using hull-mounted mid-frequency active sonar or in-water explosives. While it was determined that the proposed mitigation area did not meet the Navy's criteria as a key area of biological importance for sea turtles, this mitigation would also reduce or avoid impacts to any sea turtles present.

#### I.3.2.3.2 Practicality of Geographic Mitigation – Chalan Kanoa Reef

Access to a variety of bathymetric features, including shallow areas, is critical to support realistic Anti-Submarine Warfare training and testing activities using sonar. Areas with shallow depths are limited in the Mariana Archipelago; therefore, the Navy has determined that it would be imprudent to limit the use of sonar at the Chalan Kanoa Reef Area.

The Navy has access to established, nearshore training and testing areas for the use of explosive munitions; therefore, the Navy has determined that it would be practical to avoid using explosives in the Chalan Kanoa Reef Area.

#### I.3.2.3.3 Summary – Chalan Kanoa Reef

As a result of the assessment for the proposed Chalan Kanoa Reef Geographic Mitigation Area, the Navy is proposing to implement the mitigation and reporting requirements described in Table I-5. Geographic mitigation would reduce or avoid impacts to any marine mammals or sea turtles present in the event a ship does transit through the area and mission requirements necessitate using active sonar while conducting a training or testing activity. Given that the Chalan Kanoa Reef may be an area for humpback whale reproductive behaviors, the Navy has developed special reporting requirements, similar to those employed in the Hawaiian Humpback Whale Sanctuary, specifically for the use of MF1 surface ship hull-mounted mid-frequency active sonar, which will aid the Navy and NMFS in continuing to analyze potential impacts of training and testing in this area.

Based on current operational projections and the availability of other similar, suitable training and testing locations in the Study Area, the Navy has determined that it would be practical to avoid using in-water explosives in the Chalan Kanoa Reef Area year-round under the Proposed Action. Such geographic mitigation would ensure that marine mammals are not exposed to explosives in this area, which is thought to be particularly important for humpback whale reproductive behaviors. The Navy does need to retain some degree of capability to potentially conduct active sonar in the limited shallow, nearshore waters of the Study Area, including Chalan Kanoa Reef, to ensure transiting vessels can meet critical training and testing requirements for MF1 surface ship hull-mounted mid-frequency active sonar.

**Table I-5: Proposed Mitigation Within the Chalan Kanoa Reef Geographic Mitigation Area**

| *Mitigation Area Description* |
|---|
| **Stressor or Activity**<br>MF1 surface ship hull-mounted mid-frequency active sonar<br>In-water explosives |
| **Identified Resource Protection Focus**<br>Humpback whales; seasonally present<br>Marine mammals; potentially present year-round<br>Sea turtles; present year-round |
| **Mitigation Area Requirements**<br>Seasonal (December–April): – The Navy will report the total hours of MF1 surface ship hull-mounted mid-frequency active sonar used in this area in its annual training and testing activity reports submitted to NMFS<br>Year-round: Prohibition on the use of in-water explosives<br>Should national security present a requirement to use in-water explosives that could potentially result in the take of marine mammals during training or testing, naval units will obtain permission from the appropriate designated Command authority prior to commencement of the activity. The Navy will provide NMFS with advance notification of an event involving the use of in-water explosives and include information about the event in its annual activity reports submitted to NMFS. The designated Command authority will base such authorization on the unique characteristics of the area from a military readiness perspective, taking into account the importance of the area for humpback whales and the need to avoid adverse impacts to the maximum extent practicable. Furthermore, the Command authority conducting the activity will provide specific direction to operational units on required mitigation prior to conducting training or testing using in-water explosives in this area. |

### I.3.3 Proposed Geographic Mitigation Area – Agat Bay Nearshore

The proposed Agat Bay Nearshore Geographic Mitigation Area (Figure I-4) encompasses the shoreline between Tipalao, Dadi Beach, and Agat on the west coast of Guam, with a boundary across the bay enclosing an area of approximately 5 $km^2$ in relatively shallow waters (less than 100 m). The boundaries of the proposed Agat Bay Nearshore Geographic Mitigation were defined by Navy scientists based on spinner dolphin sightings documented during small boat surveys from 2010 through 2014. Sea turtle sightings documented during surveys from 2007 through 2017 were also used to define the mitigation area (Fulling et al., 2011; HDR, 2011; HDR EOC, 2012; Hill et al., 2013a; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Jones & Van Houtan, 2014b; Jones et al., 2015; Jones & Martin, 2016; Ligon et al., 2011; Martin & Jones, 2016; Martin et al., 2016; Martin et al., 2018; Oleson & Hill, 2010b).

#### I.3.3.1 Resources within Agat Bay Nearshore Geographic Mitigation Area

Biological resources within the proposed Agat Bay Nearshore Geographic Mitigation Area include spinner dolphins, sea turtles, invertebrates including corals, and fishes. These resources and their occurrence in the Study Area are discussed in detail in this SEIS/OEIS in the following sections: Section 3.4 (Marine Mammals), Section 3.5 (Sea Turtles), Section 3.8 (Marine Invertebrates), and Section 3.9 (Fishes).

As shown in Table I-6, species documented as sighted or having a satellite tag detection[2] within the boundaries of the proposed Agat Bay Nearshore Geographic Mitigation Area include spinner dolphin and sea turtles (as noted in the sections above, most likely green and hawksbill sea turtles).

**Table I-6: Marine Mammals and Sea Turtles Documented Within the Proposed Agat Bay Nearshore Geographic Mitigation Area**

| Common Name | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2017 |
|---|---|---|---|---|---|---|---|
| Spinner dolphin | S | S | S | S | | | |
| Sea Turtle | S | S | S | S+T | S+T | S+T | S |

Notes: S = One or more sightings during a survey in the area; T = one or more satellite tag detections; S+T = one or more sightings and satellite tag detections in a given year; empty cells indicate no documented occurrence of the species in the given year; years not shown indicate that no surveys were conducted in the area in that year.

[2] There was one instance during an 11.4 day period in 2016 where a satellite-tracked pantropical spotted dolphin had one reported position just within the outer boundary of the Agat Bay Nearshore area (Hill et al., 2017a). However, given the uncertainty in the reported position due to the limited precision (error range) of even high-quality Argos satellite fixes, and in particular with regard to reduced longitudinal precision, associated with the polar orbits used by the Argos satellites (Boyd & Brightsmith, 2013; Vincent et al., 2002), the reported position does not sufficiently demonstrate that the animal was in the Agat Bay Nearshore Geographic Mitigation Area. Given the wide-ranging use of offshore waters by the same animal as demonstrated by the remainder of the detections over the 11-day tracking period, the track of the animal between subsequent positions, and the lack of precision for the locations, pantropical spotted dolphins are not expected to be present in the Agat Bay Nearshore Geographic Mitigation Area.

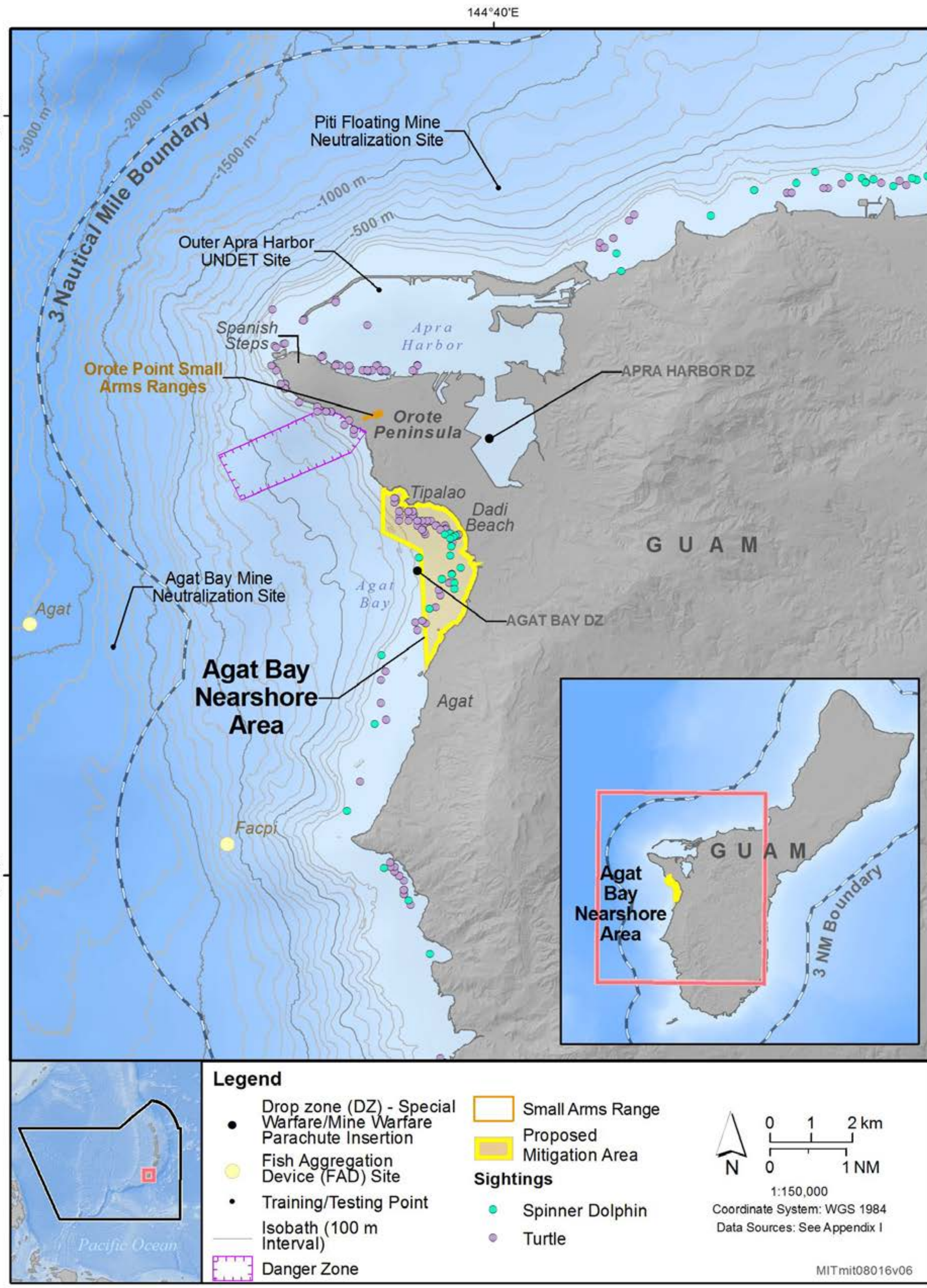


**Figure I-4: Proposed Agat Bay Nearshore Potential Geographic Mitigation Area**

#### I.3.3.1.1 Marine Mammals

##### I.3.3.1.1.1 Spinner Dolphins

Spinner dolphins have been the most frequently encountered species during small boat reconnaissance surveys conducted in the Mariana Islands since 2010. Consistent with more intensive studies completed for the species in the Hawaiian Islands, island-associated spinner dolphins are expected to occur in shallow water resting areas (about 50 meters [m] deep or less) in the morning and throughout the middle of the day, moving into deep waters offshore during the night to feed (Heenehan et al., 2016b; Heenehan et al., 2017a; Hill et al., 2010; Norris & Dohl, 1980). As reported by Ligon et al. (2011), this behavior is consistent with reports from Guam residents and tour boat captains describing spinner dolphin nearshore resting areas at Agat Bay; the Merizo channel, tucked into the several small remote bays between Merizo and Facpi Point; Piti Bay; Hagatna; Tumon Bay; and Pugua Point.

