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3.5 Sea Turtles

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3.5 SEA TURTLES

SEA TURTLE SYNOPSIS

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

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

Preferred Alternative

- Acoustic: Pursuant to the Endangered Species Act (ESA), the use of sonar and other active acoustic sources, and underwater explosives may affect and is likely to adversely affect ESA-listed green, hawksbill, olive ridley, leatherback, and loggerhead sea turtles. Pile driving and swimmer defense airguns may affect but are not likely to adversely affect the green sea turtle, and would have no effect on hawksbill, olive ridley, leatherback, or loggerhead sea turtles. Weapons firing, launch and impact noise, and vessel and aircraft noise may affect but are not likely to adversely affect ESA-listed sea turtles.
- Energy: Pursuant to the ESA, the use of electromagnetic devices may affect but is not likely to adversely affect ESA-listed green, hawksbill, olive ridley, leatherback, and loggerhead turtles.
- Physical Disturbance or Strike: Pursuant to the ESA, use of vessels may affect and is likely to adversely affect ESA-listed green, hawksbill, olive ridley, leatherback, and loggerhead sea turtles. The use of in-water devices, military expended materials, and seafloor devices may affect, but is not likely to adversely affect ESA-listed sea turtles.
- Entanglement: Pursuant to the ESA, fiber optic cables, guidance wires, and parachutes may affect but are not likely to adversely affect ESA-listed green, hawksbill, olive ridley, leatherback, and loggerhead sea turtles.
- Ingestion: Pursuant to the ESA, the potential for ingestion of military expended materials may affect but is not likely to adversely affect ESA-listed green, hawksbill, olive ridley, leatherback, and loggerhead sea turtles.
- Secondary: Pursuant to the ESA, secondary stressors may affect but are not likely to adversely affect sea turtles because changes in sediment, water, and air quality from explosives, explosive byproducts and unexploded ordnance, metals and chemicals are not likely to be detectable, and no detectable changes in growth, survival, propagation, or population-levels of sea turtles are anticipated.

3.5.1 INTRODUCTION

Section 3.5 analyzes potential impacts on sea turtles found in the Hawaii-Southern California Training and Testing (HSTT) Study Area (Study Area). Section 3.5.1 introduces sea turtle species and taxonomic groups. Section 3.5.2 describes the affected environment. The analysis and summary of potential impacts of the Proposed Action are provided in Section 3.5.4.

The status of sea turtle populations is determined primarily from assessments of the adult female nesting population. Much less is known about other life stages of these species (Mrosovsky et al. 2009, Schofield et al. 2010, Witt et al. 2010). The National Research Council (2010) recently reviewed the current state of sea turtle research, and concluded that relying too much on nesting beach data limits a more complete understanding of sea turtles and the evaluation of management options for their overall health and recovery.

In 2012, NMFS designated critical habitat for the leatherback sea turtle in California (from Point Arena to Point Vincente) and from Cape Flattery, Washington, to Winchester Bay, Oregon, out to the 2,000 mile (mi.) (3,218.7 kilometer [km]) depth contour (National Marine Fisheries Service 2012). This designated critical habitat is north of the Southern California (SOCAL) Range Complex boundary; therefore, the U.S. Department of the Navy (Navy) has determined that training and testing activities would not affect critical habitat for the leatherback sea turtle. None of the primary constituent elements of the designated critical habitat would be impacted.

The five sea turtles found in the Study Area are listed under the Endangered Species Act (ESA) as endangered or threatened. Section 3.0 discusses the regulatory framework of the ESA. The status, presence, and nesting occurrence of sea turtles in the Study Area are listed by region in Table 3.5-1.

Table 3.5-1: Status and Presence of Endangered Species Act-Listed Sea Turtles in the Hawaii-Southern California Training and Testing Study Area

Species Name and Regulatory Status			Presence in Study Area		
Common Name	**Scientific Name**	**Endangered Species Act Status**	**Open Ocean/ Transit Corridor**	**California Current/ Southern California**	**Insular Pacific-Hawaiian**
Family Cheloniidae (hard-shelled sea turtles)					
Green sea turtle	*Chelonia mydas*	Threatened, Endangered[1]	Yes	Yes	Yes*
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered[2]	Yes	Yes	Yes*
Loggerhead sea turtle	*Caretta caretta*	Endangered[3]	Yes	Yes	Yes
Olive ridley sea turtle	*Lepidochelys olivacea*	Threatened, Endangered[4]	Yes	Yes	Yes**

Table 3.5-1: Status and Presence of Endangered Species-Act Listed Sea Turtles in the Hawaii-Southern California Training and Testing Study Area (continued)

Species Name and Regulatory Status			Presence in Study Area		
Common Name	**Scientific Name**	**Endangered Species Act Status**	**Open Ocean/ Transit Corridor**	**California Current/ Southern California**	**Insular Pacific-Hawaiian**
Family Dermochelyidae (leatherback sea turtle)					
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Yes	Yes	Yes

Notes:

[1] As a species, the green sea turtle is listed as Threatened. However, the Florida and Mexican Pacific Coast nesting populations are listed as Endangered. Green sea turtles found in the Study Area may include individuals from the Mexican Pacific Coast population.

[2] Research suggests that green and hawksbill sea turtles may be present in all life stages (Musick and Limpus 1997; National Marine Fisheries Service [NMFS] and U.S. Fish and Wildlife Service 2007b).

[3] The only distinct population segment of loggerheads that occurs in the Study Area—the North Pacific Ocean distinct population segment—is listed as Endangered.

[4] NMFS and U.S. Fish and Wildlife Service only consider the breeding populations of Mexico's Pacific coast as Endangered. Other populations are listed as Threatened (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f).

* Indicates nesting activity within the Study Area portion. Only green sea turtles and hawksbill sea turtles are known to nest regularly in the Study Area.

** There have been four documented olive ridley sea turtle nesting events in the main Hawaiian Islands: one on Oahu in 2009 at Marine Corps Base Hawaii, Kaneohe; one at Paia, Maui, in 1985; and two on Hawaii Island in 2002 and 2011.

3.5.2 AFFECTED ENVIRONMENT

Sea turtles are highly migratory, and are present in coastal and open ocean waters of the Study Area. Most sea turtles prefer to live in warm waters because they are cold-blooded reptiles. Leatherbacks are the exception, and are more likely to be found in colder waters at higher latitudes because of their unique ability to maintain an internal body temperature higher than that of the environment (Dutton 2006). Habitat use varies among species and within the life stages of individual species, correlating primarily with the distribution of preferred food sources, as well as the locations of nesting beaches.

Habitat and distribution vary among species and life stages, and are discussed further in the species profiles. Little information is available about a sea turtle's stage of life after hatching. Open-ocean juveniles spend an estimated 2 to 14 years drifting, foraging, and developing. Because of the general lack of knowledge of this period, it has been described as "the lost years." After this period, juvenile hawksbill (*Eretmochelys imbricata*), olive ridley (*Lepidochelys olivacea*), loggerhead (*Caretta caretta*), and green (*Chelonia mydas*) turtles settle into coastal habitat, with individuals often remaining faithful to a specific home range until adulthood (Bjorndal and Bolten 1988; National Marine Fisheries Service and U.S. Fish and Wildlife 1991). Leatherback turtles remain primarily in the open ocean throughout their lives, except for mating in coastal waters and females going ashore to lay eggs. All species can migrate long distances across large expanses of the open ocean, primarily between nesting and feeding grounds (National Marine Fisheries Service and U.S. Fish and Wildlife 2007c).

All sea turtle species are believed to use a variety of orientation mechanisms on land and at sea (Lohmann et al. 1997). After emerging from the nest, hatchling turtles use visual cues, such as light wavelengths and shape patterns, to find the ocean (Lohmann et al. 1997). Once in the ocean, hatchlings use wave cues to navigate offshore (Lohmann and Lohmann 1992). In the open ocean, turtles in all life stages are thought to orient to the earth's magnetic field to position themselves in oceanic currents; this helps them locate seasonal feeding and breeding grounds and return to their nesting sites (Lohmann and Lohmann 1996a; Lohmann et al. 1997). The stimuli that help sea turtles find their nesting beaches

are still poorly understood, particularly the fine-scale navigation that occurs as turtles approach the site, and could also include chemical and acoustic cues.

3.5.2.1 Diving

Sea turtle dive depth and duration varies by species, the age of the animal, the location of the animal, and the activity (i.e., foraging, resting, migrating). The diving behavior of a particular species or individual has implications for mitigation and monitoring. In addition, their relative distribution through the water column is an important consideration when conducting acoustic exposure analyses. The following text briefly describes the dive behavior of each species.

Green sea turtle. In the open ocean, Hatase et al. (2006) observed that green sea turtles dive to a maximum of 260 feet (ft.) or 79 meters (m). Open-ocean resting dives rarely exceed 50 ft. (15 m), while most open-ocean foraging dives average about 80 ft. (24 m) (Hatase et al. 2006). A difference in duration between night and day dives was observed, with day dives lasting 1 to 18 minutes and night dives averaging 35 to 44 minutes (Rice and Balazs 2008). In their coastal habitat, green sea turtles typically make dives shallower than 100 ft. (31 m), with most dives not exceeding 58 ft. (18 m) (Hays et al. 2004; Rice and Balazs 2008). Green sea turtles are known to forage and also rest at depths of 65 to 165 ft. (20 to 50 m) (Balazs 1980; Brill et al. 1995).

