3.6 Marine Birds

Supplemental Environmental Impact Statement/

Overseas Environmental Impact Statement

Mariana Islands Training and Testing

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3.6 Marine Birds

The purpose of this section is to supplement the analysis of impacts on marine birds 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 marine birds associated with the Proposed Action is provided in this section. Comments received from the public during scoping related to marine birds are addressed in Section 3.6.3 (Public Scoping Comments).

3.6.1 Affected Environment

As presented in the 2015 MITT Final EIS/OEIS, the habitat found within the MITT Study Area supports a wide diversity of resident and migratory marine birds, with regionally important rookeries for numerous species on FDM. Descriptions of the climate, productivity, and oceanographic conditions were presented in the 2015 MITT Final EIS/OEIS, as well as important rookery locations throughout the Mariana Islands. Because FDM is the only land area within the Study Area that would be impacted by the proposed changes in activities described in Chapter 2 (Description of Proposed Action and Alternatives), the other rookery locations analyzed in the 2015 MITT Final EIS/OEIS are not included in the Study Area for this Supplemental EIS (SEIS)/OEIS. The species assemblage in open ocean portions of the Study Area has not changed, nor has the status of rookeries on FDM changed since the publication of the 2015 MITT Final EIS/OEIS. As such, the general description in the 2015 MITT Final EIS/OEIS of the existing conditions within the Study Area remains valid.

Endangered Species Act Listed Marine Bird Species

Three marine birds present in the Study Area are listed under the Endangered Species Act (ESA) as threatened or endangered species. The short-tailed albatross (*Phoebastria albatrus*) and Hawaiian petrel (*Pterodroma sandwichensis*) are listed as endangered, and the Newell's shearwater (*Puffinus auricularis newelli*)[1] is listed as threatened(U.S. Fish and Wildlife Service, 2010, 2015). None of these species have been observed on FDM or within other rookery locations for other species within the Mariana Islands. The short-tailed albatross, Hawaiian petrel, and Newell's shearwater nest outside the Study Area and are thought to occur only rarely within the Study Area (U.S. Fish and Wildlife Service, 2010, 2015), and there would be little to no overlap with at-sea training and testing activities. The 2015 MITT Final EIS/OEIS relied in part on information collected in 2007 from the Navy-funded Mariana Islands Sea Turtle and Cetacean Survey (U.S. Department of the Navy, 2007). Because the short-tailed albatross, Hawaiian petrel, and Newell's shearwater were not expected to be impacted by activities analyzed in the 2015 MITT Final EIS/OEIS, the Section 7(a)(2) ESA consultation between the Navy and U.S. Fish and Wildlife Service (USFWS) did not include these species (U.S. Fish and Wildlife Service, 2015). No new survey information is available on at-sea observations of marine birds and shorebirds that would change

[1] The current taxonomic classification of this species holds that the Newell's shearwater is a subspecies of the Townsend's shearwater. In some instances, this subspecies is also named the Newell's Townsend's shearwater; however, both Newell's shearwater and Newell's Townsend's shearwater refer to the same subspecies (scientific name *Puffinus auricularis newelli*).

the analysis from the 2015 MITT Final EIS/OEIS. As such, the description regarding at-sea observations of marine birds presented in the 2015 MITT Final EIS/OEIS remains valid.

3.6.1.1 Group Size

Section 3.6.2.1 of the 2015 MITT Final EIS/OEIS included a description of marine bird group sizes and reasons why some marine birds congregate in groups. Within the Study Area, the largest grouping of marine birds is anticipated during large upwelling events for feeding, and on-land rookery locations (at FDM). There is no new information that changes the basis of the conclusion on the group size analysis from the 2015 MITT Final EIS/OEIS. As such, the additional description regarding group sizes of marine birds presented in the 2015 MITT Final EIS/OEIS remains valid.

3.6.1.2 Diving Behavior

Section 3.6.2.2 of the 2015 MITT Final EIS/OEIS describes dive behaviors exhibited by different types of marine birds. Marine birds will dive to various depths in pursuit of prey items, exhibiting plunge diving. Many of the marine bird species found in the Study Area will dive, skim, or grasp prey at the water's surface or within the upper portion (1–2 meters [m]) of the water column (Cook et al., 2011; Jiménez et al., 2012; Sibley, 2014), although some marine birds will dive to depths greater than 30 m in pursuit of prey, with dive durations lasting from a few seconds to several minutes for deep diving marine birds. Dive durations are correlated with depth and range from a few seconds in shallow divers to several minutes in alcids (Ponganis, 2015). No new information is available on dive behavior that would alter the analysis from the 2015 MITT Final EIS/OEIS. As such, the additional description regarding dive behavior presented in the 2015 MITT Final EIS/OEIS remains valid.

3.6.1.3 Flight Altitudes

While foraging birds will be present near the water surface, migrating birds may fly at various altitudes. Flight altitudes for birds have traditionally been estimated from on the ground (or boat) observations, or from planes; however, flight altitude information increasingly relies on radar studies and telemetry techniques, where the bird's measured altitude is subtracted from the ground elevation (Poessel et al., 2018). Jongbloed (2016) completed a literature review to determine flight height of marine birds to assess potential risks from wind turbine collisions. This review found that most seabird species fly beneath the rotor blade altitudes of offshore wind turbines, which reduces the risk for collision. Some species such as sea ducks and loons may be commonly seen flying just above the water's surface, but the same species can also be spotted flying high enough (5,800 feet [ft.]) that they are barely visible through binoculars (Lincoln et al., 1998). While there is considerable variation, the favored altitude for most small birds appears to be between 500 ft. (152 m) and 1,000 ft. (305 m). Radar studies have demonstrated that 95 percent of the migratory movements occur at less than 10,000 ft. (3,050 m), with the bulk of the movements occurring under 3,000 ft. (914 m) (Lincoln et al., 1998). Weather factors may also influence flight heights. Tarroux et al. (2016) examined the flying tactics of Antarctic petrels, (*Thalassoica Antarctica)*, in Antarctica revealing the flexibility of flight strategies. Birds tend to fly higher with favorable wind conditions, and fly at near ground level during strong winds. Birds were found to adjust their speed and heading during stronger winds to limit drift, however, they were able to tolerate a limited amount of drift (Tarroux et al., 2016). This was also found by Stumpf et al. (2011) for marbled murrelets using radar to quantify flight heights off of the Olympic Peninsula and by Sanzenbacher et al. (2014) off of Northern California. In summary, most marine birds can be expected to fly relatively close to the surface, but may range upwards in altitude depending on a number of factors such as wind speed and direction, precipitation avoidance, time of day or night, foraging behaviors, migration, and distance to coast. In general the flight altitude of low migrating birds is likely distinctly lower offshore than along the coast or inland of islands within the Mariana Archipelago.

3.6.1.4 Distance from Shore

Pelagic ranges, as a function of distance from shore, can range widely for different species. Much of the recent research regarding abundance and distribution as a function of distance from shore for marine birds was conducted to better understand potential impacts on marine birds from offshore energy development. Spiegel et al. (2017) tracked the movements of over 400 individuals of three species (northern gannets, red-footed loon, and surf-scooter) over the course of five years off of the mid-Atlantic coast. In winter, all three species exhibited a largely near-shore, coastal, or in-shore distribution. Habitat use was concentrated in or around large bays, with the most extensive use at bay mouths. Northern gannets ranged much farther offshore than the other two species, and covered a much larger area (including instances of individuals using both the Gulf of Mexico and the mid-Atlantic within a single season). Spiegel et al. (2017) determined that the differences among species distributions were likely due to differences in motility and distribution of their preferred prey. In summary, marine bird distance from shore can depend on a variety of factors, such as physiological abilities of a particular species to tolerate long distance and duration flights, mobility of prey, and seasonal variations in ranges.

Pelagic marine birds are widely distributed throughout the Marianas, but they tend to congregate in areas of high productivity and prey availability. The 2015 MITT Final EIS/OEIS relied on information collected in 2007 from the Navy-funded Mariana Islands Sea Turtle and Cetacean Survey (U.S. Department of the Navy, 2007). No new information is available on at-sea observations of marine birds and shorebirds that would change the analysis from the 2015 MITT Final EIS/OEIS. As such, the description regarding at-sea observations of marine birds presented in the 2015 MITT Final EIS/OEIS remains valid.

3.6.1.5 Hearing and Vocalization

Section 3.6.2.3 of the 2015 MITT Final EIS/OEIS includes a description of marine bird hearing in air, as well as under water. The Navy's literature review of updated information since the publication of the 2015 MITT Final EIS/OEIS has found new information regarding in-air and underwater hearing sensitivities of marine birds.

The Navy conducted a literature search for new information since the publication of the 2015 MITT Final EIS/OEIS on bird hearing and vocalizations that may change the analysis of potential impacts on birds. New information regarding hearing sensitivities of waterbirds, including various duck species and lesser scaups, is summarized below, along with recent publications that show differences in hearing sensitivities between freshwater divers and pelagic birds. This information is summarized below with an overview of the most current best available science regarding bird hearing and vocalization.

Although hearing range and sensitivity has been measured for many land birds, little is known of seabird hearing. The majority of the published literature on bird hearing focuses on terrestrial birds and their ability to hear in air. A review of 32 terrestrial and marine species indicates that birds generally have greatest hearing sensitivity between 1 and 4 kilohertz (kHz) (Beason, 2004; Dooling, 2002). Very few can hear below 20 hertz, most have an upper frequency hearing limit of 10 kHz, and none exhibit hearing at frequencies higher than 15 kHz (Dooling, 2002; Dooling & Popper, 2000). Hearing capabilities have been studied for only a few seabirds (Beason, 2004; Beuter et al., 1986; Crowell et al., 2015; Johansen et al., 2016; Thiessen, 1958; Wever et al., 1969); these studies show that seabird hearing ranges and sensitivity in air are consistent with what is known about bird hearing in general.

Auditory abilities have been measured in 10 diving bird species in-air using electrophysiological techniques (Crowell et al., 2015; Maxwell et al., 2017). All species tested had the best hearing sensitivity from 1 to 3 kHz. The red-throated loon (*Gavia stellata*) and northern gannet (*Morus bassanus*) (both non-duck species) had the highest thresholds while the lesser scaup (*Aythya affinis*) and ruddy duck (*Oxyura jamaicensis*) (both duck species) had the lowest thresholds (Crowell et al., 2015). Auditory sensitivity varied amongst the species tested, spanning over 30 decibels (dB) in the frequency range of best hearing. While electrophysiological techniques provide insight into hearing abilities, auditory sensitivity is more accurately obtained using behavioral techniques. Crowell et al. (2016) used behavioral methods to obtain an in-air audiogram of the lesser scaup. Hearing frequency range in air was similar to other birds, with best sensitivity at 2.86 kHz with a threshold of 14 dB referenced to (re) 20 micropascals (µPa).