Consistent with documented resting behavior, a large pod of resting spinner dolphins (average group size between 22 and 85 individuals) was encountered in Agat Bay in the morning on six consecutive survey days in 2010 (February 9–14) (Ligon et al., 2011; Oleson & Hill, 2010a). Groups larger than 25 have not been observed again in Agat Bay during the small boat surveys since these sightings in 2010 (HDR, 2011, 2012; HDR EOC, 2012; Hill et al., 2011; Hill et al., 2013a; Hill et al., 2013b; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Jones & Van Houtan, 2014b; Jones et al., 2015; Jones & Martin, 2016; Ligon et al., 2011; Martin & Jones, 2016; Martin et al., 2016; Martin et al., 2018; Oleson & Hill, 2010b).

In February 2011, during two survey passes, a group of four spinner dolphins were observed resting in Agat Bay, but none were present in the area on subsequent survey days (HDR, 2011). No spinner dolphins were observed in two survey passes of Agat Bay in August–September 2011, although there were multiple sightings involving large pods of spinner dolphins present nearshore off Guam north of Apra Harbor, off Anderson, and south of Pati Point on the east side of Guam, as well as elsewhere in the Mariana Islands (Hill et al., 2011). In March 2012, a group of 20 spinner dolphins was present during one of two passes through Agat Bay (HDR EOC, 2012), and in June 2013 a group of 25 was present in the bay (Hill et al., 2013a). From 2014 through 2017, no spinner dolphins were observed in Agat Bay during seven surveys of the area (four passes in May 2014, one pass in 2015, and two passes in 2017) (Hill et al., 2018b). The Agat Bay area was not surveyed in 2016 (Hill et al., 2016b).

In 2010, Agat Bay was described as the “bread and butter” of the Guam dolphin-watching industry given its proximity to various small boat harbors and the expected presence of spinner dolphins (Ligon et al., 2011). Concerns have been raised in Hawaii where daytime resting by spinner dolphins has been chronically disturbed by watching boats, kayaks, and swimmer traffic, resulting in spinner dolphins spending less time in essential resting habitats (Heenehan et al., 2016a; Heenehan et al., 2016b; Heenehan et al., 2017a; Heenehan et al., 2017b; Tyne et al., 2014; Tyne, 2015; Tyne et al., 2015; Tyne et al., 2017; Tyne et al., 2018). Ligon et al. (2011) reported being uncertain of the number of boats that interacted with the spinner dolphins in Agat Bay on a daily basis, but that some of the dolphin watch boats were known to make multiple viewing trips per day, and that during the survey they occasionally observed two to three boats grouped together in the area where the dolphins were regularly observed. Given the concern over similar tourism-related disturbance elsewhere, this impact may be why there have not been reported routine sightings of spinner dolphins or pods larger than 25 during subsequent small boat surveys of Agat Bay since 2010.

#### I.3.3.1.2 Sea Turtles

Sea turtle sightings around Guam have increased steadily since 2000 (Jones et al., 2015; Martin et al., 2016; Martin et al., 2018). A summary of 32 years of in-water aerial surveys around Guam was compiled by Martin et al. (2016). Aerial surveys conducted by the Guam Division of Aquatic and Wildlife Resources indicated the year-round presence of a resident population in Guam's nearshore waters (Kolinski et al., 2001; Martin et al., 2016; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1998; Pultz et al., 1999). As presented in Section 3.5 (Sea Turtles), it is most likely that the species present would be green or hawksbill turtles (Jones & Van Houtan, 2014b; Jones et al., 2015; Martin et al., 2016; Martin et al., 2018). The summarized results of five decades of marine surveys around Guam indicate the entire west coast of Guam, including the proposed Agat Bay Nearshore Geographic Mitigation Area, should be expected to have a relatively uniform density of sea turtles (Zone 6 in Martin et al. (2016)).

As described in Sections 3.5.1.2 (Habitat Use) and 3.5.1.3 (Dive Behavior), it is assumed that the shallow water area within proposed Agat Bay Nearshore Geographic Mitigation Area would be used for foraging by sea turtles. There has been no known nesting at Dadi Beach, but there have been a relatively high number of documented sea turtle sightings in the water off Tipalao. There have been 47 sea turtles sighted in the Agat Bay Nearshore Geographic Mitigation Area between 2010 and 2017 (HDR, 2011, 2012; HDR EOC, 2012; Hill et al., 2011; Hill et al., 2013a; Hill et al., 2013b; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Jones & Van Houtan, 2014b; Jones et al., 2015; Jones & Martin, 2016; Ligon et al., 2011; Martin & Jones, 2016; Martin et al., 2016; Martin et al., 2018; Oleson & Hill, 2010b). The distribution of sea turtle sightings is a result of the survey coverage, and Agat Bay should not be interpreted as the only area where sea turtles would be expected to be found in waters off Guam. The proposed Agat Bay Nearshore Geographic Mitigation Area overlaps a portion of what was identified as a "core area" of based on the movements of tagged green sea turtles (Martin et al., 2018). Two tags that remained active after 189 days tracked the turtles' movements to the north from Agat, with one going to as far as Apra Harbor and the other to Pati Point on the north coast of Guam (Martin et al., 2016), indicating that green sea turtles move and forage widely around Guam.

### I.3.3.2 Navy Training and Testing Activities – Agat Bay Nearshore

The Agat Bay Nearshore Area is a low-use area for most types of Navy training and testing activities. Explosive munitions have not been used in this area nor has sonar use been reported in this area. However, transiting vessels could conduct training or testing activities within this area using sonar or explosives while implementing procedural mitigation measures and following Standard Operating Procedures to ensure public safety. Navy training and testing activities have been shut down or canceled in the vicinity of the proposed mitigation area in the past due to the presence of marine mammals and civilian boat traffic.

### I.3.3.3 Mitigation Assessment – Proposed Agat Bay Nearshore Geographic Mitigation Area

#### I.3.3.3.1 Biological Assessment – Agat Bay Nearshore

Spinner dolphins are known to use Agat Bay, including the proposed Agat Bay Nearshore Geographic Mitigation Area, for resting behavior, and a relatively high number of sea turtles have been documented in the area off Tipalao. The available data on spinner dolphin occurrence and behaviors and the data on sea turtles indicate that the Agat Bay Nearshore Geographic Mitigation Area does meet the Navy's criteria as an area of biological importance for spinner dolphins and sea turtles. As discussed in detail in Section 3.4.2.1.2 (Impacts from Sonar and Other Transducer Stressors) and Section 3.4.2.2.2 (Impacts from Explosive Stressors), marine mammals engaged in important behaviors, such as resting, may be more likely to ignore or tolerate a source of disturbance and continue their natural behavior patterns. Behavioral reactions, if occurring at all, are likely to be short term and low-to-moderate severity and unlikely to produce long-term consequences. The Navy has determined that impacts to spinner dolphins and sea turtles are likely to be avoided or reduced by prohibiting the use of MF1 surface ship hull-mounted mid-frequency active sonar and in-water explosives in the Agat Bay Nearshore Geographic Mitigation Area.

#### I.3.3.3.2 Practicality of Geographic Mitigation – Agat Bay Nearshore

Access to a variety of bathymetric features, including shallow areas, is critical to support realistic Anti-Submarine Warfare training and testing activities using sonar. However, due to multiple factors impacting its value for some training and testing activities, such as the very shallow depth of this area, and the proximity to shore and civilian boating activity, the Navy has determined that it would be appropriate and practical to restrict the use of MF1 surface ship hull-mounted mid-frequency active sonar.

As the Navy has access to established, nearshore training and testing areas for explosive munitions, the Navy has determined that it would be practical to avoid using in-water explosives in the Agat Bay Nearshore Geographic Mitigation Area year round.

#### I.3.3.3.3 Summary – Agat Bay Nearshore

As a result of the assessment for the Agat Bay Nearshore Geographic Mitigation Area, the Navy is proposing implementation of geographic mitigation as described in Table I-7. Based on current operational projections and the availability of other similar, suitable training and testing locations in the Study Area, the Navy has determined that it would be practical to avoid using surface ship hull-mounted mid-frequency active sonar and in-water explosives in the proposed Agat Bay Nearshore Geographic Mitigation Area year-round under the Proposed Action. Such geographic mitigation would ensure that spinner dolphins and sea turtles are not exposed to MF1 sonar and explosives in this area, which has the potential to disturb spinner dolphin resting behavior and sea turtle foraging behavior.

## Table I-7: Proposed Mitigation Within the Agat Bay Nearshore Geographic Mitigation Area

| *Mitigation Area Description* |
|---|
| **Navy Activity**<br>MF1 surface ship hull-mounted mid-frequency active sonar<br>In-water explosives |
| **Identified Resource Protection Focus**<br>Spinner dolphins; present year-round<br>Sea turtles; present year-round |
| **Mitigation Area Requirements**<br>Year-round: Prohibition on use of MF1 mid-frequency active sonar and in-water explosives<br>Should national security present a requirement to use MF1 mid-frequency active sonar or in-water explosives that could potentially result in the take of marine mammals or sea turtles during training or testing, naval units will obtain permission from the appropriate designated Command authority prior to commencement of the activity. The Navy will provide NMFS with advance notification of an event involving the use of in-water explosives and include information about the event in its annual activity reports submitted to NMFS. The designated Command authority will base such authorization on the unique characteristics of the area from a military readiness perspective, taking into account the importance of the area for spinner dolphins and sea turtles and the need to avoid adverse impacts to the maximum extent practicable. Furthermore, the Command authority conducting the activity will provide specific direction to operational units on required mitigation prior to conducting training or testing using in-water explosives in this area. |

## I.4 Geographic Mitigation Assessment – Areas Not Carried Forward for Implementation

The Navy received scoping comments suggesting areas for potential mitigation within the MITT Study Area. The comments and a brief description and assessment of the areas are presented in the following subsections.

### I.4.1 West Mariana Ridge

The West Mariana Ridge was identified by the Governor of the Commonwealth of the Northern Mariana Islands (CNMI) (Ralph D.L.G. Torres) as an area of potential geographic mitigation in a scoping comment on the 2017 Draft SEIS/OEIS Notice of Intent. The area was originally identified by the previous governor, Governor Eloy S. Inos, in a comment on the 2013 MITT Draft EIS/OEIS. The comment recommended that the Navy avoid conducting activities with sonar and explosives along the bathymetric feature known as the West Mariana Ridge.