Hawksbill turtle. Hawksbill turtles make short, active foraging dives during the day, and longer resting dives at night (Blumenthal et al. 2009; Storch et al. 2005; Van Dam and Diez 1996). Lutcavage and Lutz (1997) cited a maximum dive duration of 73.5 minutes for a female hawksbill in the U.S. Virgin Islands. Van Dam and Diez (1996) reported that foraging dives at a study site in the northern Caribbean ranged from 19 to 26 minutes at depths of 25 to 35 ft. (8 to 11 m), with resting night dives ranging from 35 to 47 minutes (Van Dam and Diez 1996). Foraging dives of immature hawksbills are shorter, ranging from 8.6 to 14 minutes in duration (Van Dam and Diez 1996), with a mean and maximum depth of 5 ft. (1.5 m) and 65 ft. (20 m), respectively (Blumenthal et al. 2009; Van Dam and Diez 1996).

Loggerhead turtle. Loggerhead turtles foraging in nearshore habitat dive to the seafloor (average depth 165 to 490 ft. [50 to 149 m]) and those in open-ocean habitat dive in the 0 to 80 ft. (0 to 24 m) depth range (Hatase et al. 2007). Dive duration was significantly longer at night, and increased in warmer waters. The average overall dive duration was 25 minutes, although dives exceeding 300 minutes were recorded. Turtles in open-ocean habitat exhibited mid-water resting dives at around 45 ft. (14 m), where they could remain for many hours. This (resting) appears to be the main function of many of the night dives recorded (Hatase et al. 2007). Another study on coastal foraging loggerheads by Sakamoto et al. (1993) found that virtually all dives were shallower than 100 ft. (31 m).

On average, loggerhead turtles spend over 90 percent of their time underwater (Byles 1988; Renaud and Carpenter 1994). Studies investigating dive characteristics of loggerheads under various conditions confirm that loggerheads do not dive particularly deep in the open-ocean environment (approximately 80 ft. [24 m]) but will forage to bottom depths of at least 490 ft. (149 m) in coastal habitats (Hatase et al. 2007; Polovina et al. 2002; Soma 1985).

Olive ridley sea turtle. Most studies on olive ridley diving behavior have been conducted in shallow coastal waters (Beavers and Cassano 1996, Sakamoto et al. 1993), however, Polovina et al. (2002) radio tracked two olive ridleys (and two loggerheads) caught in commercial fisheries. The results showed that the olive ridleys dove deeper than loggerheads, but spent only about 10 percent of time at depth under 100 ft. (31 m). Daily dives of 200 m (656 ft.) occurred, with one dive recorded at 254 m (833 ft.)

(Polovina et al. 2002). The deeper-dive distribution of olive ridleys is also consistent with their oceanic habitat, which differs from the loggerhead habitat. Olive ridleys are found south of the loggerhead habitat in the central portion of the subtropical gyre. The oceanography of this region is characterized by a warm surface layer, a deep thermocline depth, an absence of strong horizontal temperature gradients, and physical or biological fronts (Polovina et al. 2002).

Leatherback sea turtle. The leatherback is the deepest diving sea turtle, with a recorded maximum depth of 4,200 ft. (1,280 m), although most dives are much shallower (usually less than 820 ft. [250 m]) (Hays et al. 2004; Sale et al. 2006). Diving activity (including surface time) is influenced by a suite of environmental factors (e.g., water temperature, availability and vertical distribution of food resources, bathymetry) that result in spatial and temporal variations in dive behavior (James et al. 2006; Sale et al. 2006). Leatherbacks dive deeper and longer in the lower latitudes than in the higher latitudes (James et al. 2005a), where they are known to dive in waters with temperatures just above freezing (James et al. 2006; Jonsen et al. 2007). James et al. (2006) noted that dives in higher latitudes are punctuated by longer surface intervals, perhaps in part to thermoregulate (i.e., bask). Tagging data also revealed that changes in individual turtle diving activity appear to be related to water temperature, suggesting an influence of seasonal prey availability on diving behavior (Hays et al. 2004). In their warm-water nesting habitats, dives are likely constrained by bathymetry adjacent to nesting sites during this time (Myers and Hays 2006). For example, patterns of relatively deep diving are recorded off St. Croix in the Caribbean (Eckert et al. 1986) and Grenada (Myers and Hays 2006) in areas where deep waters are close to shore. A maximum depth of 1,560 ft. (476 m) was recorded (Eckert et al. 1986), although even deeper dives were inferred where dives exceeded the maximum range of the time depth recorder (Eckert et al. 1989). Shallow diving occurs where shallow water is close to the nesting beach in areas such as the China Sea (Eckert et al. 1996), Costa Rica (Southwood et al. 1999), and French Guiana (Fossette et al. 2007).

Information on the diving behavior of each species of sea turtle was compiled in a Technical Report (U.S. Department of the Navy 2011) that summarizes time-at-depth for the purpose of distributing animals within the water column in the acoustic exposure model.

3.5.2.2 Hearing and Vocalization

The auditory system of the sea turtle appears to work via water and bone conduction, with lower-frequency sound conducted through skull and shell, and does not appear to function well for hearing in air (Lenhardt et al. 1983, 1985). Sea turtles do not have external ears or ear canals to channel sound to the middle ear, nor do they have a specialized eardrum. Instead, fibrous and fatty tissue layers on the side of the head may be the sound-receiving membrane in the sea turtle, a function similar to that of the eardrum in mammals, or may serve to release energy received via bone conduction (Lenhardt et al. 1983). Sound is transmitted to the middle ear, where sound waves cause movement of cartilaginous and bony structures that interact with the inner ear (Ridgway 1969). Unlike mammals, the cochlea of the sea turtle is not elongated and coiled, and likely does not respond well to high frequencies, a hypothesis supported by a limited amount of information on sea turtle auditory sensitivity (Ridgway 1969, Bartol 1999).

Investigations suggest that sea turtle auditory sensitivity is limited to low-frequency bandwidths, such as the sound of waves breaking on a beach. The role of underwater low-frequency hearing in sea turtles is unclear. Sea turtles may use acoustic signals from their environment as guideposts during migration and as cues to identify their natal beaches (Lenhardt et al. 1983). Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 to 2,000 Hertz (Hz), with a range of maximum sensitivity between 100 and 800 Hz (Bartol 1999, Ridgway 1969, Lenhardt 1994, Bartol and Ketten 2006,

Lenhardt 2002). Hearing below 80 Hz is less sensitive but still potentially usable (Lenhardt 1994). Greatest sensitivities are from 300 to 400 Hz for the green sea turtle (Ridgway 1969) and around 250 Hz or below for juvenile loggerheads (Bartol 1999). Bartol et al. (1999) reported that the range of effective hearing for juvenile loggerhead sea turtles is from at least 250 to 750 Hz using the auditory brainstem response technique. Juvenile and sub-adult green sea turtles detect sounds from 100 to 500 Hz underwater, with maximum sensitivity at 200 and 400 Hz (Bartol and Ketten 2006). Auditory brainstem response recordings on green sea turtles showed a peak response at 300 Hz (Yudhana et al. 2010). Juvenile Kemp's ridley turtles detected underwater sounds from 100 to 500 Hz, with a maximum sensitivity between 100 and 200 Hz (Bartol and Ketten 2006). Audiometric information is not available for leatherback sea turtles; however, their anatomy suggests they would hear similarly to other sea turtles. Functional hearing is assumed for this analysis to be 10 Hz to 2 kilohertz (kHz).

Sub-adult green sea turtles show, on average, the lowest hearing threshold at 300 Hz (93 decibels [dB] referenced to[re] 1 micro Pascal [µPa]), with thresholds increasing at frequencies above and below 300 Hz, when thresholds were determined by auditory brainstem response (Bartol and Ketten 2006). Auditory brainstem response testing was also used to detect thresholds for juvenile green sea turtles (lowest threshold 93 dB re 1 µPa at 600 Hz) and juvenile Kemp's ridley sea turtles (thresholds above 110 dB re 1 µPa across hearing range) (Bartol and Ketten 2006). Auditory thresholds for yearling and two-year-old loggerhead sea turtles were also recorded. Both yearling and two-year-old loggerhead sea turtles had the lowest hearing threshold at 500 Hz (yearling: approximately 81 dB re 1 µPa and two-year-olds: approximately 86 dB re 1 µPa), with thresholds increasing rapidly above and below that frequency (Ketten and Bartol 2006). In terms of sound production, nesting leatherback turtles were recorded producing sounds (sighs or belch-like sounds) up to 1,200 Hz with most energy ranging from 300 to 500 Hz (Bartol and Ketten 2006).