Crowell et al. (2015) also compared the vocalizations of the same 10 diving bird species to the region of highest sensitivity of in-air hearing. Of the birds studied, vocalizations of only eight species were obtained due to the relatively silent nature of two of the species. The peak frequency of the vocalizations of seven of the eight species fell within the range of highest sensitivity of in-air hearing. Crowell et al. (2015) suggested that the colonial nesters tested had relatively reduced hearing sensitivity because they relied on individually distinctive vocalizations over short ranges. Additionally, Crowell et al. (2015) observed that the species with more sensitive hearing were those associated with freshwater habitats, which are relatively quieter compared to marine habitats with wind and wave noise.

Although important to seabirds in air, it is unknown if seabirds use hearing or vocalizations underwater for foraging, communication, predator avoidance or navigation (Crowell, 2016; Dooling & Therrien, 2012). Some scientists suggest that birds must rely on vision rather than hearing while underwater (Hetherington, 2008), while others suggest birds must rely on an alternative sense in order to coordinate cooperative foraging and foraging in low light conditions (e.g., night, depth) (Dooling & Therrien, 2012).

There is little known about the hearing abilities of birds underwater (Dooling & Therrien, 2012). In air, the size of the bird is usually correlated with the sensitivity to sound (Johansen et al., 2016); for example, songbirds tend to be more sensitive to higher frequencies and larger non-songbirds tend to be more sensitive to lower frequencies (Dooling & Popper, 2000). Two studies have tested the ability of a single diving bird, a great cormorant (*Phalacrocorax carbo sinensis*), to respond to underwater sounds (Hansen et al., 2017; Johansen et al., 2016). These studies suggestthat the cormorant's hearing in air is less sensitive than birds of similar size; however, the hearing capabilities in water are better than what would be expected for a purely in-air adapted ear (Johansen et al., 2016). The frequency range of best hearing underwater was observed to be narrower than the frequency range of best hearing in air, with greatest sensitivity underwater observed around 2 kHz (about 71 dB re 1 µPa based on behavioral responses). Although results were not sufficient to be used to generate an audiogram, Therrien (2014) also examined underwater hearing sensitivity of long-tailed ducks (*Clangula hyemalis*) by examining behavioral responses. The research showed that auditory thresholds at frequencies within the expected range of best sensitivity (1, 2, and 2.86 kHz) are expected to be between 77 and 127 dB re 1 µPa.

Diving birds may not hear as well underwater, compared to other (non-avian) species, based on adaptations to protect their ears from pressure changes (Dooling & Therrien, 2012). Because reproduction and communication with conspecifics occurs in air, adaptations for diving may have evolved to protect in-air hearing ability and may contribute to reduced sensitivity underwater (Hetherington, 2008). There are many anatomical adaptations in diving birds that may reduce sensitivity both in air and underwater. Anatomical ear adaptations are not well investigated, but include cavernous tissue in the meatus and middle ear that may fill with blood during dives to compensate for increased pressure on the tympanum, active muscular control of the meatus to prevent water entering the ear, and interlocking feathers to create a waterproof outer covering (Crowell et al., 2015; Rijke, 1970; Sade et al., 2008). The northern gannet, a plunge diver, has unique adaptations to hitting the water at high speeds, including additional air spaces in the head and neck to cushion the impact and a thicker tympanic membrane than similar-sized birds (Crowell et al., 2015). All of these adaptions could explain why best hearing frequencies are narrower under water than on the surface or in flight.

This new information increases the understanding of bird auditory abilities; however, no new information is available on bird hearing that would alter the analysis from the 2015 MITT Final EIS/OEIS. As such, the additional description regarding dive behavior presented in the 2015 MITT Final EIS/OEIS remains valid.

3.6.1.6 General Threats

Section 3.6.2.4 (General Threats) of the 2015 MITT Final EIS/OEIS described the general threats facing marine birds within the Study Area. No new information is available that would change the characterization of threats described in the 2015 document; therefore, the description regarding general threats presented in the 2015 MITT Final EIS/OEIS remains valid. Since the publication of the 2015 MITT Final EIS/OEIS, more complete information regarding potential climate change-related impacts on water quality, which in turn may impact prey base and rookery resiliency to storm events, has become available and been included in this SEIS/OEIS. Section 3.1 (Sediments and Water Quality) describes the updated information included in this SEIS/OEIS in regards to potential impacts on water quality from climate change. These changes (e.g., air and sea temperatures, precipitation, frequency and intensity of storms, pH level of sea water, sea level rise) may potentially impact marine birds by reducing overall marine productivity and biodiversity, which could affect the food resources, distribution, and reproductive success of marine birds (Duffy, 2011; Frost et al., 2017; Lorrain et al., 2017; Ostrom et al., 2017; Ramírez et al., 2017; Trainer, 2017). In the long term, climate change could be the largest threat to marine birds.

On FDM, the primary threats to marine bird rookeries include invasive species currently on the island (e.g., rodents that prey on marine bird eggs and chicks). Extensive biosecurity planning by range operators is in place for land-based training activities on FDM to prevent the accidental introduction of other invasive species, such as the brown treesnake (U.S. Fish and Wildlife Service, 2010, 2015). A more detailed description of stressors on the terrestrial environment of FDM is provided in Section 3.10 (Terrestrial Species and Habitats).

3.6.1.7 Rookery Locations and Breeding Activities on FDM

The 2015 MITT Final EIS/OEIS included a summary of statistical analyses conducted on marine bird counts collected since 1997 and the findings from a non-published technical report produced by the same authors as the published report. Since the publication of the 2015 MITT Final EIS/OEIS, Camp et al. (2016) published this information. During the 159 counts conducted between February 1997 and August 2014, the numbers detected during each count ranged from 0 to 447 for brown booby, 6 to 404 for masked booby, and 42 to 915 for red-footed booby. From 1997 to 2014, there is some evidence that masked and red-footed booby populations on FDM have declined, while brown booby populations have increased. However, the general conclusion is that all three species exhibited population fluctuations over time. Combined with the level of variability observed in the count data, this precluded any definite conclusions about long-term population trends (i.e., the data showed no statistically significant trends)

(Camp et al., 2016). Since the publication of the 2015 MITT Final EIS/OEIS, one additional aerial survey was completed in September 2016. Because of a lack of commercial helicopter transit services, surveys have not been conducted since 2016.

3.6.2 Environmental Consequences

In the 2015 MITT Final EIS/OEIS, the Navy considered all potential stressors associated with ongoing training and testing activities in the Mariana Islands and then analyzed their potential impacts on marine birds in the Study Area. In this SEIS/OEIS, the Navy has reviewed the analysis of impacts from these ongoing activities and additionally analyzed new or changing training and testing activities as projected into the reasonably foreseeable future. The Navy has completed a literature review for information on marine birds within the Study Area, which included a search for the best available science since the publication of the 2015 MITT Final EIS/OEIS. Where there has been no substantive or otherwise meaningful change in the action, science, or regulations, the Navy will rely on the previous 2015 MITT Final EIS/OEIS analysis. Where there has been substantive change in the action, science, or regulations, the information and analysis provided in this SEIS/OEIS will supplement the 2015 MITT Final EIS/OEIS to support environmental compliance with applicable environmental statutes for marine birds.

In the alternatives descriptions for this SEIS/OEIS, there have been some modifications to the quantity and type of acoustic stressors under the two action alternatives compared to the 2015 MITT Final EIS/OEIS. In addition, the analysis of potential impacts associated with sonar and other transducers has been improved by incorporating additional information regarding marine bird hearing abilities in water. There have been no updates to the assessment of potential impacts on marine birds from other acoustic sources (e.g., vessel noise, airguns, weapons firing noise, and aircraft noise).

The stressors applicable to birds include the new stressor (high-energy laser) and the same stressors considered in the 2015 MITT Final EIS/OEIS. High-energy laser is detailed in Section 3.0.4.3.2.2 (High-Energy Lasers) and analyzed under the energy stressor category for potential impacts on birds (see Section 3.6.2.3, Energy Stressors).

In general, there have been no substantial changes to the activities analyzed in the 2015 MITT Final EIS/OEIS, which would change the conclusions reached regarding populations of marine birds in the Study Area. 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 compared. The increased use of FDM for training activities proposed in this SEIS/OEIS necessitates FDM-focused analysis for some stressor categories.

Use of acoustic stressors (sonar and other active acoustic sources) and use of explosives have occurred since the 2015 completion of the MITT Final EIS/OEIS Record of Decision. There have been no known adverse effects to marine birds or population impacts that were not otherwise previously analyzed or accounted for in the 2015 MITT Final EIS/OEIS (U.S. Department of the Navy, 2015). The potential stressors associated with the training and testing activities in the Study Area included the following:

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

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

During the preparation of the 2015 MITT Final EIS/OEIS, the Navy assessed the potential for wires and cables, along with decelerators/parachutes, to entangle marine birds. The Navy determined at that time that these materials would not present entanglement risks for marine birds because these items would be expended outside of their range of foraging abilities. During the Navy's literature review, no new information regarding fiber optic cables and guidance wires and decelerators/parachutes was found that would alter this conclusion in the 2015 MITT Final EIS/OEIS; therefore, they are not analyzed further in this SEIS/OEIS.

<u>**Analysis of Stressors on Farallon de Medinilla**</u>

Analysis of Proposed Increases in Number of Events, Munitions, and Net Explosive Weight on Farallon de Medinilla

Under Alternative 1 and Alternative 2, there would be an overall increase in the number of training events and munitions used on FDM, 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 (see Table 3.0-19). 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 will result in an increase in net explosive weight (NEW) of explosives over the course of a training year. The calculations for NEW expended on NEW resulting from proposed training activities are shown on 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 the 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 the 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 the 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. Examples of these training activities include Gunnery Exercise (Air-to-Ground) and Bombing Exercise (Air-to-Ground). 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).

Taken together, the increase in the number of events per year or the amount of ordnance used during events would result in more ordnance use on FDM and an increase in the amount of NEW expended on FDM each year. Although the amount of increased NEW is negligible (less than 1 percent), the number of events per year and the number of ordnance items (most of which are small and medium projectiles) expended increases the potential exposure to stressors associated with ordnance use. 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 as with the 2015 MITT Final EIS/OEIS (see Section 5.5 Terrestrial Mitigation Measures to be Implemented).