The West Mariana Ridge (Figure I-5) consists of a seafloor ridge formed by a chain of conical seamounts extending northward to Japan, approximately parallel to the island chain that forms Guam and the CNMI. Coordinates or a map for the entire West Marina Ridge area were not provided in the scoping comment so, for the purposes of this assessment, the potential mitigation area was defined as an area centered approximately over the ridge that extends out to the 3,500 m isobath between approximately 13° north and 18° north latitude and would include (according to the comment letter) “some seamounts (including the Pathfinder, Arakane, and Suruga seamounts between 142° and 143° E) [that] rise to summits less than 50 m below sea level.” As shown in Figure I-5, the area spans approximately 1,000 km north to south and covers an area of 69,800 $km^2$ within the Study Area, although the bathymetric feature defining this area continues extends north of the Study Area, terminating in waters off Japan.

The ridge is approximately 250 km west of Guam and, as stated in the comment by Governor Inos in 2013, “support[s] a rich diversity of coral reef and continental slope species,” and “dense concentrations of biological productivity: high planktonic production, and large schools of small and predatory fishes including skipjack and other species of tuna.” Also specifically mentioned in the comment were two beaked whale sightings, detections of short-finned pilot whales, and satellite tag detections of a false killer whale in the vicinity of the ridge. The comment letter indicated that “… multiple sightings of several cetacean species…supported the delineation of a geographic mitigation area and were evidence indicative of… a biologically important feature that should be protected.”

The Navy recognizes that biological productivity is often associated with bathymetric features like ocean ridges and seamounts; however, productivity in such areas is often highly dependent on changeable conditions, including weather patterns, wind intensity and direction, localized currents and eddies, and the presence of nutrients in the water column.

Based on the distribution of marine mammals as known from visual surveys and satellite tag detections within the Study Area ( Figure I-5), limiting Navy training and testing activities at the West Mariana Ridge and surrounding region to the 3,500 m isobath would not result in avoiding “high concentrations” of marine mammals (Fulling et al., 2011; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Klinck et al., 2015; Klinck et al., 2016; Ligon et al., 2011; Munger et al., 2014; Munger et al., 2015; National Oceanic and Atmospheric Administration, 2015; Nieukirk et al., 2016; Norris et al., 2017; Oleson et al., 2015; Tetra Tech Inc., 2014; U.S. Department of the Navy, 2007, 2012, 2013, 2014b, 2018b; Yack et al., 2016). While marine mammals have been observed in the area of the West Mariana Ridge, the vast majority of marine mammal sightings and satellite tag detections have been recorded far to the east of the ridge (Figure I-5) (Fulling et al., 2011; Hill et al., 2018b). The available data do not indicate that the West Mariana Ridge or surrounding area is an area of key biological importance for marine mammals or other marine species, nor is it clear that limiting the use of sonar and explosives in the area would result in an avoidance or reduction of impacts. Therefore the West Mariana Ridge area does not meet the Navy's criteria for effective geographic mitigation.

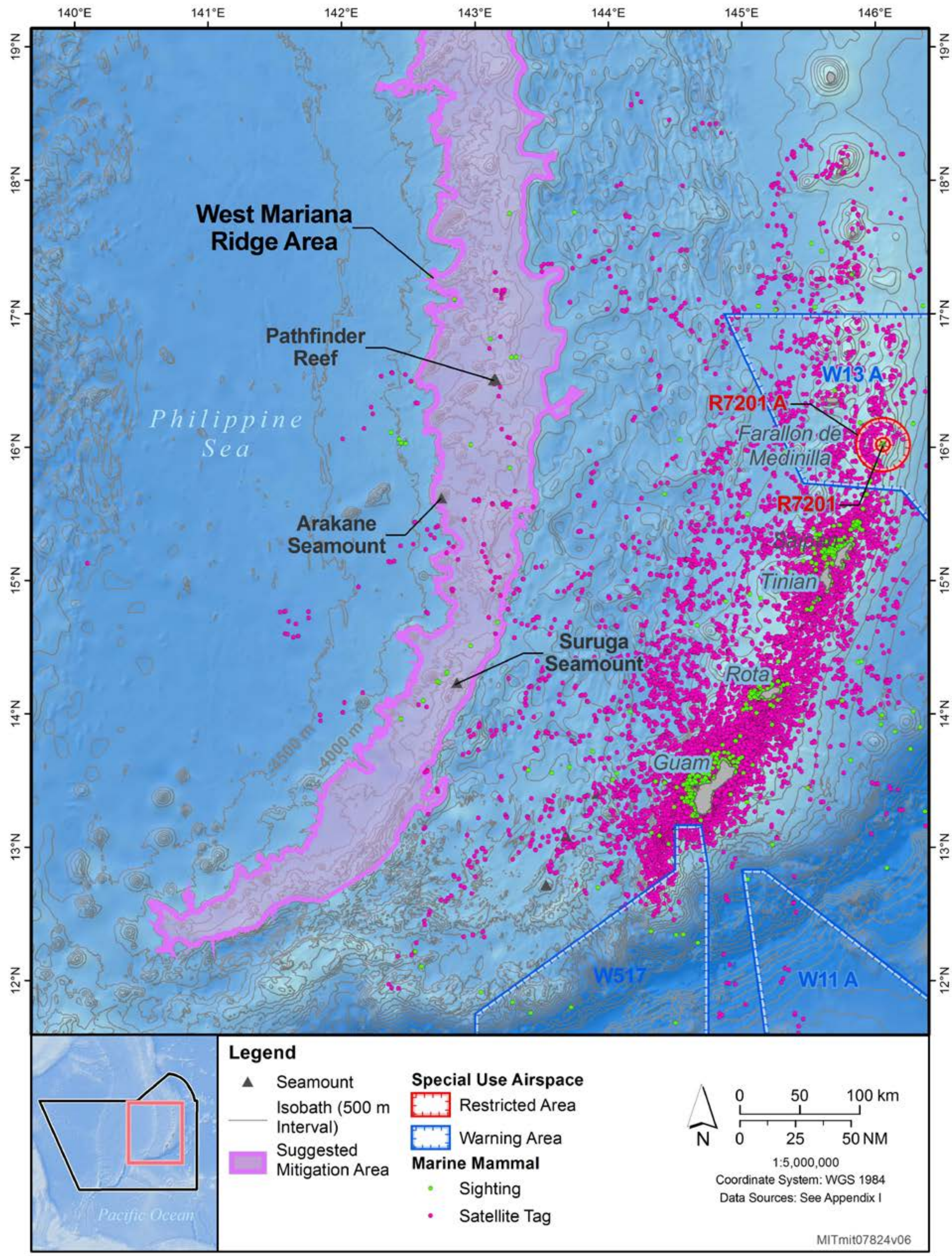


**Figure I-5: West Mariana Ridge Area Suggested as a Potential Mitigation Area**

This area was identified by the Governor of the CNMI (Ralph D.L.G. Torres) in a scoping comment on the 2017 Draft SEIS/OEIS Notice of Intent. The comment recommended that the Navy avoid conducting activities with sonar and explosives around the Islands of the CNMI landward of the 3,500 m isobath (Figure I-6). The comment was originally submitted by the previous governor, Governor Eloy S. Inos, as a comment on the 2013 MITT Draft EIS/OEIS.

The comment indicates there are island-associated populations of marine mammals present in the Study Area. The comment assumes there are island-associated populations in the Mariana Islands, because there have been a number of small and resident populations documented in the Hawaiian Islands (Baird et al., 2015). The comment offers that because "…insular populations of odontocetes are generally concentrated within the 3,500 m isobath…" around the Hawaiian Islands, then that same isobath should be used to define the boundary for a mitigation area in the Mariana Islands to mitigate "… the distinct risks posed to resident marine mammal populations, near island habitat…." The comment goes on to suggest that results of small boat, nearshore surveys in the Mariana Islands are indicative of site fidelity for several species, including spinner dolphins, bottlenose dolphins, rough-toothed dolphins, and short-finned pilot whales in waters shallower than 3,500 m (Hill et al., 2011; Hill et al., 2014; Hill et al., 2018b), similar to the findings from Hawaii (Baird et al., 2015). However, data from surveys conducted in the Study Area and cited in the comment, as well as other surveys (Fulling et al., 2011; Hill et al., 2013a; Hill et al., 2014; Hill et al., 2018b; Klinck et al., 2015; Norris et al., 2017; Oleson & Hill, 2010a) and data from satellite tags recording the movement of individual animals, indicate many of those same species utilize ocean areas beyond the 3,500 m isobath. Many of these species, including bottlenose dolphins, rough-toothed dolphins, pantropical spotted dolphins, false killer whales, and beaked whales have wide-ranging distributions in the Study Area.

Additionally, research from areas, including Hawaii, where training and testing activities occur more often and involve more concentrated use of sonar and explosives, such as at the Pacific Missile Range Facility, has documented the presence of numerous small and resident populations of marine mammals and long-term residency of individuals (Baird et al., 2015). These marine mammals have co-existed for decades alongside areas of concentrated Navy training and testing activity.

Furthermore, there are no indications from satellite tag data or photographic identification of marine mammals that there are any island-associated small or resident populations of marine mammals in the Mariana Islands (Ampela et al., 2014; HDR, 2011, 2012; HDR EOC, 2012; Hill et al., 2011; Hill et al., 2013a; Hill et al., 2015a; Hill et al., 2013b; Hill et al., 2014; Hill et al., 2015b; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Ligon et al., 2011). For additional information on the results from research and monitoring where the Navy has been training and testing for decades in the Mariana Islands, refer to Section 3.4.3.4 (Summary of Monitoring and Observations During Navy Activities Since 2015) of this SEIS/OEIS.

With regard to the practicality of geographic mitigation, the suggested mitigation area overlaps with all nearshore training and testing areas and completely encompasses FDM and R-7201. The suggested area overlaps with the northern part of W-517, most of W-13A, and a small part of W-13B. Essentially every training and testing activity in the Proposed Action may occur in the suggested mitigation area, and many of the Navy's activities would only occur in the suggested mitigation area.