3.5.2.3 General Threats

The sea turtle species in the Study Area have unique life histories and habitats; however, threats are common among all species. On beaches, wild domestic dogs, pigs, and other animals ravage sea turtle nests. Humans continue to harvest eggs and nesting females in some parts of the world, threatening some Pacific Ocean sea turtle populations (Maison et al. 2010). Coastal development can cause beach erosion and introduce non-native vegetation, leading to a subsequent loss of nesting habitat. It can also introduce or increase the intensity of artificial light, confusing hatchlings and leading them away from the water, thereby increasing the chances of hatchling mortality. Threats in nearshore foraging habitats include fishing and habitat degradation. Fishing can injure or drown juvenile and adult sea turtles. Habitat degradation, such as poor water quality, invasive species, and disease, can alter ecosystems, limiting the availability of food and altering survival rates. See Chapter 4 (Cumulative Impacts), for further descriptions of threats to sea turtles and ongoing conservation concerns.

Bycatch in commercial fisheries, ship strikes, and marine debris are primary threats in the offshore environment (Lutcavage 1997). One comprehensive study estimated that, worldwide, 447,000 sea turtles are killed each year from bycatch in commercial fisheries (Wallace 2010). Precise data are lacking for sea turtle mortalities directly caused by ship strikes. However, live and dead turtles are often found with deep cuts and fractures indicative of collision with a boat hull or propeller (Lutcavage 1997; Hazel 2007). Marine debris can also be a problem for sea turtles through entanglement or ingestion. Floating plastic garbage can be mistakenly ingested by sea turtles. Leatherback sea turtles in particular may mistake a floating plastic garbage as jellyfish, an important component of the leatherback diet (Mrosovsky et al. 2009). Other marine debris, including derelict fishing gear and cargo nets, can entangle and drown turtles of all life stages.

Global climate change trends are toward increasing ocean and air temperatures, increasing acidification of oceans, and sea level rise; these trends may adversely impact turtles in all life stages (Chaloupka, Kamezaki, et al. 2008; Mrosovsky et al. 2009; Schofield et al. 2010; Witt et al. 2010). Effects include embryo deaths caused by high nest temperatures, skewed sex ratios because of increased sand temperature, loss of nesting habitat to beach erosion, coastal habitat degradation (e.g., coral bleaching), and alteration of the marine food web, which can decrease the amount of prey species. Each sea turtle recovery plan has detailed descriptions of threats in the nesting and marine environment, ranking the seriousness of threats in each of the U.S. Pacific coast states and territories (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998a, b, c, d, e, f).

3.5.2.4 Green Sea Turtle (*Chelonia mydas*)

The green sea turtle is found in tropical and subtropical coastal and open ocean waters, between 30 degrees (°) North (N) and 30° South (S). Major nesting beaches are found throughout the western and eastern Atlantic, Indian, and western Pacific Oceans, and are found in more than 80 countries worldwide (Hirth 1997).

3.5.2.4.1 Status and Management

The green sea turtle was listed under the ESA in July 1978 because of excessive commercial harvest, a lack of effective protection, evidence of declining numbers, and habitat degradation and loss (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a). The green sea turtle breeding populations off Florida and the Pacific coast of Mexico are listed as endangered, and all other populations are listed as threatened. Genetic studies indicate that the eastern, western, and central Pacific Ocean populations of green sea turtles are distinct, and may require independent management (Dutton et al. 1998; Dutton et al. 2008); however, green sea turtles found in the Study Area may include individuals from the Mexican Pacific Coast population. Critical habitat has not been designated in the Pacific Ocean. Recovery plans have been prepared for Pacific Ocean green sea turtles (western and central Pacific populations) and eastern Pacific Ocean green sea turtle populations (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998a,b).

3.5.2.4.2 Habitat and Geographic Range

Green sea turtles nest on beaches within the Insular Pacific-Hawaiian Large Marine Ecosystem, while they feed and migrate throughout all waters of the Study Area. Green sea turtles likely to occur in the Study Area come from eastern Pacific Ocean and Hawaiian nesting populations. There are very few reports of turtles from southern Pacific Ocean populations occurring in the northern Pacific Ocean (Limpus et al. 2009).

Green sea turtle eggs incubate in the sand for approximately 48 to 70 days. Green sea turtle hatchlings are 2 inches (in.) (5 centimeters [cm]) long, and weigh approximately 1 ounce (oz.) (28 grams [g]). When they leave the nesting beach, hatchlings begin an oceanic phase (Carr 1987), floating passively in current systems (gyres), where they develop (Carr and Meylan 1980). Hatchlings live at the surface in the open ocean for approximately 1 to 3 years (Hirth 1997). Upon reaching the juvenile stage (estimated at 5 to 6 years and shell length of 8 to 10 in. [20 to 25 cm]), they move to lagoons and coastal areas that are rich in seagrass and algae (Bresette et al. 2006; Musick and Limpus 1997). The optimal habitats for late juveniles and adults are warm, quiet, shallow waters (depths of 10 to 33 ft.) (3 to 10 m), with seagrasses and algae, that are near reefs or rocky areas used for resting (Makowski et al. 2006). This habitat is where they will spend most of their lives (Bjorndal and Bolten 1988; Makowski et al. 2006; National Marine Fisheries Service and U.S. Fish and Wildlife Service 1991). A small number of green sea turtles

appear to remain in the open ocean for extended periods, perhaps never moving to coastal feeding sites (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a; Pelletier et al. 2003).

Green sea turtles are known to live in the open ocean during the first 5 to 6 years of life, but little is known about preferred habitat or general distribution during this life phase. Migratory routes within the open ocean are unknown. The main source of information on distribution in the Study Area comes from catches in U.S. fisheries. About 57 percent of green sea turtles (primarily adults) captured in longline fisheries in the North Pacific Subtropical Gyre and North Pacific Transition Zone come from the endangered Mexican nesting population, while 43 percent are from the threatened Hawaiian nesting populations. The Hawaii-based longline tuna fishery is active on the high seas, between 15 °N and 35° N and 150° West (W) to 180° W. The Hawaii-based longline swordfish fishery is active on the high seas northeast of the Hawaiian Islands in the North Pacific Transition Zone (Gilman et al. 2007). These findings suggest that green sea turtles found on the high seas of the western and central Pacific Ocean are from these two populations. Though few observations of green sea turtles in the offshore waters along the U.S. Pacific coast have been verified, their occurrence within the nearshore waters from Baja California to Alaska indicates a presence in the California Current Large Marine Ecosystem (Stinson 1984), including San Diego Bay.

Green sea turtles are estimated to reach sexual maturity at 20 to 50 years of age. This prolonged time to maturity has been attributed to their low-energy plant diet (Bjorndal 1995), and may be the highest age for maturity of all sea turtle species (Chaloupka and Musick 1997; Hirth 1997; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a).

Once mature, green sea turtles may reproduce for 17 to 23 years (Carr et al. 1978). They return to their birth beaches to nest every 2 to 5 years (Hirth 1997). This irregular pattern can cause wide year-to-year changes in numbers of nesting females at a given nesting beach. Each female nests three to five times per season, laying an average of 115 eggs in each nest (clutch). A female green sea turtle may deposit 9 to 33 clutches in a lifetime. With an average of approximately 100 eggs per nest, a female green sea turtle may lay 900 to 3,300 eggs in a lifetime (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a).

When green sea turtles are not breeding, adults live in coastal feeding areas that they sometimes share with juveniles (Seminoff and Marine Turtle Specialist Group Green Turtle Task Force 2004). Green sea turtles of all ages have a dedicated home range, in which they repeatedly visit the same feeding and breeding areas (Bresette et al. 1998; Makowski et al. 2006).

The green sea turtle is the most common sea turtle species in the Hawaii region of the Study Area, occurring in the coastal waters of the main Hawaiian Islands throughout the year and commonly migrating seasonally to the Northwestern Hawaiian Islands to reproduce. The first recorded green sea turtle nest on the Island of Hawaii occurred in 2011. Green sea turtles are found in inshore waters around all of the main Hawaiian Islands and Nihoa Island, where reefs, their preferred habitats for feeding and resting, are most abundant. They are also common in an oceanic zone surrounding the Hawaiian Islands. This area is frequently inhabited by adults migrating to the Northwestern Hawaiian Islands to reproduce during the summer and by ocean-dwelling individuals that have yet to settle into coastal feeding grounds of the main Hawaiian Islands. Farther offshore, green sea turtles occur in much lower numbers and densities.

Green sea turtles have been sighted in Pearl Harbor, but do not nest in the harbor; they are routinely seen in the outer reaches of the entrance channel (U.S. Department of the Navy 2001b). The number of resident turtles at the entrance channel is estimated at 30 to 40, with the largest number occurring at Tripod Reef and the Outfall Extension Pipe. They are also found beneath the outfall pipe of the Fort Kamehameha wastewater treatment plant, at depths of approximately 65 ft. (20 m) (Smith 2010). Green sea turtles are also regularly seen in West Loch (Smith et al. 2006). In the spring of 2010, two green sea turtles nested at Pacific Missile Range Facility for the first time in more than a decade, with successful hatching in August 2010 (O'Malley 2010). Green sea turtles are also common at all three landing beaches of U.S. Marine Corps Base Hawaii in Kaneohe Bay, where they forage in the shallow water seagrass beds (U.S. Department of the Navy 2002).