Table 3.6-1: Number of Events by Activity Type on Farallon de Medinilla

Activity	Number of Events			Percent Increase from 2015 MITT Final EIS/OEIS	
	2015 MITT Final EIS/OEIS	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Marine Air Ground Task Force Exercise (Amphibious) – Battalion	4	4	4	0.0%	0.0%
Naval Surface Fire Support Exercise – Land-based target	10	10	15	0.0%	40.0%
Bombing Exercise (Air-to-Ground)	2,300	2,300	2,300	0.0%	0.0%
Gunnery Exercise (Air-to-Ground)	96	96	96	0.0%	0.0%
Missile Exercise	85	115	115	30.0%	30.0%
Direct Action (Tactical Control Party)	18	18	18	0.0%	0.0%
Total	***2,513***	***2,543***	***2,548***	***1.2%***	***1.4%***

Notes: EIS = Environmental Impact Statement, MITT = Mariana Islands Training and Testing, NEPM = Non-explosive practice munition, OEIS = Overseas EIS

Table 3.6-2: Number of Munitions by Activity Type on Farallon de Medinilla

Activity	Munitions Type	Number of Munitions			Percent Increase from 2015 MITT Final EIS/OEIS	
		2015 MITT Final EIS/OEIS	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Naval Surface Fire Support Exercise – Land-based target	NEPM Rounds	1,800	-	-	NA	NA
	Explosive large-cal rounds	1,000	2,800	4,200	94.7%	123.1%
Bombing Exercise (Air-to-Ground)	NEPM Rounds	2,670	2,670	2,670	0.0%	0.0%
	Explosive Rounds	6,242	6,242	6,242	0.0%	0.0%
Gunnery Exercise (Air-to-Ground)	Small-cal rounds	24,000	24,000	24,000	0.0%	0.0%
	Med-cal rounds	94,150	94,650	94,650	0.5%	0.5%
	Explosive med-cal rounds	17,350	17,500	17,500	0.9%	0.9%
	Explosive large-cal rounds	200	200	200	0.0%	0.0%
Missile Exercise	Explosive rockets	2,000	2,000	2,000	0.0%	0.0%
	Explosive missiles	85	115	115	30.0%	30.0%
Direct Action (Tactical Control Party)	Small-cal rounds	18,000	30,000	30,000	50.0%	50.0%
	Medium-cal explosives	-	1,000	1,000	NA	NA
	Explosives (grenades/mortars)	600	1,000	1,000	50.0%	50.0%
Total		***166,297***	***181,177***	***182,577***	***8.6%***	***9.3%***

Notes: EIS = Environmental Impact Statement, MITT = Mariana Islands Training and Testing, NEPM = Non-explosive practice munition, OEIS = Overseas EIS

Table 3.6-3: Munitions Use on Farallon de Medinilla, Net Explosive Weight Comparisons

Explosive Munitions used at FDM	Bin	NEW Range[1]	NEW			Percent Increase from 2015 MITT Final EIS/OEIS	
			2015 MITT Final EIS/OEIS	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Explosive Bombs ≤ 2,000 lb.	E10-E13	250-1,740	3,121,000-10,861,080	3,121,000-10,861,080	3,121,000-10,861,080	0.0%	0.0%
Missiles	E6	10-20	850-1,700	1,150-2,300	1,150-2,300	30.0%	30.0%
Large-caliber Projectiles	E5	5-10	6,000-12,000	15,000 – 30,000	22,000 – 44,000	85.7%	114.3%
Medium-caliber Projectiles	E4	2.5-5	43,375-86,750	46,250 - 92,500	46,250 - 92,500	6.4%	6.4%
Rockets	E4	2.5-5	1,000-20,000	1,000-20,000	1,000-20,000	0.0%	0.0%
Explosive Grenades and Mortars	E2	0.25-0.5	150-300	250-500	250-500	50.0%	50.0%
Total			***3,172,375-10,981,830***	***3,184,650-11,006,380***	***3,191,650-11,020,380***	***0.22 – 0.39%***	***0.35 – 0.61%***

[1] NEW (Net Explosive Weight) measured in lb. (pounds)

Notes: EIS = Environmental Impact Statement, FDM = Farallon de Medinilla, lb. = pounds, MITT = Mariana Islands Training and Testing, NEW = Net Explosive Weight (lb.)

Population-Level Impact Analysis

Under the Migratory Bird Treaty Act (MBTA) regulations applicable to military readiness activities (50 Code of Federal Regulation [CFR] part 21), the stressors introduced during training and testing activities would not result in a significant adverse effect on marine birds protected under the MBTA. While this determination is applicable to all marine birds that occur in the Study Area, the Navy carried out a focused analysis for marine birds known to breed within the Study Area, particularly for breeding marine birds on FDM. The Navy identified two birds in particular that have a heightened concern with regards to 50 CFR Part 21—the great frigatebird and the masked booby.

In the 2015 MITT Final EIS/OEIS, the Navy assessed the significance of injury and mortality of individual masked boobies and great frigatebirds relative to the viability of these species' populations. The populations of the masked booby and great frigatebird were defined based on (1) the distribution of subspecies *S. d. personata* and *F. m. palmerstoni*, (2) the colony locations within these distributions, and (3) the number of individual birds associated with these colonies. The Navy then compared the number of masked boobies and great frigatebirds that are found within the colonies within the Marianas (particularly FDM) to that of the regional population within the western and central Pacific.

Because the numbers of activities described in this SEIS/OEIS potentially affecting these birds and the amount of NEW used on FDM do not appreciably differ from what was analyzed previously, the conclusions within the 2015 MITT Final EIS/OEIS remain valid. These conclusions are summarized below:

- The great frigatebird may occasionally nest on FDM, which is one of only two small breeding colonies known to exist within the Mariana Islands (the other is located on Maug in the northern portion of the archipelago). FDM does not appear to be a temporally or spatially stable rookery location. Compared to the numbers of great frigatebirds estimated throughout central and western Pacific (10,000 pairs in the Hawaiian Islands, with other colonies on Howland, Baker, Jarvis, Johnston Atoll, and Christmas Island), and the apparent low numbers of great frigatebirds from historic times through the present within the Mariana archipelago, the direct and indirect effects on effects of military activities on FDM would not represent a significant adverse impact on the population of the great frigatebird.
- For the masked booby, FDM is the largest breeding colony in Mariana Islands. The colony numbers recorded by the Navy appear to be stable, and the data do not suggest any significant declines of masked booby numbers. Although the masked booby may be subject to short- and long-term impacts of military use of FDM and individuals likely suffer injury and mortality from some activities, FDM continues to support a relatively stable rookery. In the central and western Pacific, 2,500 pairs are estimated within the Northwestern Hawaiian Islands, Jarvis (up to 1,200 pairs), Barker Island (over 1,500 pairs), and smaller colonies in American Samoa, Palmyra, Johnson Atoll, and northern islands in the Mariana archipelago (Maug, Uracas, Guguan, and FDM). Based on the long-term use and stability of the masked booby breeding population on FDM and the wide geographic range and abundance of the masked booby throughout the Pacific, the effects of military use of FDM would not represent a significant adverse impact on the population of the masked booby.
- Pursuant with the Department of Defense's obligations under 50 CFR Part 21, the Department of Defense will continue to implement training restrictions on FDM (see Section 5.5, Terrestrial Mitigation Measures to be Implemented) and monitoring of bird populations on FDM.

3.6.2.1 Acoustic Stressors

Section 3.6.3.1 (Acoustic Stressors) in the 2015 MITT Final EIS/OEIS provided an overview of marine bird hearing, including an explanation of how birds can suffer injury, hearing loss, and physiological stress, as well as various behavioral reactions exhibited by birds when a noise event induces a response. In addition, long-term consequences associated with noise-induced impacts are discussed in the 2015 MITT Final EIS/OEIS in Section 3.6.3.1 (Acoustic Stressors).

3.6.2.1.1 Impacts from Sonar and Other Transducer Stressors Under Alternative 1

Under Alternative 1, 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 (see Table 3.0-2 and Table 3.0-3 in this SEIS/OEIS) would decrease overall. Therefore, the analysis in the 2015 MITT Final EIS/OEIS remains valid. Decreases in sonar hours shown 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, based on the analysis below.

Sonar and other transducers emit sound waves into the water to detect objects, safely navigate, and communicate. Use of sonar and other transducers would typically be transient and temporary. General categories of sonar systems are described in Section 3.0.4.1 (Acoustic Stressors).

Information regarding the impacts of sonar on birds is unavailable, and little is known about the ability for birds to hear underwater. The limited information and data from other species suggest the range of best hearing may shift to lower frequencies in water (Dooling & Therrien, 2012; Johansen et al., 2016; Therrien, 2014). Because few birds can hear above 10 kHz in air, it is likely that the only sonar sources they may be able to detect are low- and mid-frequency sources. Other than pursuit diving species, the exposure to birds by these sounds is likely to be negligible because they spend only a very short time underwater (plunge-diving or surface-dipping) or forage only at the water surface. Pursuit divers may remain underwater for minutes, increasing the chance of underwater sound exposure.

In addition to diving behavior, the likelihood of a bird being exposed to underwater sound depends on factors such as duty cycle (defined as the percentage of the time during which a sound is generated over a total operational period), whether the source is moving or stationary, and other activities that might be occurring in the area. When used, continuously active sonars transmit more frequently (greater than 80 percent duty cycle) than traditional sonars, but at a substantially lower source level. However, it should be noted that active sonar is rarely used continuously throughout the listed activities, and many sources are mobile. For moving sources such as hull-mounted sonar, the likelihood of an individual bird being repeatedly exposed to a sound source over a short period of time is low because the training and testing activities are transient, and sonar use and bird diving are intermittent. The potential for birds to be exposed to intense sound associated with stationary sonar sources would likely be limited for some training and testing activities because other activities occurring in conjunction may cause them to leave the immediate area. For example, birds would likely react to helicopter noise during dipping sonar exercises by flushing from the immediate area.

Injury due to acoustic resonance of air space in the lungs due to sonar and other transducers is unlikely in birds. Unlike mammals, birds have compact, rigid lungs with strong pulmonary capillaries that do not change much in diameter when exposed to extreme pressure changes (Baerwald et al., 2008), leading to resonant frequencies lower than the frequencies used for Navy sources.

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

In general, birds are less susceptible to both TTS and PTS than mammals (Saunders & Dooling, 1974). Diving birds have adaptations to protect the middle ear and tympanum from pressure changes during diving that may affect hearing (Dooling & Therrien, 2012). While some adaptions may exist to aid in underwater hearing, other adaptations to protect in-air hearing may limit aspects of underwater hearing (Hetherington, 2008). Because of these reasons, the likelihood of a diving bird experiencing an underwater exposure to sonar or other transducer that could result in an impact on hearing is considered low.

Because there is no new information since the 2015 MITT Final EIS/OEIS that would change the previous analysis for potential impacts on ESA-listed marine bird species, the conclusions in the 2015 MITT Final EIS/OEIS remain valid. The described training and testing activities would present no measurable chance for interaction with ESA-listed marine bird species (e.g., short-tailed albatross, Hawaiian petrel, Newell's shearwater). In the 2015 MITT Final EIS/OEIS and during consultation between the Navy and USFWS, the Navy determined that the use of sonar and other transducers would have no effect on ESA-listed marine birds.

Because of the small numbers of birds potentially exposed to stressors associated with sonar and other transducers, and the low potential of any injurious exposure to sonar and other transducers while birds are under water, marine bird population impacts would not occur.

Pursuant to the ESA, acoustic stressors from the use of sonar and other transducers during training and testing activities, as described under Alternative 1, would have no effect on ESA-listed Hawaiian petrels, short-tailed albatrosses, and Newell's shearwaters. This determination is consistent with the previous consultation between the Navy and USFWS for activities described in the 2015 MITT Final EIS/OEIS.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), the impacts from sonar and other transducers during training and testing activities described under Alternative 1 would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.1.2 Impacts from Sonar and Other Transducer Stressors under Alternative 2

As with Alternative 1, the number of sonar hours used under Alternative 2 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 Table 3.0-3) would decrease overall. Therefore, the analysis in the 2015 MITT Final EIS/OEIS remains valid. Decreases in the number of training and testing activities would potentially decrease the level of acoustic stressors in the Study Area. The conclusions for ESA-listed species presented in the 2015 MITT Final EIS/OEIS is the same as for Alternative 1 in this SEIS/OEIS.