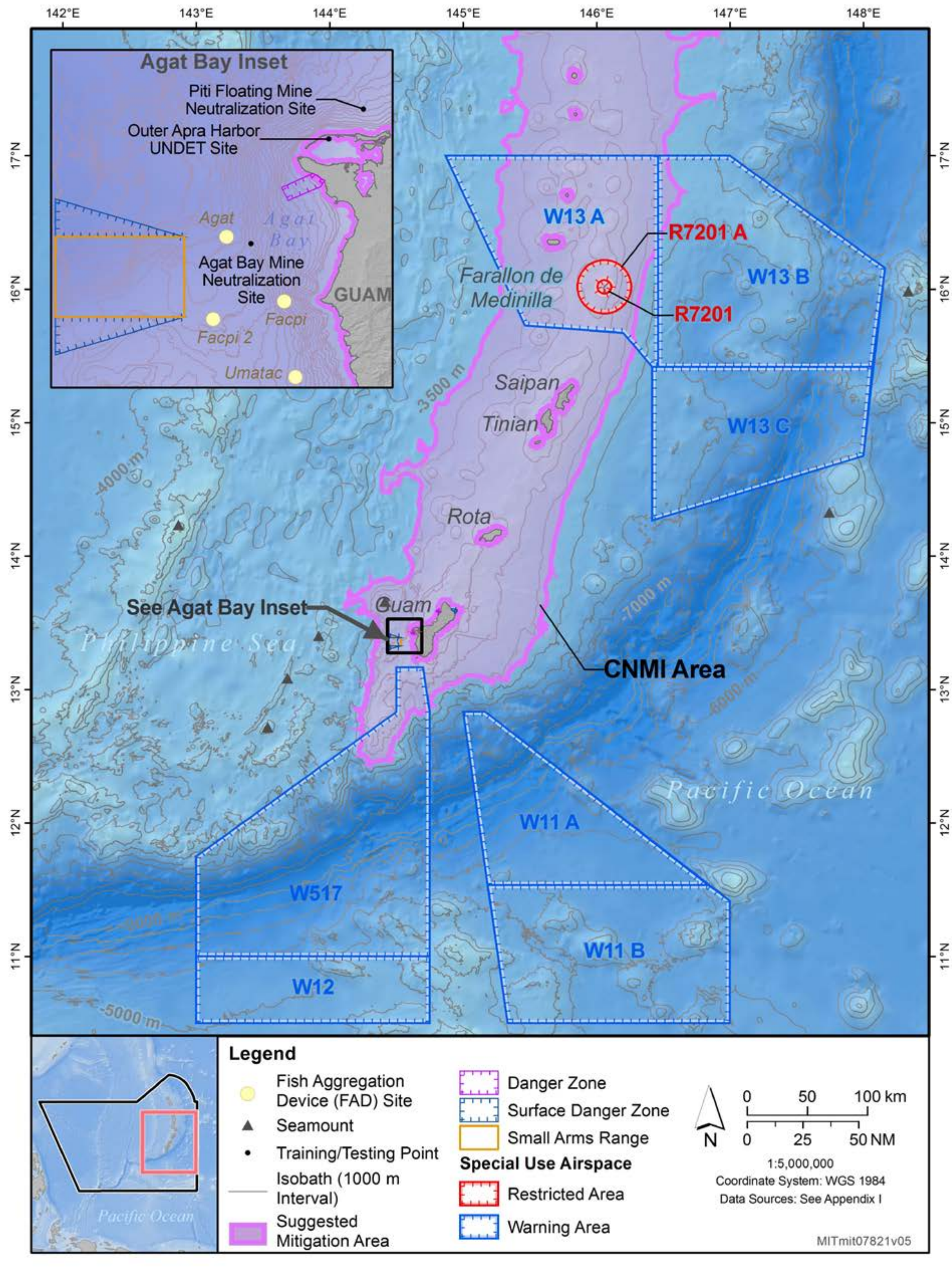


**Figure I-6: Commonwealth of the Northern Mariana Islands Landward of the 3,500 Meter Isobath Suggested as a Potential Mitigation Area**

W-517 is special use airspace and is important because it overlays a large, contiguous deep-ocean area that is relatively free of surface vessel traffic. W-517 altitude limits are from the surface to infinity and it supports GUNEX, CHAFFEX, MISSILEX, MINEX, SINKEX, BOMBEX, TORPEX, and Carrier training activities. W-517 is a laser certified open-ocean range. It is also used for surface vessel unit-level training.

FDM consists of the island land mass and the restricted airspace around it, R-7201. It contains a live-fire and inert bombing range and supports live-fire and inert engagements such as surface-to-ground and air-to-ground GUNEX, BOMBEX, MISSILEX, and Naval Surface Fire Support. FDM is an uncontrolled and un-instrumented, laser-certified range with fixed targets, including boxes and truck frames in various configurations within the lightweight, inert-only zone.

The suggested geographic mitigation area encompasses all mine neutralization sites, all shorelines, all anchorages, and all drop zones. All proposed amphibious warfare training and expeditionary warfare activities can only occur in the suggested mitigation area.

In addition to the training and testing areas where sonar may be used (e.g., required in-port sonar testing in Apra Harbor, Operating Areas), the suggested mitigation area encompasses open-ocean areas and several transit corridors between operating areas where sonar may be used for unit-level training or testing. Requiring units to take circuitous transit routes between Operating Areas in order to complete their required unit-level training and testing outside the 3,500 m isobath would add a substantial burden in terms of lost time for productive events, time away from home, unnecessary wear on equipment, and excessive fuel usage.

The MIRC provides training and testing venues that support the operational readiness of the Navy, U.S. Marine Corps, U.S. Air Force, Guam Army National Guard, Guam Air National Guard, Army Reserves Marianas, U.S. Coast Guard, and other users based and deployed in the Western Pacific. The MIRC is characterized by a unique combination of attributes that make it a strategically important range complex for the Services. These attributes include

- location within U.S. territory;
- live-fire ranges on Guam and FDM;
- expansive airspace, surface sea space, and underwater sea space;
- authorized use of multiple types of live and inert ordnance on FDM;
- support for all Navy warfare areas and numerous other Service roles, missions, and tactical tasks;
- support to homeported Navy, Army, U.S. Coast Guard, and U.S. Air Force units based at military installations on Guam and CNMI;
- training support for deployed forces;
- Western Pacific Theater training venue for Special Warfare forces;
- ability to conduct Joint and combined force exercises; and
- rehearsal area for WESTPAC contingencies.

Geographic mitigation for explosives and sonar landward of the 3,500 m isobath would have a substantial impact on training and testing activities and largely negate the existence of the MIRC; it is unlikely that Naval forces would be able to meet required conditions of readiness, and it could impact readiness for the other services. It would not be operationally practical to implement.

### I.4.2 Earthjustice and on Behalf of Tinian Women Association, Guardians of Gani', PaganWatch, and Center for Biological Diversity

Scoping comments on five topics regarding marine species were submitted by Earthjustice and on behalf of the Tinian Women Association, Guardians of Gani', PaganWatch, and Center for Biological Diversity in response to the Notice of Intent for this SEIS/OEIS. The basis for the mitigation as stated by the Earthjustice letter was that the MITT activities "… threaten serious harm to marine mammals," citing to the current authorization of MMPA takes of marine mammals in the Study Area. There have been two previous sets of analyses of impacts on marine mammals by NMFS and the Navy, including two previous Letters of Authorization pursuant to the MMPA, and two Biological Opinions pursuant to the ESA for Navy activities in the Study Area. To date, there has been no empirical evidence suggesting, and NMFS has made no findings of, "serious harm" as suggested in the comment. The Navy models take as defined under the MMPA, the Navy does not model instances of "serious harm," and the vast majority of the takes modeled for this Proposed Action are temporary behavioral reactions. Species-specific comments provided in the Earthjustice letter are provided in the following subsections.

#### I.4.2.1 Minke Whale Habitat

The commenter suggested geographic mitigation for minke whale habitat. Minke whales have been detected acoustically in the Mariana Islands (Fulling et al., 2011; Klinck et al., 2015; Klinck et al., 2016; Norris et al., 2012; Norris et al., 2017; Oleson & Hill, 2010a), and this body of research has been considered and integrated into this SEIS/OEIS (see Section 3.4.1.12, Minke Whale [*Balaenoptera acutorostrata*] and supporting documents) (U.S. Department of the Navy, 2018b). As the cited research indicates, minke whales are one of the most abundant species of baleen whales worldwide (Norris et al., 2017). The purpose of the research was to reliably estimate minke whale abundance in the survey area based on passive acoustic detections of "calling" minke whales (Norris et al., 2017). The acoustic detections of minke whales in the area do not indicate the Mariana Islands are in any way unique or represent key areas of biological importance. While the authors state "There are also advantages to using passive acoustic methods for identifying important habitat for species of marine mammals with low densities," that statement is in the context of survey detection, not with regard to determination of specific areas of importance. Methods for estimating density from acoustic detections are currently being developed and numerous assumptions are associated with the calculations. Norris et al. (2017) mention "several caveats, biases, uncertainties and potential violations of the assumptions," which make clear the "preliminary" nature of "some obvious and interesting patterns" in the distribution of acoustic detections (Norris et al., 2017). Basically, those patterns were that all 30 individual minke whales detected acoustically during the 2007 survey (Fulling et al., 2011) were located to the south and east of the Mariana Islands within an area of approximately 156,600 $km^2$. Such a large area lacks precision to identify particularly key important areas and is much too large to be practical for geographic mitigation. In addition to Norris et al. (2017) noting the requirement for more detailed analyses of the current data, these results were collected from only a single season (January to April 2007), so it remains unknown if the minke whale detections were associated with static features such as water depth and bathymetry slope or were associated with dynamic ocean conditions present during that particular survey. Given the temporally dynamic redistributions of marine mammals in response to both seasonal variation and longer-term climate change affecting ocean conditions (Becker et al., 2017; Forney et al., 2015; Ramp et al., 2015; Risch et al., 2014; Silber et al., 2017), and that species such as minke whales migrate from low-productivity tropical waters in the summer (Jefferson et al., 2015; Perrin & Brownell, 2009), it is possible that minke whales may not have a fixed distribution within the MITT Study Area.

Therefore, establishing a mitigation area based on the results from a single survey would not be scientifically valid and does not meet the Navy's criteria for a geographic mitigation area (see Section I.2.2, Assessing Mitigation Effectiveness). There is no evidence delineating a specific area that is particularly important for any biologically important life process (e.g., foraging, migration, reproduction), and there is no empirical evidence of significant impacts on the minke whale population in the Study Area resulting from military readiness activities. Therefore, mitigation would not result in an avoidance or reduction of impacts.

#### I.4.2.2 Humpback Whale Calving Grounds

Earthjustice commented: "The SEIS must examine the impacts of MITT activities on humpback whale calving grounds, particularly given the potential the affected whales come from the endangered Western North Pacific humpback population. See Hill et al. (2017)." As noted in this SEIS/OEIS in Section 3.4.1.11 (Humpback Whale [*Megaptera novaeangliae]*), the Navy-funded surveys and research have resulted in the documentation of recorded mother-calf pairs, competitive groups, and 35 additional photo-identified non-calf whales (Fulling et al., 2011; Hill et al., 2015a; Hill et al., 2015b; Hill et al., 2016a; Hill et al., 2016b; Hill et al., 2017a; Hill et al., 2018b; Hill et al., 2018c), so it is possible that humpback whale calving is occurring somewhere (as yet unknown) in the Mariana Islands (National Marine Fisheries Service, 2018), but the literature and the commenter provide no details on where a hypothetical calving ground mitigation area would be specifically located. The Navy has proposed two areas off Saipan (Section I.3.1, Proposed Geographic Mitigation Area – Marpi Reef; and Section I.3.2, Proposed Geographic Mitigation Area – Chalan Kanoa Reef) as geographic mitigation areas that were based largely on the aggregated sightings of humpback whales engaged in reproductive behaviors, though calving itself has not been observed.

#### I.4.2.3 Marine Mammal Biologically Sensitive Areas

Earthjustice requested that consideration should be given to "…severely limit training and testing activities in biologically sensitive areas" specific to marine mammals. The Navy interpreted this to mean Biologically Important Areas (BIAs) as have been identified for marine mammals in other geographic areas of the Pacific (Ferguson et al., 2015a; Van Parijs et al., 2015). In the Mariana Islands, no BIAs have been identified. No critical habitat has been designated for ESA-listed marine mammals within the Study Area. However, in lieu of BIAs or critical habitat, the Navy has compiled and assessed existing data from the Study Area and proposed mitigation areas in this appendix based upon that data. As detailed in Chapter 5 (Mitigation) of this SEIS/OEIS, the Navy, in consultation with NMFS, has implemented mitigation measures to reduce or avoid impacting marine species and their habitat in general. If in the future there is a location identified as a BIA, then the Navy, in consultation with NMFS, will undertake analysis of that location as described in Section 5.2 (Mitigation Development Process) to consider implementation of geographic mitigation measures as part of the adaptive management process.