More than 90 percent of all Hawaiian Island green sea turtle breeding and nesting occurs at French Frigate Shoals in the Northwestern Hawaiian Islands, the largest nesting colony in the central Pacific Ocean, where 200 to 700 females nest each year (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a). A large foraging population resides in and returns to the shallow waters surrounding the main Hawaiian Islands (especially around Maui and Kauai), where they are known to come ashore at several locations on all eight of the main Hawaiian Islands for basking or nesting.

Green sea turtles are widely distributed in the subtropical coastal waters of southern Baja California, Mexico, and Central America, several hundred kilometers (km) south of the Study Area (Cliffton et al. 1995; National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998b). The main group of eastern Pacific Ocean green sea turtles is found on the breeding grounds of Michoacán, Mexico, from August through January and year-round in the feeding areas, such as those on the western coast of Baja California, along the coast of Oaxaca, and in the Gulf of California (the Sea of Cortez) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998b). Bahía de Los Angeles in the Gulf of California has been identified as an important foraging area for green sea turtles (Seminoff et al. 2003). Eastern Pacific Ocean green sea turtles have been reported as far north as British Columbia (48.15° N) (Eckert 1993; National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998b). The western coasts of Central America, Mexico, and the United States constitute a shared habitat for this population (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998b). The green sea turtle is not known to nest on Southern California beaches.

In general, turtle sightings increase during summer as warm water moves northward along the coast (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998b). Sightings may also be more numerous in warmer years compared to colder years. In waters south of Point Conception, Stinson (1984) found this seasonal sighting pattern to be independent of interyear temperature fluctuations. More sightings occurred during warmer years north of Point Conception. Stinson also reported that more than 60 percent of eastern Pacific Ocean green sea turtles observed in California were in areas where the water was less than 165 ft. (50 m) deep, often observed along shore in areas of eelgrass.

San Diego Bay is home to a resident population of green sea turtles (Dutton and McDonald 1990; Stinson 1984). A 20-year monitoring program of these turtles indicates an annual abundance of between 16 and 61 turtles (Eguchi et al. 2010). Eelgrass beds and marine algae are particularly abundant in the southern half of the bay, and green sea turtles are frequently observed foraging on these items (Dutton et al. 2002; U.S. Department of the Navy and San Diego Unified Port District 2011). Until December 2010, the southern part of San Diego Bay was warmed by the effluent from the Duke Energy power plant, a fossil fuel power generation facility in operation since 1960. Green sea turtles are known to congregate in this area. The closure of the power plant may impact these resident turtles and alter

movement patterns. Ultrasonic tracking studies have shown that green sea turtles in southern San Diego Bay have relatively small home ranges (Dutton et al. 2002). Between 2009 and 2011, MacDonald et al. (2012) used acoustic telemetry to track 25 green sea turtles in San Diego Bay. The results of the study suggest that resident turtles likely do not spend much, if any, time foraging in central or northern San Diego Bay, where human activities are greatest (including Navy activities). A few sea turtles have been observed in northern San Diego Bay, but these are likely transient green sea turtles that enter the bay in warmer months (MacDonald et al. 2012). Another green sea turtle population resides in Long Beach, California, although less is known about this population (Eguchi et al. 2010).

Ocean waters off Southern California and northern Baja California are also designated as areas of occurrence because of the presence of rocky ridges and channels and floating kelp habitats suitable for green sea turtle foraging and resting (Stinson 1984); however, these waters are often at temperatures below the thermal preferences of this primarily tropical species.

3.5.2.4.3 Population and Abundance

Based on data from 46 nesting sites around the world, between 108,761 and 150,521 female green sea turtles nest each year (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a), which is a 48 to 65 percent decline in the number of females nesting annually over the past 100 to 150 years (Seminoff and Marine Turtle Specialist Group Green Sea Turtle Task Force 2004). Of nine major nesting populations in the Pacific Ocean, four appear to be increasing (Hawaii, Mexico, Japan, Heron Island), three appear to be stable (Galapagos, Guam, Mexico), and the trend is unknown for two (Central American Coast and Raine Island). In addition to these 9 sites, at least 166 smaller nesting sites are scattered across the western Pacific Ocean, with an estimated 22,800 to 42,580 females nesting in the Pacific Ocean each year (Maison et al. 2010; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a). Outside of the United States, the harvest of eggs and females for their meat on nesting beaches across the Pacific Ocean remains a primary threat to the species (Maison et al. 2010).

The only nesting population in the Study Area is in Hawaii, with 200 to 700 females nesting annually at French Frigate Shoals, as well as nesting on the Big Island of Hawaii and other minor nesting grounds on other main Hawaiian Islands (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b). Four other populations are located in the eastern Pacific Ocean, south of the Study Area, with nesting occurring along the western Mexico coast, as well as within the Gulf of California (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a). The Hawaiian population is under review for being considered a distinct stock. Individuals spend most of their lives within the Insular Pacific-Hawaiian Large Marine Ecosystem. This population appears to have increased gradually over the past 30 years, with near-capacity nesting at French Frigate Shoals (Balazs and Chaloupka 2006; Chaloupka et al. 2008b).

3.5.2.4.4 Predator and Prey Interactions

The green sea turtle is the only sea turtle that is mostly herbivorous (Mortimer 1995), although its diet changes throughout its life. While at the surface, hatchlings feed on floating patches of seaweed and, at shallow depths, on comb jellies and gelatinous eggs, appearing to ignore large jellyfish (Salmon et al. 2004). While in the open ocean, juveniles smaller than 8 to 10 in. (20 to 25 cm) eat worms, small crustaceans, aquatic insects, grasses, and algae (Bjorndal 1997). After settling into a coastal habitat, juveniles eat mostly seagrass or algae (Balazs et al. 1994; Mortimer 1995). Some juveniles and adults that remain in the open ocean, and even those in coastal waters, also consume jellyfish, sponges, and sea pens (Blumenthal et al. 2009; Godley et al. 1998; Hatase et al. 2006; Heithaus et al. 2002; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a; Parker and Balazs 2005).

Predators of green sea turtles vary according to turtle location and size. Land predators that feed on eggs and hatchlings include ants, crabs, birds, and mammals, such as dogs, raccoons, and feral pigs. Aquatic predators, mostly fish and sharks, impact hatchlings most heavily in nearshore areas. Sharks are also the primary predators of juvenile and adult turtles (Stancyk 1982).

3.5.2.5 Hawksbill Sea Turtle (*Eretmochelys imbricata*)

The hawksbill turtle is the most tropical of the world's sea turtles, rarely occurring higher than 30° N or 30° S in the Atlantic, Pacific, and Indian Oceans (Lazell 1980). It inhabits coastal waters in more than 108 countries and nests in at least 70 countries (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b).

3.5.2.5.1 Status and Management

The hawksbill turtle is listed as endangered under the ESA (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998c). Critical habitat has not been designated for the hawksbill in the Pacific Ocean. While the current listing as a single global population remains valid at this time, data may support separating populations at least by ocean basin under the distinct population segment policy (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b), which would lead to specific management plans for each designated population. The hawksbill shell has been prized for centuries by artisans and their patrons for jewelry and other adornments. This trade, prohibited under the Convention on International Trade in Endangered Species, remains a critical threat to the species (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b).

3.5.2.5.2 Habitat and Geographic Range

Hawksbills are considered the most coastal of the sea turtles that inhabit the Study Area, with juveniles and adults preferring coral reef habitats (National Marine Fisheries Service 2010b). Reefs provide shelter for resting hawksbills day and night, and they are known to visit the same resting spot repeatedly. Hawksbills are also found around rocky outcrops and high-energy shoals—optimum sites for sponge growth—as well as in mangrove-lined bays and estuaries (National Marine Fisheries Service 2010b).

Hatchling and early juvenile hawksbills have also been found in the open ocean, in floating mats of seaweed (Maison et al. 2010; Musick and Limpus 1997). Although information about foraging areas is largely unavailable due to research limitations, juvenile and adult hawksbills may also be present in open ocean environments (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b). Very little is known about the open ocean habitat and distribution of hawksbills in the Transit Corridor.

Hawksbills are mostly found in the coastal waters of the eight main islands of the Hawaiian Island chain. Stranded or injured hawksbills are occasionally found in the Northwestern Hawaiian Islands (Parker et al. 2009). Hawksbills are the second-most-common species in the offshore waters of the Hawaiian Islands, yet they are far less abundant than green sea turtles (Chaloupka et al. 2008b). The lack of hawksbill sightings during aerial and shipboard surveys likely reflects the species' small size and difficulty in identifying them from a distance.

Hawksbills have been captured in Kiholo Bay and Kau (Hawaii), Palaau (Molokai), and Makaha (Oahu) (Hawaii Department of Land and Natural Resources 2002). Strandings have been reported in Kaneohe and Kahana Bays (Oahu) and throughout the main Hawaiian Islands (Eckert 1993; National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998c). No stranding data are available for Niihau (U.S. Department of the Navy 2001a). Hawksbills primarily nest on the southeastern beaches of the Island of Hawaii (Aki et al. 1994). Since 1991, 81 nesting female hawksbills have been tagged on the

Island of Hawaii at various locations. This number does not include nesting females from Maui or Molokai, which would add a small number to the total. Post-nesting hawksbills have been tracked moving between Hawaii and Maui over the deep waters of the Alenuihaha Channel (Parker et al. 2009). Only two hawksbills have ever been sighted in the Pearl Harbor entrance channel, and none have been sighted inside the harbor (Smith 2010).