As with Alternative 1, taken together, the small numbers of birds potentially exposed to stressors associated with sonar and other transducers under Alternative 2, and the low potential of any injurious exposure to sonar and other transducers while birds are under water, there would be no impacts on marine bird populations.

Pursuant to the ESA, acoustic stressors from the use of sonar and other transducers during training and testing activities, as described under Alternative 2, would have no effect on ESA-listed Hawaiian petrels, short-tailed albatrosses, and Newell's shearwaters. This determination is consistent with the previous consultation between the Navy and USFWS for activities described in the 2015 MITT Final EIS/OEIS.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), the impacts from sonar and other transducers during training and testing activities described under Alternative 2 would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.1.2.1 Impacts from Sonar and Other Transducer 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 Navy activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts on marine birds from sonar and other transducers, but would not measurably improve the overall distribution or abundance of marine birds.

3.6.2.1.3 Impacts from Aircraft Noise

Section 3.6.3.1.3.1 (Fixed-Wing Aircraft) and Section 3.6.1.3.2 (Helicopters) of the 2015 MITT Final EIS/OEIS discuss the different types of aircraft and the noise they generate, along with a summary of potential responses marine birds may exhibit. Since the publication of the 2015 MITT Final EIS/OEIS, no new information was identified during the Navy's literature review that would substantially alter the assessment of potential impacts on marine birds from aircraft noise. Therefore, the information contained in Section 3.6.3.1.3.3 (Vessels) of the 2015 MITT Final EIS/OEIS remains valid.

Birds in areas that may experience repeated exposure often habituate and do not respond behaviorally (Larkin et al., 1996; National Park Service, 1994; Plumpton, 2006). Throughout the Study Area, repeated exposure of individual birds or groups of birds is unlikely based on the dispersed nature of the overflights and the capability of birds to avoid or rapidly vacate an area of disturbance. Therefore, the general health of individual birds would not be compromised. Occasional startle or alert reactions to aircraft noise are not likely to disrupt major behavior patterns (such as migrating, breeding, feeding, and sheltering) or to result in serious injury to any birds.

Training and testing activities where aircraft are used typically occur further offshore; however, increased use of FDM may increase the potential for aircraft strike of birds. Therefore, for the purposes of this SEIS/OEIS, only the use of aircraft related to FDM training activities are discussed below under the alternatives analysis for birds for this stressor category.

3.6.2.1.3.1 Impacts from Aircraft Noise Stressors Under Alternative 1

Under Alternative 1, the number of proposed activities including aircraft would decrease overall throughout the study area (see Table 3.0-11). In the open ocean, marine birds would be exposed to additional aircraft noise sources, but these activities are spread out throughout the Study Area. Because of the increase in munitions use at FDM, however, aircraft overflights over FDM would increase, depending on the delivery platform. For example, some of the increases are associated with ship to surface, while others may involve helicopters and fixed-wing aircraft. Therefore, the analysis in this section focuses on FDM, where actual aircraft overflights would likely increase.

Increased training activities under Alternative 1 would increase the potential for noise exposures for birds on FDM because the increase in the number of training activities would require more aircraft to fly over the island (potentially at low altitude) and land on the island to deliver and pick up personnel. As shown in Table 2.5-1, activities that would increase aircraft overflights include Missile Exercise and Direct Action (Tactical Air Control Party) activities.

Aircraft overflights are expected to elicit short-term behavioral responses in nesting birds at FDM. Based on studies from other nesting bird areas (Barnas et al., 2018; Bowles, 1995; Larkin et al., 1996), any period away from the nest would last a few seconds to a few minutes, which is likely not long enough for opportunistic predation of a nest (e.g., by rats on FDM). The 2015 MITT Final EIS/OEIS analyzed other adverse effects, such as damage to eggs and startling of juveniles and adults.

Anecdotally, some birds typically take flight while roosting or nesting during quarterly helicopter-based marine bird surveys over FDM; birds that are stationary and not on the wing are counted (U.S. Department of the Navy, 2013a). Although no studies are available specific to marine bird responses to low-level overflights over FDM, other studies of shorebird responses to military aircraft overflights are helpful. Black (2005), studied the effects of low-altitude (less than 500 ft. [152 m] above ground level) military training flights with sound levels from 55 to 100 A-weighted decibels on wading bird colonies (i.e., great egret, snowy egret, tricolored heron, and little blue heron). The training flights involved three or four aircraft and occurred once or twice per day. This study concluded that the reproductive activity—including nest success, nestling survival, and nestling chronology—was independent of F-16 overflights. Dependent variables were more strongly related to ecological factors, including location and physical characteristics of the colony and climatology. Another study on the effects of circling fixed-wing aircraft and helicopter overflights on wading bird colonies found that at altitudes of 195 ft. (59 m) to 390 ft. (119 m), there was no reaction in nearly 75 percent of the 220 observations. Ninety percent displayed no reaction or merely looked toward the direction of the noise source. Another 6 percent stood up, 3 percent walked from the nest, and 2 percent flushed (but were without active nests) and returned within five minutes (Kushlan, 1978).

These studies, coupled with anecdotal observations on FDM during quarterly marine bird monitoring surveys, suggest that aircraft overflights do not have harmful effects on nesting and roosting marine birds on FDM, and that the behavioral responses are short term (Camp et al., 2016).

Although some degree of disturbance is expected from the increase in aircraft noise over FDM, the island will likely continue to serve as an important rookery for regional species without long-term significant impacts on marine bird populations. As discussed in Section 3.6.1.7 (Rookery Locations and Breeding Activities on FDM), Camp et al. (2016) published results of multi-year population monitoring of three species of boobies on FDM, showing that is some evidence that masked and red-footed booby populations on FDM have declined, while brown booby populations have increased. However, the general conclusion is that all three species exhibited population fluctuations over time. Combined with the level of variability observed in the count data, this precluded any definite conclusions about long-term population trends (i.e., the data were non-significant) (Camp et al., 2016).

Because of the dispersed nature of overflights in open ocean training areas, birds or groups of birds in pelagic environments would not likely be exposed to repeated overflights. Because any exposures would be infrequent, and these exposures would not cause injury, population impacts would not occur for bird species in the open ocean.

Aircraft activity described in this SEIS/OEIS would present no measurable chance for interaction with ESA-listed marine bird species (e.g., short-tailed albatross, Hawaiian petrel, Newell's shearwater). In the 2015 MITT Final EIS/OEIS and during consultation between the Navy and USFWS, the Navy determined that aircraft activity would have no effect on ESA-listed marine birds. Although the amount of training and testing activities using aircraft would increase compared to the 2015 MITT Final EIS/OEIS, the potential for geographic and temporal overlap would remain negligible; therefore, the conclusions for ESA-listed species presented in the 2015 MITT Final EIS/OEIS is the same as for Alternative 1 in this SEIS/OEIS.

Pursuant to the ESA, aircraft noise during training activities, as described under Alternative 1, would have no effect on ESA-listed Hawaiian petrels, short-tailed albatrosses, and Newell's shearwaters.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), the impacts from aircraft noise during training activities described under Alternative 1 would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.1.3.2 Impacts from Aircraft Noise Stressors Under Alternative 2

Under Alternative 2, the number of activities including aircraft would decrease compared to levels analyzed under the 2015 MITT Final EIS/OEIS, but would be more than proposed under Alternative 1 (see Table 3.0-11).

As with Alternative 1, the dispersed nature of overflights in open ocean training areas under Alternative 2 would not likely expose birds or groups of birds in pelagic environments to repeated overflights. Because any exposures would be infrequent, and these exposures would not cause injury, population impacts would not occur for bird species in the open ocean.

No additional targets would be used, and this activity would be constrained by confining targeting to specific sites within designated impact zones. Because the same locations would be used for targeting activities, the impacts of Alternative 2 are the same as Alternative 1. In the open ocean, marine birds would be exposed to additional aircraft noise sources, but these activities are spread out throughout the Study Area, and the potential impacts of at-sea training and testing activities would not be discernable from Alternative 1. Therefore, impacts on marine birds under Alternative 2 from aircraft noise would be negligible.

Pursuant to the ESA, aircraft noise during training activities, as described under Alternative 2, would have no effect on ESA-listed Hawaiian petrels, short-tailed albatrosses, and Newell's shearwaters.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), the impacts from aircraft noise during training activities described under Alternative 2 would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.1.3.3 Impacts from Aircraft Noise 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 Navy activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts on marine birds from aircraft noise, but would not measurably improve the overall distribution or abundance of marine birds.

3.6.2.1.4 Impacts from Weapons Noise

Sounds produced by weapons firing (muzzle blast), launch boosters, and projectile travel are potential stressors to birds and are discussed as impulsive noise under Section 3.6.3.1.2.2 (Explosions on Land and In-Air) in the 2015 MITT Final EIS/OEIS. Since the publication of the 2015 MITT Final EIS/OEIS, no new information was identified during the Navy's literature review that would substantially alter the assessment of potential impacts on marine birds from weapons noise.

3.6.2.1.4.1 Impacts from Weapons Noise Stressors Under Alternative 1

Under Alternative 1, the number of training and testing activities that would expose marine birds to weapons noise would decrease throughout the Study Area, compared to levels analyzed in the 2015 MITT Final EIS/OEIS (Table 3.0-14 and Table 3.0-16). A bird in the open ocean could be exposed to weapons noise if not already displaced by the visual or noise disturbance of a vessel supporting weapons-firing exercises. 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.

Supersonic projectiles, which would be similar in size to shells fired from 5-inch/54 guns, would travel at approximately 2,600 ft./second, creating a bow shock wave. Pater and Shea (1981) measured the characteristics of a bow shock wave from a 5 inch projectile and found that the shock wave ranged from 40 to 147 dB re 20 µPa sound pressure level peak taken at the ground surface at 1,100 m from the firing location and 190 m perpendicular from the trajectory (for safety reasons). Shells fired from a kinetic energy weapon are considered hypersonic, and would travel at about 6,500 ft./second, and peak pressures would be expected to be several dB higher than for shell velocities described by (Pater & Shea, 1981). By definition, bow shock waves, regardless of shell velocity, would travel at the speed of sound in air. Marine birds would be exposed to this type of noise for a very brief period of time (a few seconds), and would likely cause brief and temporary behavioral reactions described previously for other in-air noise disturbances.

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. Birds foraging or migrating through a training area in the open ocean may respond by avoiding areas where weapons-firing exercises occur. Exposures of most marine birds would be infrequent, based on the brief duration and dispersed nature of the vessels, and the brief duration of the weapons-firing noise. If a bird responds to weapons noise, only short-term behavioral responses such as startle responses, head turning, or avoidance responses would be expected. Weapons noise near rookery locations (only at FDM) may induce startle responses, inducing birds to temporarily leave nests. Because impacts on individual birds, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any bird populations, and weapons noise would not have a significant adverse effect on populations of migratory bird species.