#### I.4.2.4 Sea Turtle Biologically Sensitive Areas

Earthjustice requested that consideration should be given to "…severely limit training and testing activities in biologically sensitive areas" and restrictions on MITT activities "…in areas identified as containing high densities of imperiled sea turtles." The Navy has funded much of the research providing information on sea turtles in the Mariana Islands (Hill et al., 2014; Hill et al., 2018b; Jones & Van Houtan, 2014b; Jones et al., 2015; Jones & Martin, 2016; Martin et al., 2016; Martin et al., 2018; Summers et al., 2017; Summers et al., 2018) and has considered those references and others in the analysis presented in this SEIS/OEIS. Sea turtle sightings around Guam have increased steadily since 2000 (Martin & Jones, 2016; Martin et al., 2016; Martin et al., 2018), which does not suggest ongoing Navy training and testing activities are resulting in negative effects on sea turtle populations in the area Martin et al. (2018). While sea turtle nesting areas on land can be considered sensitive areas in need of protection from certain activities, the Navy already actively manages nesting areas at onshore locations like Spanish Steps and Haupto on Guam, and currently implements mitigation measures associated with training and testing activities in other locations where sea turtle nesting may occur (U.S. Department of the Navy, 2015). The Navy has also proposed two geographic mitigation areas (see Section 1.3.2, Mitigation Area – Chalan Kanoa Reef; and Section I.3.3, Mitigation Area – Agat Bay Nearshore) that are locations where sea turtles have been routinely sighted during surveys. As detailed in Section 3.5.2 (Environmental Consequences) and in consideration of the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to individual sea turtle or sea turtle populations are not expected as a result of the proposed training and testing activities.

### I.4.3 Seafloor Habitat less than 700 Meters Deep

The NMFS Habitat Conservation Division recommended that the Navy avoid all areas where the seafloor is less than 700 m deep, including offshore banks, shoals, and seamounts, because the use of expended materials in depths shallower than 700 m would impact seafloor Essential Fish Habitat. This area would include approximately 7,500 $km^2$ of the waterspace around the Mariana Islands.

As detailed in Section 3.1 (Sediments and Water Quality) and Section 3.9 (Fishes), the evidence indicates that effects to seafloor habitat would be minimal and localized where expended materials are in direct contact with the seafloor. This is expected to result in small proximate changes or otherwise minimal impact to the environment and insignificant changes in ecological functions (67 Federal Register 2354). The Navy considers an impact minimal if:

- the intensity of the impact at the specific site being affected is low,
- the spatial extent of the impact relative to the availability of the habitat type affected is small,
- the sensitivity/vulnerability of the habitat to the impact is low,
- the habitat functions that may be altered by the impact (e.g., shelter from predators) are negligible, and
- the timing of the impact relative to when the species or life stage needs the habitat is not critical

Adverse effects to Essential Fish Habitat under the Magnuson-Stevens Act are evaluated by the lost value to the management unit species, and appropriate mitigation or offsets produce outcomes that result in no more than minimal adverse effects to Essential Fish Habitat. The Navy completed an Essential Fish Habitat consultation with NMFS in 2014 for these ongoing training and testing activities. NMFS provided conservation recommendations to avoid, minimize, or offset adverse impacts. The Navy responded to NMFS' concerns, agreed to implement all practicable recommendations, and provided explanations for any disagreements as required by the Magnuson-Stevens Act. The Navy cannot practicably avoid discharging expended materials in all waters less than 700 m in depth, which encompass many training and testing areas that are specifically designed for these types of activities and are required to be near shore for accessibility (e.g., small arms ranges). In addition, the Navy currently implements mitigation for seafloor resources as described in Section 5.4.1 (Mitigation Areas for Seafloor Resources), which should also avoid or reduce impacts on sensitive seafloor habitat.

### I.4.4 Various and Anonymous Commenters – Generalized Geographic Avoidance

The Navy received comments suggesting that in the future the Navy should stop conducting training and testing activities in various generalized or notional locations in the Mariana Islands. The Navy considered all public comments received during the National Environmental Policy Act scoping process. There were scoping comments related to the general theme of geographic mitigation that are not addressed individually here. These comments fell into one of three categories: (1) they involved notional suggestions and provided no specific location where a mitigation might be implemented; (2) they lacked scientific basis in support of the recommendation; or (3) science did not support the recommendation by the commenter.

The Navy currently implements integrated at-sea procedural mitigation (see Section 5.3, At-Sea Procedural Mitigation to be Implemented) and at-sea mitigation areas for seafloor resources (see Section 5.4, At-Sea Mitigation Areas to be Implemented) wherever and whenever applicable activities occur, as detailed in Chapter 5 (Mitigation) of this SEIS/OEIS.

Scoping comments specific to a particular marine resource were summarized at the end of the applicable resource section in this SEIS/OEIS (see Section 3.4.6, Public Scoping Comments). The concerns raised were generally based on assumptions that significant harm or damage would occur to marine resources in the future if ongoing training and testing activities were to continue into the future, despite decades of ongoing activities with no evidence of the harm or damage. In addition, a more generalized presentation of the rationale for eliminating many non-specific geographic locations from consideration was also provided in the 2015 MITT Final EIS/OEIS 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). Those sections explained why the Navy cannot generally impose geographic limitations on ongoing training and testing activities. Reasons include (1) an increased safety risk to personnel, (2) an unacceptable impact on the effectiveness of training and testing activities that would affect military readiness, and (3) impractical burden with regard to implementation. For more information on how mitigation measures were developed in general, see Section 5.2 (Mitigation Development Process) in this SEIS/OEIS.

With regard to assumptions that significant harm or damage would occur to marine resources if Navy training and testing were to continue, potential effects on marine mammals and sea turtles from sonar and other active acoustic sources and explosives were quantitatively analyzed using the Navy's acoustic effects model. The Navy's modeled takes, the majority of which are temporary behavioral reactions, are not modeled instances of "significant harm." As detailed in Section 3.4.3.4 (Summary of Monitoring and Observations During Navy Activities Since 2015), the Navy's analysis, the previous analyses by NMFS, and the monitoring that has occurred have not indicated any significant harm or damage would occur to marine resources as a result of Navy training and testing activities. Based on the analysis, no mortality or serious injury were predicted in 2015, none have occurred, and none are predicted in this SEIS/OEIS. Additionally, as detailed in Chapter 3 (Affected Environment and Environmental Consequences), long-term consequences to other marine resources in the Mariana Islands are not expected.

## I.5 Summary of Geographic Proposed Mitigation Areas

Based on the extensive review and analysis presented in this appendix, the Navy proposes to implement the mitigation areas summarized in Table I-8 and depicted in Figure I-7. The Navy has taken into account public comments received as well as reviewed available scientific information in making these determinations. The proposed mitigation areas were developed because they met the biological effectiveness criteria when balanced against the operational practicality criteria. The Navy finds that implementing these geographic mitigations would, in combination with procedural mitigation, effect the least practicable adverse impact on marine mammal species or stocks and their habitat.

**Table I-8: Summary of Navy-Proposed Geographic Mitigation**

| Area Name | Stressors Limited | Timeframe for Measures |
|---|---|---|
| Marpi Reef | MF1 Sonar | Seasonal: December–April special reporting |
| Marpi Reef | Explosives | Year-round prohibition |
| Chalan Kanoa Reef | MF1 Sonar | Seasonal: December–April special reporting |
| Chalan Kanoa Reef | Explosives | Year-round prohibition |
| Agat Bay Nearshore | MF1 Sonar and Explosives | Year-round prohibition |

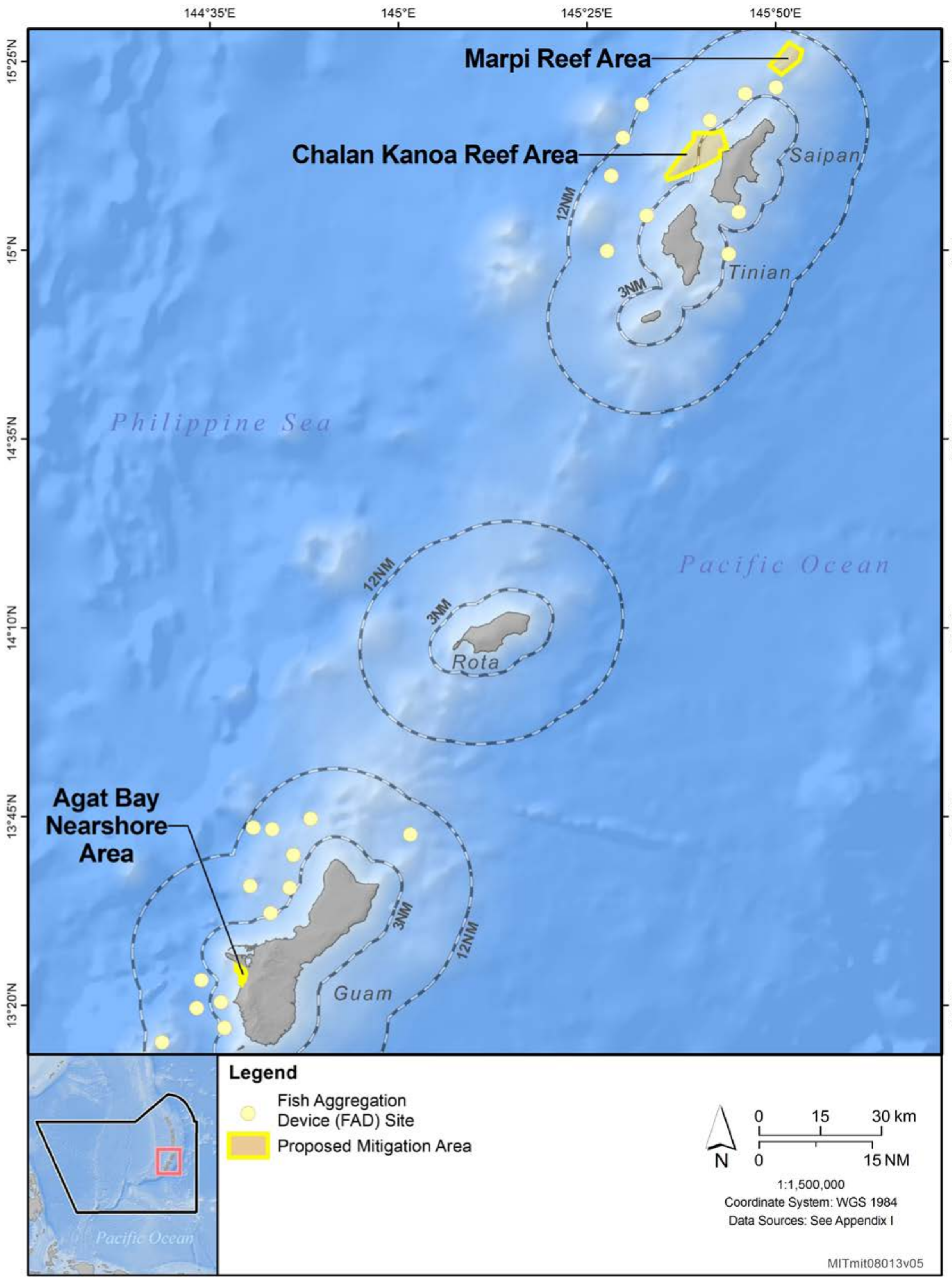


**Figure I-7: Navy-Proposed Geographic Mitigation Areas**

# REFERENCES

Ampela, K., J. Chadbourne, M. Deakos, D. Fertl, J. Latusek-Nabholz, D. Spontak, and R. Uyeyama. (2014). *Summary Report: Compilation of Visual Survey Effort and Sightings for Marine Species Monitoring in the Mariana Islands Range Complex*. Appendix A: Comprehensive Exercise and Marine Species Monitoring Report for the U.S. Navy's Mariana Islands Range Complex 2010–2014.