Water temperature in the Southern California region of the Study Area is generally too low for hawksbills, and they are rare. Nesting is rare in the eastern Pacific Ocean region, and does not occur along the U.S. west coast (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998c; Witzell 1983). Stinson (1984) did not mention the hawksbill turtle in her summary of sea turtle occurrences in eastern north Pacific waters from Baja California to the Gulf of Alaska, and no hawksbill sightings have been confirmed along the U.S. west coast in recent history (Eckert 1993; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b). If hawksbills were to occur in the Southern California region of the Study Area, it would most likely be during an El Niño event, when waters along the California current are unusually warm (National Marine Fisheries Service 2008).

Hawksbills were once thought to be a nonmigratory species because of the proximity of suitable nesting beaches to coral reef feeding habitats and the high rates of marked turtles recaptured in these areas; however, tagging studies have shown otherwise. For example, a post-nesting female traveled 995 miles (mi.) (1,601 kilometers [km]) from the Solomon Islands to Papua New Guinea (Meylan 1995), indicating that adult hawksbills can migrate distances comparable to those of green and loggerhead sea turtles.

Research suggests that movements of Hawaiian hawksbills are relatively short, with individuals generally migrating through shallow coastal waters and few deepwater transits between the islands. Nine hawksbill turtles were tracked within the Hawaiian Islands using satellite telemetry. Turtles traveled from 55 to 215 mi. (89 to 346 km) and took between 5 and 18 days to complete the trip from nesting to foraging areas (Parker et al. 2009).

Foraging dive durations are often a function of turtle size, with larger turtles diving deeper and longer. Shorter and more active foraging dives occur predominantly during the day, while longer resting dives occur at night (Blumenthal et al. 2009; Storch et al. 2005; Van Dam and Diez 2000). Lutcavage and Lutz (1997) cited a maximum dive duration of 73.5 minutes for a female hawksbill in the U.S. Virgin Islands. Van Dam and Diez (2000) reported that foraging dives at a study site in the northern Caribbean ranged from 19 to 26 minutes at depths of 26 to 33 ft. (8 to 10 m), with resting night dives from 35 to 47 minutes. Foraging dives of immature hawksbills are shorter, ranging from 8.6 to 14 minutes, with a mean and maximum depth of 16.4 and 65.6 ft. (5 and 20 m), respectively (Van Dam and Diez 1996). Blumenthal et al. (2009) reported consistent diving characteristics for juvenile hawksbill in the Cayman Islands, with an average daytime dive depth of 25 ft. (8 m), a maximum depth of 140 ft. (43 m), and a mean nighttime dive depth of 15 ft. (5 m). A change in water temperature affects dive duration; cooler water temperatures in the winter result in increased nighttime dive durations (Storch et al. 2005).

3.5.2.5.3 Population and Abundance

A lack of nesting beach surveys for hawksbill turtles in the Pacific Ocean and the poorly understood nature of this species' nesting have made it difficult for scientists to assess the population status of hawksbills in the Pacific (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998c; Seminoff, Nichols, et al. 2003). An assessment of 25 sites around the world indicates that hawksbill nesting has declined by at least 80 percent over the last three generations (105 years in the Atlantic and 135 years in the Indo-Pacific Ocean) (Meylan and Donnelly 1999). Only five regional populations remain

worldwide (two in Australia, and one each in Indonesia, the Seychelles, and Mexico), with more than 1,000 females nesting annually (Meylan and Donnelly 1999). The largest of these regional populations is in the South Pacific Ocean, where 6,000 to 8,000 hawksbills nest off the Great Barrier Reef (Limpus 1992).

As with all other turtle species, hawksbill hatchlings enter an oceanic phase, and may be carried great distances by surface currents. Although little is known about their open ocean stage, younger juvenile hawksbills have been found in association with brown algae in the Pacific Ocean (Musick and Limpus 1997; Parker 1995; Witherington and Hirama 2006; Witzell 1983) before settling into nearshore habitats as older juveniles. Preferred habitat is coral reefs, but hawksbills also inhabit seagrass, algal beds, mangrove bays, creeks, and mud flats (Mortimer and Donnelly 2008). Some juveniles may use the same feeding grounds for a decade or more (Meylan 1999), while others appear to migrate among several sites as they age (Musick and Limpus 1997). Indo-Pacific hawksbills are estimated to mature at between 30 and 38 years of age (Mortimer and Donnelly 2008).

Once they are sexually mature, hawksbill turtles undertake breeding migrations between foraging grounds and breeding areas at intervals of several years (Dobbs et al. 1999; Mortimer and Bresson 1999; Witzell 1983). Although females tend to return to breed where they were born (Bowen and Karl 1997), they may have foraged hundreds or thousands of kilometers from their birth beaches as juveniles, Returning to nest at their birth beaches, these sea turtles are believed to return to their juvenile foraging grounds (Mortimer and Donnelly 2008).

Hawksbills are solitary nesters on beaches throughout the tropics and subtropics. During the nesting season, female hawksbills return to their birth beaches every 2 to 3 years at night. A female hawksbill lays between three and five clutches during a single nesting season, which contain an average of 130 eggs per clutch (Mortimer and Bresson 1999; Richardson et al. 1999). In Hawaii, the nesting seasons runs approximately from May through December (Aki et al. 1994).

The Hawksbill Sea Turtle (*Eretmochelys imbricata*) 5-year Review: Summary and Evaluation (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b) assessed nesting abundance and nesting trends in all regions that the hawksbill turtles inhabit. Where possible, historical population trends were determined, and most showed declines for the 20 to 100 year period of evaluation. Recent trends for 42 of the sites indicated that 69 percent were decreasing, seven percent were stable, and that 24 percent were increasing. Seven of the 83 sites occur in the central Pacific Ocean and one occurs in the eastern Pacific Ocean (Baja California, Mexico), all with decreasing long-term population trends; only the Hawaii site has a recent increasing trend. Hawksbills in the eastern Pacific Ocean are probably the most endangered sea turtle population in the world (Gaos and Yañez 2008). Hawksbills sometimes nest in the southern part of the Baja Peninsula, while juveniles and subadults are seen foraging in coastal waters regularly. No nesting occurs on the western coast of the United States. Hawksbills in the U.S. Pacific region nest only on eastern beaches of the Island of Hawaii (5 to 10 nesting females annually, although 13 were reported in 2011 [Rivers 2011]), as well as in the Northwestern Hawaiian Islands. (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b).

3.5.2.5.4 Predator and Prey Interactions

Hawksbills eat both animals and algae during the early juvenile stage, feeding on prey such as sponges, algae, mollusks, crustaceans, and jellyfish (Bjorndal 1997). Older juveniles and adults are more specialized, feeding primarily on sponges, which comprise as much as 95 percent of their diet in some locations, although the diet of adult hawksbills in the Indo-Pacific region includes other invertebrates

and algae (Meylan 1988; Witzell 1983). The shape of their mouth allows hawksbills to reach into holes and crevices of coral reefs to find sponges and other invertebrates.

Predators of hawksbills vary according to turtle location and size. Land predators on eggs and hatchlings include ants, crabs, birds, and mammals, such as dogs, raccoons, and feral pigs. Aquatic predators, mostly fish and sharks, impact hatchlings most heavily in nearshore areas. Sharks are also the primary predators of juvenile and adult turtles (Stancyk 1982).

3.5.2.6 Loggerhead Sea Turtle (*Caretta caretta*)

Loggerhead sea turtles are one of the larger species of turtle, named for their large blocky heads that support powerful jaws used to feed on hard-shelled prey. The loggerhead is found in temperate to tropical regions of the Atlantic, Pacific, and Indian Oceans and in the Mediterranean Sea (Conant et al. 2009).

3.5.2.6.1 Status and Management

The loggerhead was the subject of a complete stock analysis conducted to identify distinct population segments within the global population (Conant et al. 2009). Three distinct population segments occur in the Pacific Ocean: North Pacific, South Pacific, and Southeast Indo-Pacific Ocean. Genetic data (Bowen et al. 1995; Resendiz et al. 1998) and tagging data (Conant et al. 2009) indicate that the South Pacific and Southeast Indo-Pacific Ocean nesting populations rarely, if ever, are found in northern Pacific Ocean waters. North Pacific Ocean loggerheads nest exclusively in Japan. Based on a review of census data collected from most of the Japanese beaches from the 1950s through the 1990s, Kamezaki et al. (2003) concluded that the annual loggerhead nesting population in Japan declined 50 to 90 percent in recent decades. Loggerheads are declining and at risk of extirpation from the northern Pacific Ocean. This drop in numbers is primarily the result of fishery bycatch from the coastal pound net fisheries off Japan, coastal fisheries that affect juvenile foraging populations off Baja California, and un-described fisheries that likely affect loggerheads in the South China Sea and the northern Pacific Ocean (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007d). In September 2011, NMFS listed all three Pacific Ocean distinct population segments of loggerhead sea turtles as endangered (76 FR 588868). Although two petitions to designate critical habitat have been submitted to NMFS (Turtle Island Restoration Network [July 16, 2007] and the Center for Biological Diversity [November 16, 2007], as cited in National Marine Fisheries Service 2010a), critical habitat has yet to be proposed and designated for Pacific Ocean loggerheads.