On FDM, however, marine birds would likely be exposed to increased weapons noise because of the increase in the number of explosive and non-explosive munitions (see Table 3.6-1, Table 3.6-2, and Table 3.6-3). Sources of weapons generating noise at the time of weapons firing on or near FDM include small-caliber rounds, rockets, medium-caliber projectiles, and large-caliber projectiles. Other munitions types used on FDM (e.g., non-explosive practice munition and explosive bombs and missiles) are launched far from the target (impact areas on FDM) or released from aircraft.

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 Section 3.10 (Terrestrial Species and Habitats) of this SEIS/OEIS and provides a summary of the different types of sounds, frequency ranges, and intensity of sounds generated from munitions use on FDM. Sources of noise from weapons firing that may be heard by marine birds on FDM 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 for this activity type 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 birds 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 some degree of disturbance is expected from the increase in weapons noise on FDM, the island will likely continue to serve as an important rookery for regional species without long-term significant impacts on marine bird populations. As discussed in Section 3.6.1.7 (Rookery Locations and Breeding Activities on FDM), Camp et al. (2016) published results of multi-year population monitoring of three species of boobies on FDM, showing that is some evidence that masked and red-footed booby populations on FDM have declined, while brown booby populations have increased. However, the general conclusion is that all three species exhibited population fluctuations over time. Combined with the level of variability observed in the count data, this precluded any definite conclusions about long-term population trends (i.e., the data were non-significant) (Camp et al., 2016).

Weapons noise would present no measurable chance for interaction with ESA-listed marine bird species (short-tailed albatross, Hawaiian petrel, Newell's shearwater). As discussed previously, ESA-listed marine bird species do not occur on FDM (or any other island within the Marianas) and have little to no overlap with the Study Area. In the 2015 MITT Final EIS/OEIS and during consultation between the Navy and USFWS, the Navy determined that weapons noise would have no effect on ESA-listed marine birds. Although the amount of training and testing activities would increase compared to the 2015 MITT Final EIS/OEIS, the potential for geographic and temporal overlap would remain negligible; therefore, the conclusions for ESA-listed species presented in the 2015 MITT Final EIS/OEIS is the same as for Alternative 1 in this SEIS/OEIS.

Pursuant to the ESA, weapons noise during training and testing activities, as described under Alternative 1, would have no effect on ESA-listed Hawaiian petrels, short-tailed albatrosses, and Newell's shearwaters.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), the impacts from weapons noise during training and testing activities described under Alternative 2 would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.1.4.2 Impacts from Weapons Noise Stressors Under Alternative 2

As with Alternative 1, under Alternative 2 the number of training and testing activities that would expose marine birds to weapons noise would decrease throughout the Study Area, compared to levels analyzed in the 2015 MITT Final EIS/OEIS (see Table 3.0-14 and Table 3.0-16). Compared to Alternative 1, there would be small increases in the number of activities using large-caliber and medium-caliber projectiles and missiles under Alternative 2 for at-sea training and testing activities. Therefore, Alternative 2 would introduce fewer weapons firing events than activities analyzed in the 2015 MITT Final EIS/OEIS for at-sea activities. Because activities would occur within the same locations as with Alternative 1, at-sea weapons firing activities would be widely dispersed, and marine birds would also be widely dispersed, the impacts of Alternative 2 are the same as for Alternative 1.

On FDM, the only training activity that would introduce weapons firing noise is Direct Action (tactical control party). As shown in 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 compared to Alternative 1; however, the number of munitions used would increase (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 birds 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.

As with Alternative 1, some degree of disturbance is expected from the increase in weapons noise on FDM; however, the island will likely continue to serve as an important rookery for regional species without long-term significant impacts on marine bird populations. As discussed in Section 3.6.1.7 (Rookery Locations and Breeding Activities on FDM), Camp et al. (2016) published results of multi-year population monitoring of three species of boobies on FDM, showing that is some evidence that masked and red-footed booby populations on FDM have declined, while brown booby populations have increased. However, the general conclusion is that all three species exhibited population fluctuations over time. Combined with the level of variability observed in the count data, this precluded any definite conclusions about long-term population trends (i.e., the data were non-significant) (Camp et al., 2016). The same conclusions for Alternative 1 for MBTA-protected marine bird species at sea and on FDM, and ESA-listed marine bird species at sea, are applicable to Alternative 2.

Pursuant to the ESA, weapons noise during training and testing activities, as described under Alternative 1, would have no effect on ESA-listed Hawaiian petrels, short-tailed albatrosses, and Newell's shearwaters.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), the impacts from weapons noise during training and testing activities described under Alternative 2 would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.1.4.3 Impacts from Weapons Noise 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 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 Navy activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts on marine birds from weapons noise, but would not measurably improve the overall distribution or abundance of marine birds.

3.6.2.2 Explosives Stressors (explosive shock wave and sound, explosive fragments)

Section 3.6.3.1.2 (Impacts from Explosives and Swimmer Defense Airguns) in the 2015 MITT Final EIS/OEIS discusses the sources and potential impacts of explosives noise on marine birds (e.g., injury, hearing loss, physiological stress, masking, and long-term consequences of exposures). Explosions in the water, near the water surface, on land (FDM), and in the air can introduce loud, impulsive, broadband sounds into the marine environment. However, unlike other acoustic stressors, explosives release energy at a high rate, producing a shock wave that can be injurious and even deadly. The information regarding training and testing activities in open ocean training environments that generate explosives noise has not changed since the publication of the 2015 MITT Final EIS/OEIS. Therefore, this section focuses on the potential for increased training activities to impact birds on FDM proposed under the alternatives described in this SEIS/OEIS.

Noise can result from direct munitions impacts (one object striking another), blasts (explosions that result in shock waves), bow shock waves (pressure waves from projectiles flying through the air), and substrate vibrations (combinations of explosion, recoil, or vehicle motion with the ground). Noise may be continuous (i.e., lasting for a long time without interruption) or impulse (i.e., short duration). Continuous impulses (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 sound are distinguished here as they differ in their effects. Continuous sounds can result in hearing damage, while impulses typically elicit physiological or behavioral responses. Some birds may be killed or injured during these activities, or expend energy stores needed for migration to avoid perturbations generated by explosions.

Because the military will continue to implement mitigation measures designed to avoid or reduce impacts on terrestrial biological resources, all additional ordnance use would still be targeted at existing impact areas.

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 Mariana Islands Range Complex 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 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 Mariana Islands Range Complex Operations. Impact Area 1 contains 10 targets of varying shapes and sizes, including four vehicles and six 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).

3.6.2.2.1 Impacts from Explosive Stressors Under Alternative 1

Under Alternative 1, there would be an overall decrease throughout the Study Area in the number of explosive munitions used during training and testing activities compared to the number analyzed in the 2015 MITT Final EIS/OEIS (Table 3.0-16).

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

Taken together, the increase in the number of training events per year or the amount of ordnance used during training events would result in an increase in the amount of NEW expended on FDM each year (see Table 3.6-1, Table 3.6-2, and 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 1 compared to what was analyzed previously in the MITT Final EIS/OEIS. 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). Therefore, the increases in ordnance use on FDM do not appreciably change the impact conclusions presented in the 2015 MITT Final EIS/OEIS. The conclusions for ESA-listed marine bird species and other marine bird species protected by the MBTA included in the 2015 MITT Final EIS/OEIS remain valid.

Explosives would present no measurable chance for interaction with ESA-listed marine bird species (short-tailed albatross, Hawaiian petrel, Newell's shearwater). In the 2015 MITT Final EIS/OEIS and during consultation between the Navy and USFWS, the Navy determined that training and testing activities using explosives would have no effect on ESA-listed marine birds. Despite the continued at-sea use of explosives compared to the 2015 MITT Final EIS/OEIS, the potential for geographic and temporal overlap would remain negligible; therefore, the conclusions for ESA-listed species presented in the 2015 MITT Final EIS/OEIS is the same as for Alternative 1 in this SEIS/OEIS.

Pursuant to the ESA, explosives used during training and testing activities, as described under Alternative 1, would have no effect on ESA-listed Hawaiian petrels, short-tailed albatrosses, Newell's shearwaters.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), the impacts from explosives stressors during training and testing activities using explosives described under Alternative 1 would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.2.2 Impacts from Explosive Stressors Under Alternative 2

As with Alternative 1, there would be an overall decrease throughout the Study Area in the number of explosive munitions used during at-sea training and testing activities compared to the number analyzed in the 2015 MITT Final EIS/OEIS. The number of explosive stressors under Alternative 2 would increase slightly as compared to Alternative 1 (see Table 3.0-16), but the conclusions for at-sea activities remains the same. Under Alternative 2, there would be an increase in the number of training 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 MITT Final EIS/OEIS and under Alternative 1.

Taken together, the increase in the number of training 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 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, 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 ESA-listed marine bird species and other marine bird species protected by the MBTA included in the 2015 MITT Final EIS/OEIS remain valid.

Explosives would present no measurable chance for interaction with ESA-listed marine bird species (short-tailed albatross, Hawaiian petrel, Newell's shearwater). In the 2015 MITT Final EIS/OEIS and during consultation between the Navy and USFWS, the Navy determined that training and testing activities using explosives would have no effect on ESA-listed marine birds. Although the amount of training and testing activities using explosives would increase compared to the 2015 MITT Final EIS/OEIS, the potential for geographic and temporal overlap would remain negligible; therefore, the conclusions for ESA-listed species presented in the 2015 MITT Final EIS/OEIS is the same as for Alternative 1 in this SEIS/OEIS.

Pursuant to the ESA, explosives used during training and testing activities, as described under Alternative 2, would have no effect on ESA-listed Hawaiian petrels, short-tailed albatrosses, Newell's shearwaters.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), the impacts from explosives stressors during training and testing activities using explosives described under Alternative 2 would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.2.3 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 Navy activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts on marine birds from explosive stressors, but would not measurably improve the overall distribution or abundance of marine birds.

3.6.2.3 Energy Stressors

The energy stressors that may impact marine birds include (1) in-air electromagnetic devices and (2) high-energy lasers. However, as discussed in Section 3.0.4.3 (Energy Stressors), in-air electromagnetic energy would be widely dispersed throughout the Study Area, but more concentrated in portions of the Study Area near ports, naval installations, and range complexes. Because these stressors are operated at power levels, altitudes, and distances from people and animals to ensure that energy received is well below levels that could disrupt behavior or cause injury and because most in-air electromagnetic energy is reflected by water, in-air electromagnetic energy would not impact birds and is not analyzed further in this section.

Since the publication of the 2015 MITT Final EIS/OEIS, additional information has become available that improves understanding of how in-air electromagnetic devices (such as radar) may impact marine birds. This new information is included in this SEIS/OEIS. Studies conducted on in-air electromagnetic sensitivity in birds have typically been associated with land, and little information exists specifically on seabird response to in-air electromagnetic changes at sea. Based on these studies, in-air electromagnetic effects can be categorized as thermal (i.e., capable of causing damage by heating tissue) or non-thermal. Thermal effects are most likely to occur when near high-power systems. Should such effects occur, they would likely cause birds to temporarily avoid the area receiving the electromagnetic radiation until the stressor ceases (Manville, 2016). Currently, questions exist about far-field, non-thermal effects from low-power, in-air electromagnetic devices. Manville (2016) performed a literature review of this topic. Although findings are not always consistent, Manville (2016) reported that several peer-reviewed studies have shown non-thermal effects can include (1) affecting behavior by preventing birds from using their magnetic compass, which may in turn affect migration; (2) fragmenting the DNA of reproductive cells, decreasing the reproductive capacity of living organisms; (3) increasing the permeability of the blood-brain barrier; (4) other behavioral effects; (5) other molecular, cellular, and metabolic changes; and (6) increasing cancer risk.