Baird, R. W., D. Cholewiak, D. L. Webster, G. S. Schorr, S. D. Mahaffy, C. Curtice, J. Harrison, and S. M. Van Parijs. (2015). Biologically Important Areas for Cetaceans within U.S. Waters—Hawaii region. In S. M. Van Parijs, C. Curtice, & M. C. Ferguson (Eds.), *Biologically Important Areas for Cetaceans Within U.S. Waters* (Vol. 41, pp. 54–64). Olympia, WA: Cascadia Research Collective.

Becker, E. A., K. A. Forney, B. J. Thayre, A. J. Debich, G. S. Campbell, K. Whitaker, A. B. Douglas, A. Gilles, R. Hoopes, and J. A. Hildebrand. (2017). Habitat-Based Density Models for Three Cetacean Species off Southern California Illustrate Pronounced Seasonal Differences. *Frontiers in Marine Science, 4*(121), 1–14.

Boyd, J. D., and D. J. Brightsmith. (2013). Error properties of Argos satellite telemetry locations using least squares and Kalman filtering. *PLoS ONE, 8*(5), e63051.

Ferguson, M. C., C. Curtice, J. Harrison, and S. M. Van Parijs. (2015a). Biologically important areas for cetaceans within U.S. waters – Overview and rationale. *Aquatic Mammals (Special Issue), 41*(1), 2–16.

Ferguson, M. C., J. M. Waite, C. Curtice, J. T. Clarke, and J. Harrison. (2015b). Biologically important areas for cetaceans within U.S. waters – Aleutian Islands and Bering Sea region. In S. M. Van Parijs, C. Curtice, & M. C. Ferguson (Eds.), *Biologically Important Areas for cetaceans within U.S. waters* (Vol. Aquatic Mammals (Special Issue) 41, pp. 79–93).

Forney, K. A., E. A. Becker, D. G. Foley, J. Barlow, and E. M. Oleson. (2015). Habitat-based models of cetacean density and distribution in the central North Pacific. *Endangered Species Research, 27*, 1–20.

Fulling, G. L., P. H. Thorson, and J. Rivers. (2011). Distribution and Abundance Estimates for Cetaceans in the Waters off Guam and the Commonwealth of the Northern Mariana Islands. *Pacific Science, 65*(3), 321–343.

Gabriele, C. M., J. L. Neilson, J. M. Straley, C. S. Baker, J. A. Cedarleaf, and J. F. Saracco. (2017). Natural history, population dynamics, and habitat use of humpback whales over 30 years on an Alaska feeding ground. *Ecosphere, 8*(1), e01641.

HDR. (2011). *Guam Marine Species Monitoring Survey: Vessel-Based Monitoring Surveys Winter 2011*. Mariana Islands, Guam: U.S. Navy Marine Species Monitoring Program.

HDR. (2012). *Summary Report: Compilation of Visual Survey Effort and Sightings for Marine Species Monitoring in the Hawaii Range Complex, 2005–2012*. Pearl Harbor, HI: U.S. Pacific Fleet.

HDR EOC. (2012). *Guam and Saipan Marine Species Monitoring Winter-Spring Survey, March 2012*. Pearl Harbor, HI: Naval Facilities Engineering Command.

Heenehan, H. L., D. W. Johnston, S. M. Van Parijs, L. Bejder, and J. A. Tyne. (2016a). *Acoustic response of Hawaiian spinner dolphins to human disturbances.* Paper presented at the Meetings on Acoustics. Dublin, Ireland.

Heenehan, H. L., J. A. Tyne, L. Bejder, S. M. Van Parijs, and D. W. Johnston. (2016b). Passive acoustic monitoring of coastally associated Hawaiian spinner dolphins, *Stenella longirostris*, ground-truthed through visual surveys. *The Journal of the Acoustical Society of America, 140*(1), 206.

Heenehan, H. L., S. M. Van Parijs, L. Bejder, J. A. Tyne, and D. W. Johnston. (2017a). Using acoustics to prioritize management decisions to protect coastal dolphins: A case study using Hawaiian spinner dolphins. *Marine Policy, 75*, 84–90.

Heenehan, H. L., S. M. Van Parijs, L. Bejder, J. A. Tyne, B. L. Southall, H. Southall, and D. W. Johnston. (2017b). Natural and anthropogenic events influence the soundscapes of four bays on Hawaii Island. *Marine Pollution Bulletin, 124*(1), 9–20.

Hill, M., E. Oleson, and K. Andrews. (2010). *New Island-Associated stocks for Hawaiian Spinner Dolphins (Stenella longirostris longirostris): Rationale and New Stock Boundaries*. Honolulu, HI: National Oceanic and Atmospheric Administration's Pacific Islands Fisheries Science Center.

Hill, M., A. D. Ligon, M. H. Deakos, U. Adam, E. Norris, and E. M. Oleson. (2011). *Cetacean Surveys of Guam and CNMI Waters: August–September, 2011* (MIRC Survey Report FY2011). Honolulu, HI: Pacific Islands Fisheries Science Center.

Hill, M., A. Ligon, M. Deakos, A. Ü, A. Milette-Winfree, and E. Oleson. (2013a). *Cetacean Surveys of Guam and CNMI Waters: May–July, 2012: Including Individual Photo-Identification of Pilot Whales, Spinner Dolphins and Bottlenose Dolphins (2010–2012)* (PIFSC Data Report). Pearl Harbor, HI: U.S. Pacific Fleet Environmental Readiness Office.

Hill, M., A. Ligon, A. Ü, and A. Bradford. (2015a). *Humpback Whales in the Marianas*. Honolulu, HI: National Oceanic and Atmospheric Administration, Pacific Islands Fisheries Science Center.

Hill, M. C., A. D. Ligon, M. H. Deakos, A. C. U, and E. M. Oleson. (2013b). *Cetacean Surveys of Guam and SNMI Waters: June–July 2013*. Pearl Harbor, HI: U.S. Pacific Fleet Environmental Readiness Office.

Hill, M. C., A. D. Ligon, M. H. Deakos, A. C. Ü, A. Milette-Winfree, A. R. Bendlin, and E. M. Oleson. (2014). *Cetacean Surveys in the Waters of the Southern Mariana Archipelago (February 2010–April 2014)*. Honolulu, HI: U.S. Pacific Fleet Environmental Readiness Office.

Hill, M. C., E. M. Oleson, A. D. Ligon, K. K. Martien, F. I. Archer, S. Baumann-Pickering, A. R. Bendlin, L. Dolar, K. P. B. Merkens, A. Milette-Winfree, P. A. Morin, A. Rice, K. M. Robertson, J. S. Trickey, A. C. Ü, A. Van Cise, and S. M. Woodman. (2015b). *Cetacean Monitoring in the Mariana Islands Range Complex, 2014*. Honolulu, HI: U.S. Pacific Fleet.

Hill, M. C., A. L. Bradford, A. D. Ligon, A. C. U, J. Rivers, R. K. Uyeyama, R. L. Brownell, Jr., and E. M. Oleson. (2016a). *Are Humpback Whales (Megaptera novaeangliae) Breeding and Calving in the Mariana Islands?* Cambridge, United Kingdom: International Whaling Commission.

Hill, M. C., E. M. Oleson, S. Baumann-Pickering, A. M. VanCise, A. D. Ligon, A. R. Bendlin, A. C. Ü, J. S. Trickey, and A. L. Bradford. (2016b). *Cetacean Monitoring in the Mariana Islands Range Complex, 2015*. Honolulu, HI: U.S. Pacific Fleet Environmental Readiness Office.

Hill, M. C., A. R. Bendlin, A. C. Ü, K. M. Yano, A. L. Bradford, A. D. Ligon, and E. M. Oleson. (2017a). *Cetacean Monitoring in the Mariana Islands Range Complex, 2016* (PIFSC Data Report DR-17-002). Honolulu, HI: U.S. Pacific Fleet Environmental Readiness Office.

Hill, M. C., A. L. Bradford, A. D. Ligon, A. C. Ü, C. S. Baker, D. Dietrich-Steel, J. Rivers, R. K. Uyeyama, and E. M. Oleson. (2017b). *Discovery of a Western North Pacific Humpback Whale (Megaptera* *novaeangliae) Wintering Area in the Mariana Archipelago (Poster)*. Paper presented at the Society for Marine Mammalogy Conference. Halifax, Nova Scotia.

Hill, M. C., A. R. Bendlin, A. M. Van Cise, A. Milette-Winfree, A. D. Ligon, A. C. Ü, M. H. Deakos, and E. M. Oleson. (2018a). Short-finned pilot whales (*Globicephala macrorhynchus*) of the Mariana Archipelago: Individual affiliations, movements, and spatial use. *Marine Mammal Science* (Online version of record before inclusion in an issue), 1–28.

Hill, M. C., A. L. Bradford, A. D. Ligon, A. C. Ü, and E. M. Oleson. (2018b). *Cetacean Monitoring in the Mariana Islands Range Complex, 2017* (PIFSC Data Report DR-18-002). Honolulu, HI: Pacific Islands Fisheries Science Center.

Hill, M. C., E. M. Oleson, A. L. Bradford, K. K. Martien, D. Steel, and C. S. Baker. (2018c). *Draft Pacific Islands Fisheries Science Center Mariana Archipelago Cetacean Surveys: A Review of Available Data and Analyses Through March 2018*. (PIFSC Data Report DR-18-xxx). Pearl Harbor, HI: U.S. Pacific Fleet Environmental Readiness Office.

Jefferson, T. A., M. A. Webber, and R. L. Pitman. (2015). *Marine Mammals of the World: A Comprehensive Guide to Their Identification* (2nd ed.). Cambridge, MA: Academic Press.

Jones, T. J., and K. S. Van Houtan. (2014a). *Sea Turtle Tagging in the Mariana Islands Range Complex (MIRC) Interim Report*. Honolulu, HI: Pacific Islands Fisheries Science Center.