3.5.2.6.2 Habitat and Geographic Range

The loggerhead turtle is found in habitats ranging from coastal estuaries to the open ocean (Dodd 1988). Most of the loggerheads observed in the eastern North Pacific Ocean are believed to come from beaches in Japan where the nesting season is late May to August (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998e). Migratory routes can be coastal or can involve crossing deep ocean waters (Schroeder et al. 2003). The species can be found hundreds of kilometers out to sea, as well as in inshore areas, such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. Coral reefs, rocky places, and shipwrecks are often used as feeding areas. The nearshore zone provides crucial foraging habitat, as well as internesting and overwintering habitat.

Loggerheads typically nest on beaches close to reef formations and adjacent to warm currents (Dodd 1988). They prefer nesting beaches facing the open ocean or along narrow bays (Conant et al. 2009). Nesting beaches tend to be wide and sandy, backed by low dunes and fronted by a flat sandy approach

from the water (Miller et al. 2003). Nests are typically laid between the high tide line and the dune front (Hailman and Elowson 1992).

Pacific Ocean loggerheads appear to use the entire North Pacific Ocean during development. There is substantial evidence that the North Pacific Ocean stock makes two transoceanic crossings. The first crossing (west to east) is made immediately after they hatch from the nesting beach in Japan, while the second (east to west) is made when they reach either the late juvenile or adult life stage at the foraging grounds in Mexico. Offshore, juvenile loggerheads forage in or migrate through the North Pacific Subtropical Gyre as they move between North American developmental habitats and nesting beaches in Japan. The highest densities of loggerheads can be found just north of Hawaii in the North Pacific Transition Zone (Polovina et al. 2000).

The North Pacific Transition Zone is defined by convergence zones of high productivity that stretch across the entire northern Pacific Ocean from Japan to California (Polovina et al. 2001). Within this gyre, the Kuroshio Extension Bifurcation Region is an important habitat for juvenile loggerheads (Polovina et al. 2006). These turtles, whose oceanic phase lasts a decade or more, have been tracked swimming against the prevailing current, apparently to remain in the areas of highest productivity. Juvenile loggerheads originating from nesting beaches in Japan migrate through the North Pacific Transition Zone en route to important foraging habitats in Baja California, and are likely to be found in the Transit Corridor of the Study Area (Bowen et al. 1995).

National Marine Fisheries Service and U.S. Fish and Wildlife Service (1998e) listed four sighting records of this species for the Hawaiian Islands, all juveniles. A single male loggerhead turtle has also been reported to visit Lehua Channel and Keamano Bay (located off the northern coast of Niihau) every June through July (U.S. Department of the Navy 2001a, 2002). Only one loggerhead stranding has been recorded in the Hawaiian Islands since 1982 (National Marine Fisheries Service 2004). While incidental catches of loggerheads in the Hawaii-based longline fishery indicate that they use these waters during migrations and development (Polovina et al. 2000), their occurrence in the offshore waters of the Hawaii portion of the Study Area is believed to be rare.

The loggerhead turtle is known to occur at sea in the Southern California portion of the Study Area, but does not nest on Southern California beaches. Loggerhead turtles primarily occupy areas where the sea surface temperature is between 59° Fahrenheit (F) and 77°F (15°C and 25°C). In U.S. waters, most records of loggerhead sightings, stranding events, and incidental bycatch have been of juveniles documented from the nearshore waters of Southern California. In general, turtle sightings increase during the summer, peaking from July to September off Southern California and southwestern Baja California (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998e; Stinson 1984).

During El Niño events, foraging loggerheads from Mexican waters may expand their range north into Southern California waters. For this reason, U.S. Pacific Ocean waters east of 120° W longitude are closed to the large mesh drift gillnet fishery targeting swordfish and thresher shark during June, July and August during a forecast or occurring El Nino event (National Marine Fisheries Service 2003). These waters are considered an area of occurrence during the warm-water period. The area of occurrence during the cold-water period is cut along the 64°F (18°C) isotherm (a line on a map representing changes of volume or pressure under conditions of constant temperature). Loggerheads are generally not found in waters colder than 60.8°F (16°C), so the area north of the 60.8°F (16°C) isotherm is depicted as an area of rare occurrence (National Marine Fisheries Service 2003).

The loggerhead embarks on transoceanic migrations, and has been reported as far north as Alaska and as far south as Chile. Loggerheads foraging in and around Baja California originate from breeding areas in Japan (Conant et al. 2009), while Australian stocks appear to migrate to foraging grounds off the coasts of Peru and Chile (Alfaro-Shigueto et al. 2004).

Diving profiles in open ocean and nearshore habitats appear to be based on the location of the food source, with turtles foraging in the nearshore habitat diving to the seafloor (average depth 165 - 330 ft.) (50 - 101 m) and those in the open ocean habitat diving exclusively in the 0 to 80 ft. (0 - 24 m) depth range (Hatase et al. 2007). Dive duration increased in warmer waters. The average foraging dive duration was 25 minutes, although night resting dives to depths of 45 ft. (14 m) longer than 300 minutes were recorded. Resting appears to be the main function of night dives (Hatase et al. 2007).

A diving study of two longline-caught loggerheads in the Central North Pacific Ocean showed that the turtles spent about 40 percent of their time in the top 3 ft. (0.9 m), 70 percent of the dives were no deeper than 15 ft. (4.6 m), and virtually all of their time was spent in water shallower than 330 ft. (101 m) (Polovina et al. 2002).

3.5.2.6.3 Population and Abundance

The global population of loggerhead turtles is estimated at 43,320 to 44,560 nesting females (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007d). The largest nesting populations occur in the subtropics on the western rims of the Atlantic and Indian Oceans. The largest nesting aggregation in the Pacific Ocean occurs in southern Japan, where fewer than 1,000 females breed annually (Kamezaki et al. 2003). Seminoff et al. (2004) carried out aerial surveys for loggerhead turtles along the Pacific Coast of the Baja California Peninsula, Mexico an area long thought to be critical habitat for juveniles. Surveys were carried out from September to October 2005 and encompassed nearly 7,000 km of track-line with offshore extents to 170 km. More than 400 turtles were sighted. Loggerheads were the most prevalent (77 percent of all sightings). Olive ridleys (12 percent), green turtles (7 percent), and leatherback turtles (less than 1 percent) were also sighted.

Females lay three to five clutches of eggs, and sometimes lay additional clutches, during a single nesting season (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007d). Mean clutch size is approximately 100 to 130 eggs (Dodd 1988). The temperature of a viable nest ranges between 79°F and 90°F (26°C and 32°C). Eggs incubate for approximately two months before they hatch (Mrosovsky 1980). As with all sea turtles, an incubation temperature near the upper end of the viable range (90°F [32°C]) produces all females, and an incubation temperature near the lower end (79°F [26°C]) produces all male hatchlings (Mrosovsky 1980).

Hatchlings travel to oceanic habitats, and often are found in seaweed drift lines (Carr 1986, 1987; Witherington and Hirama 2006). Loggerheads spend the first 7 to 11.5 years of their lives in the open ocean (Bolten 2003). At about 14 years old, some juveniles move to nearshore habitats close to their birth area, while others remain in the oceanic habitat or move back and forth between the two (Musick and Limpus 1997). Turtles may use the same nearshore developmental habitat all through maturation or may move among different areas, finally settling in an adult foraging habitat. Loggerheads reach sexual maturity at around 35 years of age, and move from subadult to adult coastal foraging habitats (Godley et al. 2003; Musick and Limpus 1997). Data from Japan (Hatase et al. 2002), Cape Verde (Hawkes et al. 2006), and Florida (Reich et al. 2007) indicate that at least some of the adult population forage in the open ocean.

3.5.2.6.4 Predator and Prey Interactions

In both open ocean and nearshore habitats, loggerheads are primarily carnivorous, although they also consume some algae (Bjorndal 1997; Dodd 1988). Both juveniles and adults forage in coastal habitats, where they feed primarily on the bottom, although they also capture prey throughout the water column (Bjorndal 2003). Adult loggerheads feed on a variety of bottom-dwelling animals, such as crabs, shrimp, sea urchins, sponges, and fish. They have powerful jaws that enable them to feed on hard-shelled prey, such as whelks and conch. During migration through the open sea, they eat jellyfish, mollusks, flying fish, and squid.

Polovina et al. (2006) found that juvenile loggerheads in the western North Pacific Ocean at times swim against weak prevailing currents because they are attracted to areas of high productivity. Similar observations have been made in the Atlantic (Hawkes et al. 2006). These results suggest that the location of currents and associated frontal eddies is important to the loggerhead's foraging during its open ocean stage (McClellan and Read 2007).