Many bird species return to the same stopover, wintering, and breeding areas every year and often follow the exact same or very similar migration routes (Akesson & Hedenstrom, 2007). However, ample evidence exists that displaced birds can successfully reorient and find their way when one or more cues are removed. For example, Haftorn et al. (1988) found that after removal from their nests and release into a different area, snow petrels (*Pagodrama nivea*) were able to successfully navigate back to their nests even when their ability to smell was removed. Furthermore, Wiltschko et al. (2011) and Wiltschko and Wiltschko (2005) report that electromagnetic pulses administered to birds during an experimental study on orientation do not deactivate the magnetite-based receptor mechanism in the upper beak altogether but instead cause the receptors to provide altered information, which in turn causes birds to orient in different directions. However, these impacts were temporary, and the ability of the birds to correctly orient themselves eventually returned.

Given (1) the information provided above; (2) the dispersed nature of Navy training and testing activities at sea; (3) the relatively small area around an emitting source that experiences high power electromagnetic pulses; and (4) the relatively low-level and dispersed use of these systems at sea, the following conclusions are reached:

- The chance that in-air electromagnetic devices would cause thermal damage to an individual marine bird is extremely low.
- It is possible, although unlikely, that some marine bird individuals would be exposed to levels of electromagnetic radiation that would cause discomfort, in which case they would likely avoid the immediate vicinity of testing and training activities.
- The strength of any avoidance response would decrease with increasing distance from the in-air electromagnetic device.

- No long-term or population-level impacts would occur.

There is only one new activity involving an energy stressor (i.e., high-energy lasers) that differs from activities with energy stressors that were previously analyzed in the 2015 MITT Final EIS/OEIS. Use of low-energy lasers was covered in the 2015 MITT Final EIS/OEIS in Section 3.0.5.2.2.3 (Lasers), but high-energy laser weapons were not part of the proposed action in the 2015 MITT Final EIS/OEIS. The use of high-energy lasers represents a new substressor used in an existing activity in this SEIS/OEIS. As discussed in this SEIS/OEIS, Section 3.0.4.3.2.2 (High-Energy Lasers), high-energy lasers are designed to disable surface targets, rendering them immobile. The primary concern is the potential for a marine bird to be struck with the laser beam at or near the water's surface, where extended exposure could result in injury or death due to traumatic burns from the beam.

Marine birds could be exposed to a laser only if they flew between the source and the target, or if the beam missed the target and a bird happened to be in the line of fire. Should the laser strike the sea surface, individual sea birds at or near the surface could be exposed. Because laser platforms are typically helicopters and ships, marine birds at sea would likely transit away or submerge in response to other stressors, such as ship or aircraft noise, although some marine birds may not exhibit a response to an oncoming vessel or aircraft, increasing the risk of contact with the laser beam. High-energy laser activities would only occur in open ocean locations (not close to land areas).

3.6.2.3.1 Impacts from High-Energy Lasers Under Alternative 1

Under Alternative 1, the number of proposed activities involving the use of high-energy lasers is shown in Table 3.0-10. High-energy lasers is a new substressor that was not analyzed in the 2015 MITT Final EIS/OEIS. As discussed above, impacts on marine birds from energy stressors should not be expected to occur.

A direct strike of a marine bird at the water's surface or within the beam path is extremely unlikely, and potential impacts on ESA-listed marine bird species are negligible. Therefore, the conclusions for ESA-listed marine bird species and other marine bird species protected by the MBTA included in the 2015 MITT Final EIS/OEIS remain valid.

During Section 7 ESA consultation between the Navy and USFWS, the Navy determined that the activities described in the 2015 MITT Final EIS/OEIS would have no effect on the ESA-listed Hawaiian petrel, short-tailed albatross, or Newell's shearwaters.

Pursuant to the ESA, the use of high-energy lasers during training and testing activities, as described under Alternative 1, would have no effect on ESA-listed Hawaiian petrels, short-tailed albatrosses, Newell's Townsend's shearwaters.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), the impacts from energy stressors during training and testing activities using high-energy lasers described under Alternative 1 would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.3.2 Impacts from High-Energy Lasers Under Alternative 2

Under Alternative 2, the use of high-energy lasers would increase as compared to Alternative 1 (Table 3.0-10), but there would be no change regarding the impact conclusions for energy stressors as summarized above under Alternative 1 and as presented in the 2015 MITT Final EIS/OEIS. Therefore, impacts on marine birds under Alternative 2 from energy stressors, including high-energy lasers, should not be expected to occur.

Pursuant to the ESA, the use of high energy lasers during training and testing activities, as described under Alternative 2, would have no effect on ESA-listed Hawaiian petrels, short-tailed albatrosses, Newell's shearwaters.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), the impacts from energy stressors during training and testing activities using high-energy lasers described under Alternative 2 would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.3.3 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 Navy activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts on marine birds from energy stressors, but would not measurably improve the overall distribution or abundance of marine birds.

3.6.2.4 Physical Disturbance and Strike Stressors

The physical disturbance and strike stressors that may impact marine birds include (1) aircraft and aerial targets, (2) vessels and in-water devices, (3) military expended materials, and (4) wildfires on FDM. For activities occurring at sea, the use of aircraft and aerial targets, vessels and in-water devices, and military expended materials would decrease under this SEIS/OEIS (Tables 3.0-11 through 3.0-17, and Table 3.0-19), with the exception of increased small caliber munitions use. Small-caliber munitions are inert, are meant to be aimed at targets, and are not long-range weapons. As a result, marine birds are extremely unlikely to be struck by expended small caliber munitions. Military expended materials would increase for training activities occurring on FDM. For the purposes of this SEIS/OEIS, only activities that occur on or over FDM and activities that would occur in the open ocean environment that have changed since the publication of the 2015 MITT Final EIS/OEIS are discussed in this section.

Physical disturbances may elicit short-term behavioral or physiological responses such as alert response, startle response, cessation of feeding, fleeing the immediate area, and a temporary increase in heart rate. These disturbances can also result in abnormal behavioral, growth, or reproductive impacts in nesting birds and can cause foraging and nesting birds to flush from or abandon their habitats or nests. Aircraft strikes often result in bird mortalities or injuries.

Physical disturbance on land may induce erosion, either from loosening of rock and soil from direct impacts (which facilitates transport of material by wind and rain) or from wildfires ignited by explosions (see Section 3.6.2.4.3, Physical Disturbance and Strike Stressors [Impacts from Wildfires]). Military use of FDM may contribute to ongoing soil disturbance and erosion from natural causes. FDM is comprised of highly weathered limestone overlain by a thin layer of clay soil (U.S. Department of the Navy, 2013b). Ordnance use, particularly within Impact Areas 2 and 3 (where explosive munitions use is permitted), would dislodge sediments that may potentially wash into nearshore waters of FDM. In addition to natural wind and water erosion (including high-energy typhoon events), erosion caused by ordnance use would contribute to increased turbidity and siltation of habitats used by marine bird prey species.

Section 3.6.3.3.1 (Impacts from Aircraft and Aerial Targets) in the 2015 MITT Final EIS/OEIS discusses the potential impacts on birds from collisions with fixed-wing aircraft, helicopters, and aerial targets. Aircraft and aerial target strikes could occur during training and testing activities that use aircraft, particularly in nearshore areas, where birds are more concentrated in the Study Area. Training and testing activities where aircraft are used typically occur further offshore; however, increased use of FDM may increase the potential for aircraft strike of birds. Therefore, for the purposes of this SEIS/OEIS, only the use of aircraft related to FDM training activities are discussed below under the alternatives analysis for birds for this stressor category.

3.6.2.4.1 Impacts from Physical Disturbance and Strike Stressors Under Alternative 1

Under Alternative 1, physical disturbance and strike stressors associated with training and testing activities would decrease in comparison to the 2015 MITT Final EIS/OEIS (Tables 3.0-12 through 3.0-18), assuming the dismissal of small-caliber munitions use for the reasons noted above. Under Alternative 1, there would be increases in the numbers of large-caliber non-explosive practice munitions (Table 3.0-14) and the number of targets expended at sea (Table 3.0-17), but overall there would be a decrease in the number of combined physical disturbance and strike stressors on marine birds. Consistent with the conclusions provided in the 2015 MITT EIS/OEIS, impacts on marine birds from physical disturbance and strike stressors are not expected to occur.

On FDM, marine birds that nest and roost on the island would be exposed to military expended materials resulting from explosive munitions and non-explosive practice munitions. Explosive munitions increase the potential for a marine bird (or nest) to be struck because of fragments dispersed throughout the blast zone.

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

Taken together, the increase in the number of training 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 (0.22 to 0.39 percent, depending on the NEW range of various munition types), the potential exposure to physical disturbance and strike stressors associated with ordnance use would increase under Alternative 1 compared to what was analyzed previously in the MITT Final EIS/OEIS. Factors that limit the potential for additional adverse impacts from 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 ESA-listed marine bird species and other marine bird species protected by the MBTA included in the 2015 MITT Final EIS/OEIS remain valid.

During Section 7 ESA consultation between the Navy and USFWS, the Navy determined that the activities described in the 2015 MITT Final EIS/OEIS would have no effect on the ESA-listed Hawaiian petrel, short-tailed albatross, or Newell's shearwater.

Pursuant to the ESA, training and testing activities that use aircraft and aerial targets, as described under Alternative 1, would have no effect on ESA-listed Hawaiian petrels, short-tailed albatrosses, Newell's shearwaters.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), the impacts from physical disturbance and strike stressors during training and testing activities described under Alternative 1 would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.4.2 Impacts from Physical Disturbance and Strike Stressors Under Alternative 2

Under Alternative 2, physical disturbance and strike stressors associated with training and testing activities would decrease in comparison to the 2015 MITT Final EIS/OEIS (Tables 3.0-12 through 3.0-18) assuming the dismissal of small-caliber munitions use for the reasons noted above. Under Alternative 2, there would be increases in the numbers of large-caliber non-explosive practice munitions (Table 3.0-14) and the number of targets expended at sea (Table 3.0-17), but overall there would be a decrease in the number of combined physical disturbance and strike stressors on marine birds. Consistent with the conclusions provided in the 2015 MITT EIS/OEIS, impacts on marine birds from physical disturbance and strike stressors are not expected to occur.

On FDM under Alternative 2, there would be an increase in the number of training 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 MITT Final EIS/OEIS and under Alternative 1.

Taken together, the increase in the number of training 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 (0.35 to 0.6 percent, depending on the NEW range of various munition types), the potential exposure to stressors associated with ordnance use would increase under Alternative 2 compared to what was analyzed previously in the 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, 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 ESA-listed marine bird species and other marine bird species protected by the MBTA included in the 2015 MITT Final EIS/OEIS remain valid.