Jones, T. T., and K. S. Van Houtan. (2014b). *Sea Turtle Tagging in the Mariana Islands Range Complex (MIRC) Annual Progress Report*. Honolulu, HI: Pacific Islands Fisheries Science Center.

Jones, T. T., S. L. Martin, and K. S. Van Houtan. (2015). *Sea Turtle Tagging in the Mariana Islands Range Complex (MIRC) Progress Report*. Honolulu, HI: Pacific Islands Fisheries Science Center.

Jones, T. T., and S. L. Martin. (2016). *Sea Turtle Tagging in the Mariana Islands Training and Testing (MITT) Study Area*. Silver Spring, MD: National Oceanic and Atmospheric Administration, Fisheries Marine Turtle Biology and Assessment Program Protected Species Division.

Klinck, H., S. L. Nieukirk, S. Fregosi, K. Klinck, D. K. Mellinger, S. Lastuka, G. B. Shilling, and J. C. Luby. (2015). *Cetacean Studies on the Mariana Islands Range Complex in September-November 2014: Passive Acoustic Monitoring of Marine Mammals Using Gliders. Final Report*. Honolulu, HI: HDR Inc.

Klinck, H., S. L. Nieukirk, S. Fregosi, K. Klinck, D. K. Mellinger, S. Lastuka, G. B. Shilling, and J. C. Luby. (2016). *Final Report Cetacean Studies on the Mariana Islands Range Complex in March–April 2015: Passive Acoustic Monitoring of Marine Mammals Using Gliders* (Submitted to Naval Facilities Engineering Command (NAVFAC) Pacific, Pearl Harbor, Hawaii). Honolulu, HI: HDR Inc.

Kolinski, S. P., D. M. Parker, L. I. Ilo, and J. K. Ruak. (2001). An assessment of the sea turtles and their marine and terrestrial habitats at Saipan, Commonwealth of the Northern Mariana Islands. *Micronesica, 34*(1), 55–72.

Ligon, A. D., M. H. Deakos, and C. U. Adam. (2011). *Small-boat cetacean surveys off Guam and Saipan, Mariana Islands, February - March 2010*. Honolulu, HI: Pacific Island Fisheries Science Center.

Martien, K. K., M. C. Hill, A. M. Van Cise, K. M. Robertson, S. M. Woodman, L. Dollar, V. L. Pease, and E. M. Oleson. (2014). *Genetic Diversity and Population Structure in Four Species of Cetaceans Around the Mariana Islands* (NOAA Technical Memorandum NMFS-SWFSC-536). La Jolla, CA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Martin, S. L., and T. T. Jones. (2016). *Sea Turtle Tagging in the Mariana Islands Training and Testing (MITT) Study Area, 15 December 2016* (NMFS-PIC-16-008). Honolulu, HI: Pacific Islands Fisheries Science Center.

Martin, S. L., K. S. Van Houtan, T. T. Jones, C. F. Aguon, J. T. Gutierrez, R. B. Tibbatts, S. B. Wusstig, and J. D. Bass. (2016). Five decades of marine megafauna surveys from Micronesia. *Frontiers in Marine Science, 2*(116), 1–13.

Martin, S. L., A. R. Gaos, and T. T. Jones. (2018). *Sea Turtle Tagging in the Mariana Islands Training and Testing (MITT) Study Area*. Honolulu, HI: Pacific Islands Fisheries Science Center.

Munger, L. M., M. O. Lammers, and W. W. L. Au. (2014). *Passive Acoustic Monitoring for Cetaceans within the Marianas Islands Range Complex. Preliminary Report*. Pearl Harbor, HI: Naval Facilities Engineering Command Pacific.

Munger, L. M., M. O. Lammers, J. N. Oswald, T. M. Yack, and W. W. L. Au. (2015). *Passive Acoustic Monitoring of Cetaceans within the Mariana Islands Range Complex Using Ecological Acoustic Recorders. Final Report*. Pearl Harbor, HI: Naval Facilities Engineering Command Pacific.

National Marine Fisheries Service, and U.S. Fish and Wildlife Service. (1998). *Recovery Plan for U.S. Pacific Populations of the East Pacific Green Turtle (Chelonia mydas)*. Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service. (2018). *#MIhumpbacks: Humpback Whales of the Mariana Islands*. Honolulu, HI: Pacific Islands Fisheries Science Center.

National Oceanic and Atmospheric Administration. (2015). Takes of marine mammals incidental to specified activities; U.S. Navy training and testing activities in the Mariana Islands Training and Testing Study Area. *Federal Register, 80*(148), 46112–46171.

National Oceanic and Atmospheric Administration. (2018). *#MIhumpbacks: Humpback Whales of the Mariana Islands*. Retrieved from https://www.fisheries.noaa.gov/feature-story/mihumpbacks-humpback-whales-mariana-islands.

Nieukirk, S. L., S. Fregosi, D. K. Mellinger, and H. Klinck. (2016). A complex baleen whale call recorded in the Mariana Trench Marine National Monument. *The Journal of the Acoustical Society of America, 140*(3), EL274.

Norris, K. S., and T. P. Dohl. (1980). Behavior of the Hawaiian spinner dolphin, *Stenella longirostris*. *Fishery Bulletin, 77*(4), 821–849.

Norris, T., T. Yack, E. Ferguson, and K. Dunleavy. (2015). *A Comparison of Acoustic Based Line-Transect Density Estimates for Sperm Whales and Minke Whales in the Northern Marianas Islands.* Paper presented at the 7th International Workshop on [Detection, Classification, Localization, and Density Estimation] of Marine Mammals using Passive Acoustics. La Jolla, CA.

Norris, T. F., J. Oswald, T. Yack, E. Ferguson, C. Hom-Weaver, K. Dunleavy, S. Coates, and T. Dominello. (2012). *An Analysis of Acoustic Data from the Mariana Islands Sea Turtle and Cetacean Survey (MISTCS)*. Encinitas, CA: Bio-Waves, Inc.

Norris, T. F., J. Oswald, T. Yack, E. Ferguson, C. Hom-Weaver, K. Dunleavy, S. Coates, and T. Dominello. (2014). *An Analysis of Acoustic Data from the Mariana Islands Sea Turtle and Cetacean Survey (MISTCS) March 2014 Revision*. Encinitas, CA: Bio-Waves, Inc.

Norris, T. F., K. J. Dunleavy, T. M. Yack, and E. L. Ferguson. (2017). Estimation of minke whale abundance from an acoustic line transect survey of the Mariana Islands. *Marine Mammal Science, 33*(2), 574–592.

Oleson, E. (2017). *Mariana Archipelago Cetacean Survey (MACS) 2015 Cruise Report*. Honolulu, HI: National Marine Fisheries Service, Pacific Islands Fisheries Science Center.

Oleson, E. M., and M. C. Hill. (2010a). *2010 Report to PACFLT: Report of Cetacean Surveys in Guam, CNMI, and the High-seas & Follow up on 2009 Main Hawaiian Islands Cetacean Survey*. Honolulu, HI: Pacific Islands Fisheries Science Center.

Oleson, E. M., and M. C. Hill. (2010b). *2010 Report to PACFLT: Report to Cetacean Surveys in Guam, CNMI, and the High-seas*. Honolulu, HI: National Marine Fisheries Service, Pacific Islands Fisheries Science Center.

Oleson, E. M., S. Baumann-Pickering, A. Širović, K. P. Merkens, L. M. Munger, J. S. Trickey, and P. Fisher-Pool. (2015). *Analysis of long-term acoustic datasets for baleen whales and beaked whales within the Mariana Islands Range Complex (MIRC) for 2010 to 2013* (Pacific Islands Fisheries Science Center Data Report DR-15-002). Honolulu, HI: Pacific Islands Fisheries Science Center.

Pack, A. A., L. M. Herman, A. S. Craig, S. S. Spitz, J. O. Waterman, E. Y. K. Herman, M. H. Deakos, S. Hakala, and C. Lowe. (2017). Habitat preferences by individual humpback whale mothers in the Hawaiian breeding grounds vary with the age and size of their calves. *Animal Behaviour, 133*, 131–144.

Perrin, W. F., and R. L. Brownell, Jr. (2009). Minke whales, *Balaenoptera acutorostrata* and *B. bonaerensis*. In W. F. Perrin, B. Wursig, & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 733–735). Cambridge, MA: Academic Press.

Pultz, S., D. O. O'Daniel, S. Krueger, and H. McSharry. (1999). Marine Turtle Survey on Tinian, Mariana Islands. *Micronesica, 31*(2), 85–94.

Ramp, C., J. Delarue, P. J. Palsboll, R. Sears, and P. S. Hammond. (2015). Adapting to a warmer ocean—Seasonal shift of baleen whale movements over three decades. *PLoS ONE, 10*(3), e0121374.

Risch, D., M. Castellote, C. W. Clark, G. E. Davis, P. J. Dugan, L. E. W. Hodge, A. Kumar, K. Lucke, M. D. K., S. L. Nieukirk, C. M. Popescu, C. Ramp, A. J. Read, A. N. Rice, M. A. Silva, U. Siebert, K. M. Stafford, H. Verdaat, and S. M. Van Parijs. (2014). Seasonal migrations of North Atlantic minke whales: Novel insights from large-scale passive acoustic monitoring networks. *Movement Ecology, 2*, 1–17.

Silber, G. K., M. D. Lettrich, P. O. Thomas, J. D. Baker, M. Baumgartner, E. A. Becker, P. Boveng, D. M. Dick, J. Fiechter, J. Forcada, K. A. Forney, R. B. Griffis, J. A. Hare, A. J. Hobday, D. Howell, K. L. Laidre, N. Mantua, L. Quakenbush, J. A. Santora, K. M. Stafford, P. Spencer, C. Stock, W. Sydeman, K. Van Houtan, and R. S. Waples. (2017). Projecting Marine Mammal Distribution in a Changing Climate. *Frontiers in Marine Science, 4*, 14.

Summers, T. M., T. T. Jones, S. L. Martin, J. R. Hapdei, J. K. Ruak, and C. A. Lepczyk. (2017). Demography of marine turtles in the nearshore environments of the Northern Mariana Islands. *Pacific Science, 71*(3), 269–286.

Summers, T. M., S. L. Martin, J. R. Hapdei, J. K. Ruak, and T. T. Jones. (2018). Endangered green turtles (*Chelonia mydas*) of the Northern Mariana Islands: Nesting ecology, poaching, and climate concerns. *Frontiers in Marine Science, 4*(428), 1–15.

Tetra Tech Inc. (2014). *Marine Mammal Survey Report in Support of the Commonwealth of the Northern Mariana Islands Joint Military Training Environmental Impact Statement/Overseas Environmental Impact Statement. Final (Version 3)*. Oakland, CA: TEC-AECOM Pacific Joint Venture

Tyne, J. A., K. H. Pollock, D. W. Johnston, and L. Bejder. (2014). Abundance and survival rates of the Hawaii Island associated spinner dolphin (*Stenella longirostris*) stock. *PLoS ONE, 9*(1), e86132.