3.5.2.7 Olive Ridley Sea Turtle (*Lepidochelys olivacea*)

The olive ridley is a relatively small, hard-shelled sea turtle named for its olive green top shell. The olive ridley is known as an open ocean species, but can be found in coastal areas. They are found in tropical waters of the south Atlantic, Indian, and Pacific Oceans. While the olive ridley is the most abundant sea turtle species in the world (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f), with some of the largest nesting beaches occurring along the Pacific coast of Central America, few data about its occurrence in the Study Area are available.

3.5.2.7.1 Status and Management

The Mexican Pacific Ocean coast nesting population has been classified as endangered because of extensive overharvesting of olive ridley turtles in Mexico, which caused a severe population decline (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f). Olive ridleys in the Study Area likely belong to this population. All other populations are listed under the ESA as threatened (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f). Before this commercial exploitation, the olive ridley was highly abundant in the eastern tropical Pacific Ocean, probably outnumbering all other sea turtle species combined in the area (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f). Today, this population appears to be stable or increasing (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007e), although the decline of the species continues at several important nesting beaches in Central America. Critical habitat has not been designated for the olive ridley.

Available information indicates that the population could be separated by ocean basins under the distinct population segment policy (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007e). Based on genetic data, the worldwide olive ridley population is composed of four main lineages: east India, Indo-Western Pacific, Atlantic, and eastern Pacific Ocean (Bowen et al. 1998; Shankar et al. 2004). Furthermore, genetic diversity of the eastern Pacific Ocean subpopulation nesting on the Baja California Peninsula may indicate that this population should be considered as a distinct management unit (Lopez-Castro and Rocha-Olivares 2005).

3.5.2.7.2 Habitat and Geographic Range

Most olive ridley turtles lead a primarily open ocean existence (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f). Outside of the breeding season, the turtles disperse, but little is

known of their foraging habitats or migratory behavior. Neither males nor females migrate to one specific foraging area, but tend to roam and occupy a series of feeding areas in the open ocean (Plotkin et al. 1994). The olive ridley has a large range in tropical and subtropical regions in the Pacific Ocean, and is generally found between 40° N and 40° S. Both adult and juvenile olive ridley turtles typically inhabit offshore waters, foraging from the surface to a depth of 490 ft. (149.4 m) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f).

The second-most-important nesting area for olive ridley turtles, globally, occurs in the eastern Pacific Ocean, along the western coast of southern Mexico and northern Costa Rica, with stragglers nesting as far north as southern Baja California (Fritts et al. 1982) and as far south as Peru (Brown and Brown 1995). Individuals occasionally occur in waters as far north as California and as far south as Peru, spending most of their life in the oceanic zone (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007e).

Data collected during tuna fishing cruises from Baja California to Ecuador, and from the Pacific coast to almost 150° W, indicated that the two most important areas in the Pacific Ocean for the olive ridley turtles are the Central American coast and the nursery and feeding area off Colombia and Ecuador. In these areas, both adults (mostly females) and juveniles are often seen (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f).

In the open ocean of the eastern Pacific Ocean, olive ridley turtles are often seen near flotsam (floating debris), possibly feeding on associated fish and invertebrates (Pitman 1992). Although no estimates are available, the highest densities of olive ridley turtles are likely found just south of Hawaii, as their distribution in the central Pacific Ocean is primarily tropical (Polovina et al. 2004). About 18 percent of the sea turtles incidentally caught by the Hawaii-based longline fishery, which operates throughout this region, are olive ridley turtles (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f, National Marine Fisheries Service 2011). Arenas and Hall (1992) found that 75 percent of sea turtles associated with floating objects in the eastern tropical Pacific Ocean were olive ridley turtles, which were present in 15 percent of the observations; this finding suggests that flotsam may provide the turtles with food, shelter, and orientation cues in an otherwise featureless landscape.

An estimated 31 olive ridley turtles have stranded in the Hawaiian Islands between 1982 and 2003 (Chaloupka et al. 2008b).Few sightings have been recorded in the nearshore waters of the main Hawaiian Islands and Nihoa. Available information suggests that olive ridley turtles traverse through the oceanic waters surrounding the Hawaiian Islands during foraging and developmental migrations. Genetic analysis of olive ridley turtles captured in the Hawaii-based longline fishery showed that 67 percent originated from the eastern Pacific Ocean (Mexico and Costa Rica), and 33 percent of the turtles were from the Indian and western Pacific Ocean rookeries (Polovina et al. 2004). These turtles were captured in deep, offshore waters of the Hawaiian Islands, primarily during spring and summer. Based on the oceanic habitat preferences of this species throughout the Pacific Ocean, this species is likely more prevalent year round in waters off the Hawaiian Islands beyond the 330 ft. (101 m) isobath, with only rare occurrences inside this isobath.

The olive ridley turtle occurs off the coast of southern and central California, but is not known to nest on California beaches. Olive ridley turtles are occasionally seen in shallow waters (less than 165 ft.) (50 m) deep), although these sightings are relatively rare (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f). In general, turtle sightings increase during summer as warm water moves

northward along the coast (Steiner and Walder 2005; Stinson 1984). Sightings may also be more numerous in warm years compared with cold years.

Pacific Ocean at-sea density and abundance were estimated for olive ridley turtles that occurred just south of California (Eguchi et al. 2007). This study produced density estimates from shipboard line-transects conducted between 1992 and 2006 in the eastern tropical Pacific Ocean, in an area defined by 5° N, 120° W, and 25° N and the coastlines of Mexico and Central America. The average density calculated from this study was 0.10 turtle per square mile (0.26 turtle per square kilometer), with a minimum of 0.16 and maximum of 0.4 turtle per square mile (minimum of 0.40 and maximum of 1.04 turtle per square kilometer).

Olive ridley turtles are found primarily in the open ocean between 73°F and 82°F (23°C and 28°C), so the entire Study Area has been listed as an area of occurrence for olive ridley turtles during summer months. The entire Study Area has been listed as an area of rare occurrence during the winter, when water temperatures are low.

The Pacific Ocean population migrates throughout the Pacific Ocean, from their nesting grounds in Mexico and Central America to the North Pacific Ocean (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007e). The post-nesting migration routes of olive ridley turtles tracked via satellite from Costa Rica traversed thousands of kilometers of deep oceanic waters from Mexico to Peru, and more than 1,865 mi. (3,000 km) out into the central Pacific Ocean (Plotkin et al. 1994). Tagged turtles nesting in Costa Rica were recovered as far south as Peru, as far north as Oaxaca, Mexico, and offshore to a distance of 1,080 nautical miles (nm) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f).

Groups of 100 or more turtles have been observed as far offshore as 120° W, at about 1,620 nm from shore (Arenas and Hall 1992). Sightings of large groups of olive ridley turtles at sea reported by Oliver in 1946 (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f) may indicate that turtles travel in large flotillas between nesting beaches and feeding areas (Márquez M. 1990). Specific post-breeding migratory pathways to feeding areas do not appear to exist, although olive ridley turtles swim hundreds to thousands of kilometers over vast oceanic areas.

Olive ridley turtles can dive and feed at considerable depths (260 to 1,000 ft.) (79 to 305 m) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f), although only about 10 percent of their time is spent at depths greater than 330 ft. (101 m) (Eckert et al. 1986; Polovina et al. 2002). In the eastern tropical Pacific Ocean, at least 25 percent of their total dive time is spent between 65 and 330 ft. (20 and 101 m) (Parker et al. 2003). In the North Pacific Ocean, two olive ridley turtles tagged with satellite-linked depth recorders spent about 20 percent of their time in the top meter and about 10 percent of their time deeper than 330 ft. (101 m); a daily maximum depth exceeded 490 ft. (149 m) at least once in 20 percent of the days, with one dive recorded at 835 ft. (255 m). While olive ridley turtles are known to forage to great depths, 70 percent of the dives from this study were no deeper than 15 ft. (4.6 m) (Polovina et al. 2002).

3.5.2.7.3 Population and Abundance

The olive ridley is the most abundant sea turtle in the world (Pritchard 1997) and the most abundant sea turtle in the open ocean waters of the eastern tropical Pacific Ocean (Pitman 1990). They nest in nearly 60 countries worldwide, with an estimated 800,000 females nesting annually (National Marine Fisheries Service 2010b). This is a dramatic decrease over the past 50 years, where the population from the five

Mexican Pacific Ocean beaches was previously estimated at 10 million adults (Cliffton et al. 1995). The number of olive ridley turtles occurring in U.S. territorial waters is believed to be small (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f). At-sea abundance surveys conducted along the Mexican and Central American coasts between 1992 and 2006 provided an estimate of 1.39 million turtles in the region, which was consistent with the increases seen on the eastern Pacific Ocean nesting beaches between 1997 and 2006 (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007e).

Little is known about the age and sex distribution, growth, birth and death rates, or immigration and emigration of olive ridley turtles. Hatchling survivorship is unknown, although presumably, as with other turtles, many die during the early life stages. Both adults and juveniles occur in open sea habitats, though sightings are relatively rare. The median age to sexual maturity is 13 years, with a range of 10–18 years (Zug et al. 2006).