Pursuant to the ESA, training and testing activities that use aircraft and aerial targets, as described under Alternative 2, would have no effect on ESA-listed Hawaiian petrels, short-tailed albatrosses, Newell's shearwaters.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), the impacts from physical disturbance and strike stressors during training and testing activities described under Alternative 2 would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.4.3 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 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 marine birds, but would not measurably improve the overall distribution or abundance of marine birds.

3.6.2.5 Ingestion Stressors

As discussed in Section 3.6.3.4 (Ingestion Stressors) of the 2015 MITT Final EIS/OEIS, a variety of ingestible materials may be released into the marine environment by training and testing activities. Types of materials that could become ingestion stressors (military expended materials – munitions and military expended materials other than munitions) for marine birds during training and testing activities in the Study Area include non-explosive practice munitions (small and medium caliber), fragments from high-explosive munitions, fragments from targets, chaff, plastic end caps from chaff cartridges, the plastic compression pads, end caps from pistons and flares, and small decelerators/parachutes. Ingestion stressors would decrease with the exception of increased small-caliber munitions use (Table 3.0-14, Table 3.0-15, Tables 3.0-22 through 3.0-24). However, small-caliber munitions are inert, small in size, do not resemble prey items, and end up as part of the seafloor where they are unlikely to be encountered by marine birds. The number of munitions and explosive munitions fragments that an individual marine bird could encounter would generally be low, based on the patchy distribution of both the munitions and open water feeding habitats of marine birds. In addition, it is assumed an animal would not ingest every munition or munition fragment it encountered, and if a munition or munition fragment were ingested, an animal may attempt to reject it when it realizes the item is not food.

3.6.2.5.1 Impacts from Ingestion Stressors Under the Alternative 1

Under Alternative 1, ingestion stressors would decrease, with the exception of increased small-caliber munitions use (Table 3.0-14, Table 3.0-15, Tables 3.0-22 through 3.0-24). For the reasons noted above, the Navy has determined that potential impacts from ingestion stressors would not be substantially different from the 2015 MITT Final EIS/OEIS. Military expended materials would be only a minute portion of the floating debris that marine birds could encounter and accidently ingest. While military expended materials may be a contributing factor to the harmful effects of manmade debris on some marine birds, an individual military expended material would not negatively impact a marine bird. The overall likelihood that individual birds would be negatively impacted by ingestion of military expended materials in the Study Area under Alternative 1 is considered low, but not discountable. Population-level effects would be very unlikely given the relatively small quantities and limited persistence of military expended materials in habitats where birds are most likely to forage. Because of the extreme low likelihood of geographic or temporal overlap with training and testing activities with ESA-listed marine birds, potential ingestion of expended materials by ESA-listed marine birds is considered negligible. Therefore, the analysis from the 2015 MITT Final EIS/OEIS remains valid.

Pursuant to the ESA, potential ingestion stressors introduced by training and testing activities under Alternative 1would have no effect on ESA-listed Hawaiian petrels, short-tailed albatrosses, Newell's shearwaters.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), potential ingestion stressors introduced by training and testing activities under Alternative 1 would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.5.2 Impacts from Ingestion Stressors Under Alternative 2

Under Alternative 2, ingestion stressors (military expended materials – munitions and military expended materials other than munitions) would decrease under this SEIS/OEIS in comparison to the ongoing activities, with the exception of increased small-caliber munitions use (Table 3.0-14, Table 3.0-15, Tables 3.0-22 through 3.0-24). Under Alternative 2, increases as compared to Alternative 1 do not change the impact conclusions for ingestion stressors as summarized above under Alternative 1 and as presented in the 2015 MITT Final EIS/OEIS. Therefore, impacts on marine birds from ingestion of military expended materials under Alternative 2 would be negligible.

Pursuant to the ESA, potential ingestion stressors introduced by training and testing activities under Alternative 2 would have no effect on ESA-listed Hawaiian petrels, short-tailed albatrosses, Newell's shearwaters.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), potential ingestion stressors introduced by training and testing activities under Alternative 2 would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.5.3 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 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 Navy activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for ingestion impacts on marine birds, but would not measurably improve the overall distribution or abundance of marine birds.

3.6.2.6 Secondary Stressors (Impacts on Habitat; Impacts on Prey Availability)

The potential for secondary stressors, defined as potential impacts on habitat and prey availability, to impact marine bird species was analyzed in Section 3.6.3.5 (Secondary Stressors) of the 2015 MITT Final EIS/OEIS. Training and testing activities analyzed in this SEIS/OEIS would not introduce additional secondary stressors or change the impacts of secondary stressors on marine bird species from what was analyzed previously in the 2015 MITT Final EIS/OEIS.

Pursuant to the ESA, secondary stressors associated with training or testing activities proposed in this SEIS/OEIS would have no effect on the ESA-listed Hawaiian petrel, Newell's shearwater, or short-tailed albatross.

Under the MBTA regulations applicable to military readiness activities (50 CFR Part 21), secondary stressors associated with training or testing activities would not result in a significant adverse effect on populations of the great frigatebird, masked booby, or other marine bird populations.

3.6.2.7 Endangered Species Act Determinations

Since the publication of the 2015 MITT Final EIS/OEIS, there have been no updates to the regulatory status, life history information, or species-specific threats that would alter the analysis from the 2015 MITT Final EIS/OEIS for the short-tailed albatross, Hawaiian petrel, or Newell's shearwater. As such, the description regarding these marine bird species presented in the 2015 MITT Final EIS/OEIS remains valid. Because of the limited period of time that ESA-listed marine bird species would be within the Study Area and the extreme unlikelihood that these birds would be subject to stressors generated by training and testing activities within the Study Area, the Navy and the USFWS have not included these species in past at-sea training and testing consultations within the Study Area (U.S. Fish and Wildlife Service, 2010, 2015). Similar to these past consultations, the activities proposed in Chapter 2 (Description of Proposed Action and Alternatives) of this SEIS/OEIS would have no effect on ESA-listed marine birds.

3.6.2.8 Migratory Bird Treaty Act

The Navy has conducted an analysis of the potential impacts of increasing the number of events, munitions, and NEW expended on FDM. Taken together with the statistical analysis of bird trends on FDM described above in Section 3.6.2 (Environmental Consequences) and determinations that no significant population impacts would occur, the small increases in events, munitions numbers, and expended NEW on FDM proposed in this SEIS/OEIS would not significantly impact bird populations, as defined in the MBTA regulations applicable to military readiness activities (50 CFR Part 21). While this determination is applicable to all marine birds that occur in the Study Area, the Navy carried out a focused analysis for marine birds known to breed on FDM (see the discussion for population-level analysis in Section 3.6.2, Environmental Consequences). Pursuant with the Department of Defense's obligations under 50 CFR Part 21, the Department of Defense will continue to implement training restrictions on FDM (see Section 5.5, Terrestrial Mitigation Measures to be Implemented) and monitoring of bird populations on FDM.

3.6.3 Public Scoping Comments

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

- **Public comments regarding potential impacts of marine bird species on FDM –** This SEIS/OEIS includes an analysis of potential impacts from the additional training activities proposed to occur at FDM. For acoustic stressors, Section 3.6.2.1.3 (Impacts from Aircraft Noise) and Section 3.6.2.1.4 (Impacts from Weapon Noise) include an analysis of how these stressor types may impact marine bird rookeries on FDM. For explosives stressors, Section 3.6.2.2 (Explosives Stressors) includes an analysis of how the proposed increase in munitions for missile exercises and direct action training activities could impact marine birds on the island. Stressor categories within physical disturbance and strike stressors, such as potential strike impacts from aircraft and impacts from wildfires, also include an FDM-focused analysis. While assessing these potential impacts of activities proposed in this SEIS/OEIS, it is important to note that all of the activities would continue under the same targeting constraints as described in the 2015 MITT Final EIS/OEIS. Mitigation measures designed in cooperation with U.S. Fish and Wildlife Service personnel provide a level of protection for the northern end of the island (where booby colonies have persisted), while ordnance use is only allowed in designated impact zones (see Section 5.5, Terrestrial Mitigation Measures to be Implemented).

- **Public comments regarding the status of nesting birds on FDM –** This SEIS/OEIS has been updated to include recent published work that provides a statistical review of repeated marine bird surveys on FDM. Camp et al. (2016) analyzed marine bird survey data collected from aerial surveys from 1997 to 2014. As discussed in Section 3.6.1.7 (Rookery Locations and Breeding Activities within the Mariana Islands), there is some evidence that masked and red-footed booby populations on FDM have declined, while brown booby populations have increased, though none of these trends were statistically significant. The general conclusion is that all three species exhibited population fluctuations over time. These fluctuations, combined with the level of variability observed in the count data, precluded any definitive conclusions about long-term population trends (i.e., the data were non-significant) (Camp et al., 2016). This SEIS/OEIS also includes historical observations and more recent surveys, such as Lusk et al. (2000), to provide context for the trend data and statistical analyses of FDM marine bird populations. Aerial surveys are conducted more frequently over FDM than on-the-ground surveys, with the primary focus to monitor marine bird rookeries (namely, brown boobies, masked boobies, and red-footed boobies). These surveys are described in more detail, along with quantitative trend analysis of populations in Section 3.6.2.6.3 (Farallon de Medinilla) of the 2015 MITT Final EIS/OEIS. All of these studies are summarized and included the Joint Region Marianas Integrated Natural Resources Management Plan (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, CNMI Department of Land and Natural Resources Division of Fish and Wildlife, and U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office).

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REFERENCES

Akesson, S., and A. Hedenstrom. (2007). How migrants get there: Migratory performance and orientation. *BioScience, 57*(2), 123–133.

Baerwald, E. F., G. H. D'Amours, B. J. Klug, and R. M. Barclay. (2008). Barotrauma is a significant cause of bat fatalities at wind turbines. *Current Biology, 18*(16), R695–R696.

Barnas, A., R. Newman, C. J. Felege, M. P. Corcoran, S. D. Hervey, T. J. Stechmann, R. F. Rockwell, and S. N. Ellis-Felege. (2018). Evaluating behavioral responses of nesting lesser snow geese to unmanned aircraft surveys. *Ecology and Evolution, 8*, 1328–1338.

Beason, R. (2004). *What Can Birds Hear?* Lincoln, NE: University of Nebraska.

Beuter, K. J., R. Weiss, and B. Frankfurt. (1986). *Properties of the auditory system in birds and the effectiveness of acoustic scaring signals.* Paper presented at the Bird Strike Committee Europe, 18th Meeting Part I, 26–30 May 1986. Copenhagen, Denmark.

Black, A. (2005). Short note: Light induced seabird mortality on vessels operating in the Southern Ocean: Incidents and mitigation measures. *Antarctic Science, 17*(1), 67–68.

Bowles, A. E. (1995). Chapter 8: Responses of Wildlife to Noise. In R. L. Knight & K. J. Gutzwiller (Eds.), *Wildlife and Recreationists: Coexistence Through Management and Research*. Washington, DC: Island Press.