Tyne, J. A. (2015). *A scientific foundation for informed management decisions: Quantifying the abundance, important habitat and cumulative exposure of the Hawaii Island spinner dolphin (Stenella longirostris) stock to human activities.* (Unpublished doctoral dissertation in Philosophy). Murdoch University, Murdoch, Australia. Retrieved from https://www.researchgate.net/publication/311608220_A_scientific_foundation_for_informed_management_decisions_Quantifying_the_abundance_important_habitat_and_cumulative_exposure_of_the_Hawaii_Island_spinner_dolphin_Stenella_longirostris_stock_to_human_.

Tyne, J. A., D. W. Johnston, R. Rankin, N. R. Loneragan, L. Bejder, and A. Punt. (2015). The importance of spinner dolphin (*Stenella longirostris*) resting habitat: Implications for management. *Journal of Applied Ecology, 52*(3), 621–630.

Tyne, J. A., D. W. Johnston, F. Christiansen, and L. Bejder. (2017). Temporally and spatially partitioned behaviours of spinner dolphins: Implications for resilience to human disturbance. *Royal Society Open Science, 4*(1), 160626.

Tyne, J. A., F. Christiansen, H. L. Heenehan, D. W. Johnston, and L. Bejder. (2018). Chronic exposure of Hawaii Island spinner dolphins (*Stenella longirostris*) to human activities. *Royal Society Open Science, 5*, e171506.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and Office of National Marine Sanctuaries. (2015). *Hawaiian Islands Humpback Whale National Marine Sanctuary Draft Management Plan/Draft Environmental Impact Statement*. Silver Spring, MD: National Oceanic and Atmospheric Administration.

U.S. Department of the Navy. (2005a). *Marine Resources Assessment for the Marianas Operating Area (Final Report)*. Pearl Harbor, HI: Commander, U.S. Pacific Fleet.

U.S. Department of the Navy. (2005b). *Marine Resources Assessment for the Hawaiian Islands Operating Area—Final Report*. Pearl Harbor, HI: Commander, U.S. Pacific Fleet.

U.S. Department of the Navy. (2007). *Marine Mammal and Sea Turtle Survey and Density Estimates for Guam and the Commonwealth of the Northern Mariana Islands - Final Report*. Newport Beach, CA: Naval Facilities Engineering Command Pacific and Commander, U.S. Pacific Fleet.

U.S. Department of the Navy. (2012). *2012 Annual Marine Species Monitoring Report for the Mariana Islands Range Complex*. Washington, DC: Office of Protected Resources.

U.S. Department of the Navy. (2013). *Final Marine Resource Assessment for the Japan and Mariana Archipelagos*. San Diego, CA: Naval Facilities Engineering Command Pacific.

U.S. Department of the Navy. (2014a). *Final Sea Turtle Marine Resources Survey Report*. Pearl Harbor, HI: Tetra Tech Inc., Sea Engineering Inc., and AECOM Technical Services Inc.

U.S. Department of the Navy. (2014b). *Final Marine Mammal Survey Report in Support of the Commonwealth of the Northern Mariana Islands Joint Military Training Environmental Impact*

*Statement/Overseas Environmental Impact Statement (Version 3)*. Pearl Harbor, HI: Naval Facilities Engineering Command, Pacific.

U.S. Department of the Navy. (2015). *Final Supplemental Environmental Impact Statement Guam and Commonwealth of the Northern Mariana Islands Military Relocation (2012 Roadmap Adjustments)*. Washington, DC: Naval Facilities Engineering Command, Pacific.

U.S. Department of the Navy. (2018a). *2017 U.S. Navy Annual Marine Species Monitoring Report for the Pacific: A Multi-Range-Complex Monitoring Report For Hawaii-Southern California Training and Testing (HSTT), Mariana Islands Training and Testing (MITT), Northwest Training and Testing (NWTT), and the Gulf of Alaska Temporary Maritime Activities Area (GOA TMAA)*. Silver Spring, MD: National Marine Fisheries Service.

U.S. Department of the Navy. (2018b). *U.S. Navy Marine Species Density Database Phase III for the Mariana Islands Training and Testing Study Area* (Naval Facilities Engineering Command Pacific Technical Report). Pearl Harbor, HI: Naval Facilities Engineering Command Pacific.

Uyeyama, R. (2014). *Compilation of Incidental Marine Mammal and Sea Turtle Sightings in the Mariana Islands Range Complex*. Pearl Harbor, HI: Commander, U.S. Pacific Fleet.

Van Parijs, S. M., C. Curtice, and M. C. E. Ferguson. (2015). Biologically important areas for cetaceans within U.S. Waters. *Aquatic Mammals (Special Issue), 41*(1), 128.

Vincent, C., B. J. McConnell, V. Ridoux, and M. A. Fedak. (2002). Assessment of Argos location accuracy from satellite tags deployed on captive grey seals. *Marine Mammal Science, 18*(1), 156–166.

Yack, T. M., T. F. Norris, and N. Novak. (2016). *Acoustic Based Habitat Models for Sperm Whales in the Mariana Islands Region*. Encinitas, CA: Bio-Waves, Inc.

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# Appendix J: Statistical Probability Analysis for Estimating Direct Strike Impact and Number of Potential Exposures from Military Expended Materials

# Supplemental Environmental Impact Statement/
# Overseas Environmental Impact Statement
# Mariana Islands Training and Testing

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# APPENDIX J STATISTICAL PROBABILITY ANALYSIS FOR ESTIMATING DIRECT STRIKE IMPACT AND NUMBER OF POTENTIAL EXPOSURES FROM MILITARY EXPENDED MATERIALS

This Appendix discusses the methods and results for calculating the probability of the direct strike of an animal by any military items from the proposed training and testing activities falling toward (or directed at) the sea surface. For the purposes of this section, military items include non-explosive practice munitions, sonobuoys, acoustic countermeasures, some targets, torpedoes, anchors, and high-energy lasers. 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 Study Area. The analysis conducted here does not account for explosive munitions because impacts from explosives are analyzed within the Navy Acoustic Effects Model as described in *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2017).

## J.1 DIRECT IMPACT ANALYSIS

These calculations 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 training or testing area in which the activities are occurring (R = area of the Mariana Islands Range Complex). 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 is over-predictive and conservative, in that it 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 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. A is multiplied by the number of animals $N_a$ in the 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 conservative scenario, the total animal footprint area is calculated for the species with the highest average seasonal density (pantropical spotted dolphins).
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 events occur in a given year. When integrating over the number of military items types for the given activity (and then over the number of events 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 events to obtain the total impact footprint area resulting from all events occurring in the training or testing area in a given year.

Though marine mammals and sea turtles are not randomly distributed in the environment, a random point calculation was chosen given the available information on an animal's or military item's spatial occurrence. Military items may be expended generally throughout the Study Area, depending on the activity and item type.

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 (for consideration of mitigation during analysis see Sections 3.4 [Marine Mammals] and 3.5 [Sea Turtles]).

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.
$A_{tot} = (L_a + 2*W_i)*(W_a + (1 + R_n)*L_i)$ 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 aerial 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 the static and dynamic 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. The potential number of exposures (t) are reported in Table J-1 through Table J-4.

### J.1.1 Parameters for Analysis

Impact probabilities (P) and number of exposures (T) were estimated for the following parameters:

1. **Two action alternatives**: Alternative 1 and Alternative 2. Animal densities, animal dimensions, and military item dimensions are the same for the two action alternatives.
2. **The following types of non-explosive munitions or other items:**
    - **Small-caliber projectiles:** up to and including .50 caliber rounds
    - **Medium-caliber projectiles:** larger than .50 caliber rounds but smaller than 57 millimeters (mm) projectiles
    - **Large-caliber projectiles:** includes projectiles greater than or equal to a 57 mm projectile
    - **Missiles:** includes rockets and jet-propelled munitions
    - **Bombs:** Non-explosive practice bombs and mine shapes, ranging from 10 to 2,000 pounds
    - **Torpedoes:** includes all lightweight torpedoes
    - **Sonobuoys:** includes all sonobuoys
    - **Targets:** includes expended, airborne and surface, targets, as well as mine shapes
    - **Lightweight torpedo accessories:** includes all accessories that are dropped along with the torpedo (nose cap, air stabilizer, etc.)
    - **Anchors:** includes blocks used to anchor mine shapes to the seafloor
    - **Acoustic countermeasures:** includes aircraft and ship-deployed acoustic countermeasures

- **High-Energy Lasers:** includes high-energy laser weapons that are directed at a surface target
- **Expended Bathythermographs:** small sensor deployed from ships or aircraft

3. **Animal species of interest:** The five species of ESA-listed marine mammals and the non-ESA listed marine mammal species with the highest average month density (pantropical spotted dolphin). The sea turtle species with the highest average month density in the training and testing areas of interest (green sea turtles).

### J.1.2 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 two action 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 bombs and rockets), are different in magnitude between the two action alternatives. All animal species input data, the military items' identification and category, and the military items' dimensions are the same for the two alternatives; only the quantities (i.e., total number of military items) are different.

### J.1.3 OUTPUT DATA

Estimates of impact probability (P) and number of exposures (T) for a given species of interest were made with the maximum annual number of military items used for each of the two action 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 between the alternatives arise from different numbers of events (and therefore military items) for the two alternatives.

Results for marine mammals and sea turtles are presented in Tables J-1 through J-4.

**Table J-1: Estimated Representative Marine Mammal Exposures from Direct Strike of a High-Energy Laser by Area and Alternative in a Single Year**

| Mariana Islands Range Complex | | |
|---|---|---|
| | Alternative 1 | Alternative 2 |
| Humpback | 0.000000 | 0.000000 |
| Sei whale | 0.000000 | 0.000000 |
| Fin whale | 0.000000 | 0.000000 |
| Blue whale | 0.000000 | 0.000000 |
| Sperm whale | 0.000001 | 0.000001 |
| Pantropical Spotted Dolphin | 0.000001 | 0.000001 |

**Table J-2: Estimated Representative Sea Turtle Guild Exposures from Direct Strike of a High-Energy Laser by Area and Alternative in a Single Year**

| Mariana Islands Range Complex | | |
|---|---|---|
| | Alternative 1 | Alternative 2 |
| Green Sea Turtle | 0.000025 | 0.000027 |

**Table J-3: Estimated Representative Marine Mammal Exposures from Direct Strike of Military Expended Materials by Area and Alternative in a Single Year**

| Mariana Islands Range Complex | | |
|---|---|---|
| | Alternative 1 | Alternative 2 |
| Humpback | 0.000024 | 0.000028 |
| Sei whale | 0.000008 | 0.000009 |
| Fin whale | 0.000002 | 0.000002 |
| Blue whale | 0.000001 | 0.000002 |
| Sperm whale | 0.000030 | 0.000035 |
| Pantropical spotted Dolphin | 0.000560 | 0.000660 |

**Table J-4: Estimated Representative Sea Turtle Exposures from Direct Strike of Military Expended Materials by Area and Alternative in a Single Year**

| Mariana Islands Range Complex | | |
|---|---|---|
| | Alternative 1 | Alternative 2 |
| Green Sea Turtle | 0.002620 | 0.003087 |

# REFERENCES

U.S. Department of the Navy. (2017). *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (Technical Report prepared by Space and Naval Warfare Systems Center Pacific). San Diego, CA: Naval Undersea Warfare Center.