Camp, R., C. Leopold, K. Brinck, and F. Juola. (2016). *Farallon de Medinilla seabird and Tinian moorhen analyses*. Hilo, HI: Hawaii Cooperative Studies Unit, University of Hawaii at Hilo.

Cook, T. R., M. Hamann, L. Pichegru, F. Bonadonna, D. Grémillet, and P. G. Ryan. (2011). GPS and time-depth loggers reveal underwater foraging plasticity in a flying diver, the Cape Cormorant. *Marine Biology, 159*(2), 373–387.

Crowell, S. C. (2016). Measuring in-air and underwater hearing in seabirds. *Advances in Experimental Medicine and Biology, 875*, 1155–1160.

Crowell, S. E., A. M. Wells-Berlin, C. E. Carr, G. H. Olsen, R. E. Therrien, S. E. Ynnuzzi, and D. R. Ketten. (2015). A comparison of auditory brainstem responses across diving bird species. *Journal of Comparative Physiology A, 201*(8), 803–815.

Crowell, S. E., A. M. Wells-Berlin, R. E. Therrien, S. E. Yannuzzi, and C. E. Carr. (2016). In-air hearing of a diving duck: A comparison of psychoacoustic and auditory brainstem response thresholds. *The Journal of the Acoustical Society of America, 139*(5), 3001.

Dooling, R. (2002). *Avian Hearing and the Avoidance of Wind Turbines*. College Park, MD: University of Maryland.

Dooling, R. J., and A. N. Popper. (2000). Hearing in birds and reptiles. In R. J. Dooling, R. R. Fay, & A. N. Popper (Eds.), *Comparative Hearing in Birds and Reptiles* (Vol. 13, pp. 308–359). New York, NY: Springer-Verlag.

Dooling, R. J., and S. C. Therrien. (2012). Hearing in birds: What changes from air to water. *Advances in Experimental Medicine and Biology, 730*, 77–82.

Duffy, D. C. (2011). No room in the ark? Climate change and biodiversity in the Pacific Islands of Oceania. *Pacific Conservation Biology, 17*, 192–200.

Frost, M. T., S. Dye, B. Stoker, P. Buckley, and J. Baxter. (2017). *Marine Climate Change Impacts: 10 Years' Experience of Science to Policy Reporting. Summary Report*. London, United Kingdom: Marine Climate Change Impacts Partnership.

Haftorn, S., F. Mehlum, and C. Bech. (1988). Navigation to nest site in the snow petrel (*Pagodroma nivea*). *The Condor, 90*(2), 484–486.

Hansen, K. A., A. Maxwell, U. Siebert, O. N. Larsen, and M. Wahlberg. (2017). Great cormorants (*Phalacrocorax carbo*) can detect auditory cues while diving. *The Science of Nature, 104*(5–6), 45.

Hetherington, T. (2008). Comparative anatomy and function of hearing in aquatic amphibians, reptiles, and birds. In J. G. M. Thewissen & S. Nummela (Eds.), *Sensory Evolution on the Threshold* (pp. 182–209). Berkeley, CA: University of California Press.

Jiménez, S., A. Domingo, M. Abreu, and A. Brazeiro. (2012). Bycatch susceptibility in pelagic longline fisheries: Are albatrosses affected by the diving behaviour of medium-sized petrels? *Aquatic Conservation: Marine and Freshwater Ecosystems, 22*(4), 436–445.

Johansen, S., O. N. Larsen, J. Christensen-Dalsgaard, L. Seidelin, T. Huulvej, K. Jensen, S. G. Lunneryd, M. Bostrom, and M. Wahlberg. (2016). In-air and underwater hearing in the great cormorant (*Phalacrocorax carbo sinensis*). *Advances in Experimental Medicine Biology, 875*, 505–512.

Jongbloed, R. H. (2016). *Flight height of seabirds. A literature study*. Ijmuiden, Netherlands: Institute for Marine Resources & Ecosystem Studies.

Kushlan, J. A. (1978). Non-rigorous foraging by robbing egrets. *Ecology, 59*, 649–653.

Larkin, R. P., L. L. Pater, and D. J. Tazlk. (1996). *Effects of Military Noise on Wildlife: A Literature Review* (USACERL Technical Report 96/21). Champaign, IL: Department of the Army, Construction Engineering Research Lab.

Lincoln, F. C., S. R. Perterson, and J. L. Zimmerman. (1998). *Migration of Birds* (Migration of Birds Circular 16). Manhattan, KS: U.S. Department of the Interior, U.S. Fish & Wildlife Service.

Lorrain, A., F. Houlbrèque, F. Benzoni, L. Barjon, L. Tremblay-Boyer, C. Menkes, D. P. Gillikin, C. Payri, H. Jourdan, and G. Boussarie. (2017). Seabirds supply nitrogen to reef-building corals on remote Pacific islets. *Scientific Reports, 7*(1), 3721.

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.

Manville, A. (2016). *A Briefing Memorandum: What We Know, Can Infer, and Don't Yet Know about Impacts from Thermal and Non-thermal Non-ionizing Radiation to Birds and Other Wildlife—for Public Release*. Washington, DC: U.S. Fish and Wildlife Service.

Maxwell, A., K. A. Hansen, S. T. Ortiz, O. N. Larsen, U. Siebert, and M. Wahlberg. (2017). In-air hearing of the great cormorant (*Phalacrocorax carbo*). *Biology Open, 6*(4), 496–502.

National Park Service. (1994). *Report on Effects of Aircraft Overflights on the National Park System* (Report to Congress prepared pursuant to Public Law 100-191, the National Parks Overflights Act of 1987). Washington, DC: National Park Service.

Ostrom, P. H., A. E. Wiley, H. F. James, S. Rossman, W. A. Walker, E. F. Zipkin, and Y. Chikaraishi. (2017). Broad-scale trophic shift in the pelagic North Pacific revealed by an oceanic seabird. *Proceedings of the Royal Society B, 284*(1851), 20162436.

Pater, L. L., and J. W. Shea. (1981). *Techniques for Reducing Gun Blast Noise Levels: An Experimental Study*. Dahlgren, VA: Naval Surface Weapons System.

Plumpton, D. (2006). *Review of Studies Related to Aircraft Noise Disturbance of Waterfowl: A Technical Report in Support of the Supplemental Environmental Impact Statement for Introduction of F/A-18 E/F (Super Hornet) Aircraft to the East Coast of the United States*. Norfolk, VA: U.S. Department of the Navy.

Poessel, S. A., A. E. Duerr, J. C. Hall, M. A. Braham, and T. E. Katzner. (2018). Improving estimation of flight altitude in wildlife telemetry studies. *Journal of Applied Ecology, 55*(4), 2064–2070.

Ponganis, P. (2015). *Diving Physiology of Marine Mammals and Seabirds*. Cambridge, United Kingdom: Cambridge University Press.

Ramírez, F., I. Afán, L. S. Davis, and A. Chiaradia. (2017). Climate impacts on global hot spots of marine biodiversity. *Science Advances, 3*(2), e1601198.

Rijke, A. M. (1970). Wettability and phylogenetic development of feather structure in water birds. *The Journal of Experimental Biology, 52*(2), 469–479.

Sade, J., Y. Handrich, J. Bernheim, and D. Cohen. (2008). Pressure equilibration in the penguin middle ear. *Acta Oto-Laryngologica, 128*(1), 18–21.

Sanzenbacher, P. M., B. A. Cooper, J. H. Plissner, and J. Bond. (2014). Intra-annual patterns in passage rates and flight altitudes of Marbled Murrelets *Brachyramphus marmoratus* at inland sites in Northern California. *Marine Ornithology, 42*, 169–174.

Saunders, J. C., and R. Dooling. (1974). Noise-induced threshold shift in the parakeet (*Melopsittacus undulatus*). *Proceedings of the National Academy of Sciences, 71*(5), 1962–1965.

Sibley, D. (2014). *The Sibley Guide to Birds* (Second ed.). New York, NY: Alfred A. Knopf.

Spiegel, C., A. Berlin, A. Gilbert, C. E. Gray, W. Montevecchi, I. Stenhouse, S. Ford, G. H. Olsen, J. Fiely, and L. Savoy. (2017). *Determining Fine-scale Use and Movement Patterns of Diving Bird Species in Federal Waters of the Mid-Atlantic United States Using Satellite Telemetry*. Sterling, VA: US Department of the Interior, Bureau of Ocean Energy Management.

Stumpf, J. P., N. Denis, T. E. Hamer, G. Johnson, and J. Verschuyl. (2011). Flight height distribution and collision risk of the marbled murrelet *Brachyramphus marmoratus*: Methodology and preliminary results. *Marine Ornithology, 39*, 123–128.

Tarroux, A., H. Weimerskirch, S.-H. Wang, D. H. Bromwich, Y. Cherel, A. Kato, Y. Ropert-Coudert, Ø. Varpe, N. G. Yoccoz, and S. Descamps. (2016). Flexible flight response to challenging wind conditions in a commuting Antarctic seabird: Do you catch the drift? *Animal Behaviour, 113*, 99–112.

Therrien, S. C. (2014). *In-air and underwater hearing of diving birds.* (Unpublished doctoral dissertation). University of Maryland, College Park, MD. Retrieved from http://hdl.handle.net/1903/2.

Thiessen, G. J. (1958). Threshold of hearing of a ring-billed gull. *The Journal of the Acoustical Society of America, 30*(11), 1047.

Trainer, V. L. (2017). *Conditions Promoting Extreme Pseudo-nitzschia Events in the Eastern Pacific but not the Western Pacific* (PICES Scientific Report No. 53, 2017). Sidney, Canada: North Pacific Marine Science Organization Science Board, Marine Environmental Quality Committee.

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. (2011). *Marianas Training Manual*. Naval Base Guam, Guam: Commander Joint Region Marianas.

U.S. Department of the Navy. (2013a). *Annual Report: Wildlife Surveys on Tinian and FDM*. Naval Base Guam, Guam: Joint Region Marianas.

U.S. Department of the Navy. (2013b). *2013 Joint Region Marianas Integrated Natural Resources Management Plan* (Final). Naval Base Guam, Guam: 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. (2018). *Joint Region Mariana Islands Integrated Natural Resources Management Plan*. Saipan, Mariana Islands: Joint Region Mariana Islands.

U.S. Fish and Wildlife Service. (2010). *Biological Opinion for the Mariana Islands Range Complex, Guam and the Commonwealth of the Northern Mariana Islands 2010–2015*. Honolulu, HI: U.S. Fish & 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.

Wever, E. G., P. N. Herman, J. A. Simmons, and D. R. Hertzler. (1969). Hearing in the blackfooted penguin (*Spheniscus demersus*), as represented by the cochlear potentials. *Proceedings of the National Academy of Sciences, 63*, 676–680.

Wiltschko, R., S. Denzau, D. Gehring, P. Thalau, and W. Wiltschko. (2011). Magnetic orientation of migratory robins, *Erithacus rubecula*, under long-wavelength light. *The Journal of Experimental Biology, 214*(18), 3096–3101.

Wiltschko, W., and R. Wiltschko. (2005). Magnetic orientation and magnetoreception in birds and other animals. *Journal of Comparative Physiology A 191*(8), 675–693.