Olive ridley turtles use two types of nesting strategies. In 18 locations around the world, they conduct annual synchronized nesting, a phenomenon known as an "arribada" (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f), where hundreds to tens of thousands of olive ridley turtles emerge over a period of a few days. In the eastern Pacific Ocean, arribada nesting occurs throughout the year, although it peaks from September to December (Fretey 2001). Arribadas occur on several beaches in Mexico, Nicaragua, Costa Rica, and Panama. Olive ridley turtles also lay solitary nests throughout the world, although little attention has been given to this nesting strategy because of the dominant interest in arribada research (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007e). Solitary nesting occurs in at least 46 countries throughout the world (Kalb and Owens 1994), including along nearly the entire Pacific Ocean coast of Mexico, with the greatest concentrations closer to arribada beaches. In Hawaii, olive ridleys have been known to nest sporadically on the Island of Maui, at U.S. Marine Corps Base Hawaii on Oahu in 2009, and on the Ka'u coast on the Island of Hawaii in 2010.

Females and males begin to group in "reproductive patches" near their nesting beaches 2 months before the nesting season, and most mate near the nesting beaches, although mating has been observed throughout the year as far as 565 mi. (909 km) from the nearest mainland (Pitman 1990). Arribadas usually last from three to seven nights, and due to the sheer number of nesters, later arrivers disturb and dig up many existing nests, lowering overall survivorship during this phase (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f). A typical female produces two clutches per nesting season, averaging 105 eggs at 15 to 17 day intervals for lone nesters and 28 day intervals for mass nesters (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f; Plotkin et al. 1994). Studies show that females that nested in arribadas remain within 3 mi. (4.8 km) of the beach most of the time during the internesting period (Kalb and Owens 1994). Incubation time from egg deposition to hatching is approximately 55 days (Pritchard and Plotkin 1995). Hatchlings emerge weighing less than 1 oz. (less than 28 g) and measuring about 1.5 inches (3.8 cm).

3.5.2.7.4 Predator and Prey Interactions

Olive ridley sea turtles are primarily carnivorous. They consume a variety of prey in the water column and on the seafloor, including snails, clams, tunicates, fish, fish eggs, crabs, oysters, sea urchins, shrimp, and jellyfish (Fritts 1981; Márquez M. 1990; Mortimer 1995; Polovina et al. 2004). Olive ridleys are subject to predation by the same predators as other sea turtles, such as sharks on adult olive ridleys, fish and sharks on hatchlings, and various land predators on hatchlings (e.g., ants, crabs, birds, and mammals) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998f).

3.5.2.8 Leatherback Sea Turtle (*Dermochelys coriacea*)

Leatherback turtles have several unique characteristics. They are distinguished from other sea turtles in the Study Area by their leathery shell, and they are the largest species of sea turtle; adults can reach 6.5 ft. (2 m) in length (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992). Leatherbacks are also the most migratory sea turtles, and are able to tolerate colder water than other species (Hughes et al. 1998; James and Mrosovsky 2004). Leatherbacks are the deepest-diving sea turtle (Hays et al. 2004). They are found in tropical to temperate regions of the Atlantic, Indian, and Pacific Oceans. Leatherbacks are known as an open ocean species, but can also rarely be found in coastal waters within the Study Area.

3.5.2.8.1 Status and Management

The leatherback turtle is listed as a single population, and is classified as endangered under the ESA. Although the U.S. Fish and Wildlife Service and NMFS believe the current listing is valid, preliminary information indicates an analysis and review of the species (e.g., genetic differences between leatherback stocks) should be conducted to determine if some stocks should be designated as distinct populations (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007c; Turtle Expert Working Group 2007). This effort is critical to focus efforts to protect the species, because the status of individual stocks varies widely across the world. Most stocks in the Pacific Ocean are faring poorly, where nesting populations have declined more than 80 percent (Sarti-Martinez 2000), while western Atlantic and South African populations are generally stable or increasing (Turtle Expert Working Group 2007). In 2012, NMFS designated critical habitat for the leatherback sea turtle in California (from Point Arena to Point Vincente) and from Cape Flattery, Washington, to Winchester Bay, Oregon, out to the 2,000 mi. (3,219 km) depth contour (National Marine Fisheries Service 2012). As stated previously, this critical habitat designation is north of the SOCAL Range Complex boundary.

By 2004, 203 nesting beaches from 46 countries around the world had been identified (Dutton 2006). The leatherback sea turtle has been reported to nest on the Island of Lanai in the past. Although these data are beginning to form a global perspective, unidentified sites likely exist, and incomplete or no data are available for many other sites. Genetic studies have been used to identify two discrete leatherback populations in the Pacific Ocean (Dutton 2006), an eastern Pacific Ocean population, which nests between Mexico and Ecuador, and a western Pacific Ocean population, which nests in numerous countries, including Australia, Fiji, Indonesia, and China. Leatherbacks have been in decline in all major Pacific basin rookeries (nesting areas/groups) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007c; Turtle Expert Working Group 2007) for at least the last two decades (Gilman 2008; Sarti-Martinez et al. 1996; Spotila et al. 1996; Spotila et al. 2000). Causes for this decline include the nearly complete harvest of eggs and high levels of mortality during the 1980s, primarily in the high seas driftnet fishery, which is now banned (Chaloupka et al. 2004; Eckert and Sarti-Martinez 1997; Gilman 2008; Sarti-Martinez et al. 1996). With only four major rookeries remaining in the western Pacific Ocean and two in the eastern Pacific Ocean, the Pacific leatherback is at an extremely high risk of extinction (Gilman 2008).

3.5.2.8.2 Habitat and Geographic Range

The leatherback turtle is the most widely distributed of all sea turtles, found from tropical to subpolar oceans, and nests on tropical and occasionally subtropical beaches (Gilman 2008; Myers and Hays 2006; National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992). Found from 71° N to 47° S, it has the most extensive range of any adult turtle (Eckert 1995). Adult leatherback turtles forage in temperate and subpolar regions in all oceans, and migrate to tropical nesting beaches between 30° N

and 20° S. Leatherbacks have a wide nesting distribution, primarily on isolated mainland beaches in tropical oceans (mainly in the Atlantic and Pacific Oceans, with few in the Indian Ocean) and temperate oceans (southwest Indian Ocean) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992), and to a lesser degree on some islands.

Hatchling leatherbacks head out to the open ocean, but little is known about their distribution for the first four years (Musick and Limpus 1997). Sightings of turtles smaller than 55 in. (140 cm) indicate that some juveniles remain in coastal waters in some areas (Eckert et al. 1999). Most of the eastern Pacific Ocean nesting stocks migrate south, away from the Study Area (Dutton unpublished data).

Few quantitative data are available concerning the seasonality, abundance, or distribution of leatherbacks in the central northern Pacific Ocean. Satellite tracking studies and occasional incidental captures of the species in the Hawaii-based longline fishery indicate that deep ocean waters are the preferred habitats of leatherback turtles in the central Pacific Ocean (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007c). The primary migration corridors for leatherbacks are across the North Pacific Subtropical Gyre, with the eastward migration route possibly to the north of the westward migration (Dutton unpublished data).

The primary data available for leatherbacks in the North Pacific Transition Zone come from longline fishing bycatch reports, as well as several satellite telemetry data sets (Benson et al. 2007). Leatherbacks from both eastern and western Pacific Ocean nesting populations migrate to northern Pacific Ocean foraging grounds, where longline fisheries operate (Dutton et al. 1998). Leatherbacks from nesting beaches in the Indo-Pacific region have been tracked migrating thousands of kilometers through the North Pacific Transition Zone to summer foraging grounds off the coast of northern California (Benson et al. 2007). Based on the genetic sampling of 18 leatherback turtles caught in the Hawaiian longline fishery, about 94 percent originated from western Pacific Ocean nesting beaches (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007c). The remaining 6 percent of the leatherback turtles found in the open ocean waters north and south of the Hawaiian Islands represent nesting groups from the eastern tropical Pacific Ocean.

Leatherback turtles are regularly sighted by fishermen in offshore waters surrounding the Hawaiian Islands, generally beyond the 3,800 ft. (1,158 m) contour, and especially at the southeastern end of the island chain and off the northern coast of Oahu (Balazs 1995). Leatherbacks encountered in these waters, including those caught accidentally in fishing operations, may be migrating through the Insular Pacific-Hawaiian Large Marine Ecosystem (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998d). Sightings and reported interactions with the Hawaii longline fishery commonly occur around seamount habitats above the Northwestern Hawaiian Islands (from 35° N to 45° N and 175° W to 180° W) (Skillman and Balazs 1992; Skillman and Kleiber 1998).

The leatherback turtle occurs within the entire Insular Pacific-Hawaiian Large Marine Ecosystem beyond the 330 ft. (101 m) isobath; inshore of this isobath is the area of rare leatherback occurrence. Incidental captures of leatherbacks have also occurred at several offshore locations around the main Hawaiian Islands (McCracken 2000). Although leatherback bycatches are common off the island chain, leatherback-stranding events on Hawaiian beaches are uncommon. Since 1982, only five leatherbacks have stranded in the Hawaiian Islands (Chaloupka et al. 2008b). Leatherbacks were not sighted during any of the aerial surveys, all of which took place over waters lying close to the Hawaiian shoreline. Leatherbacks were also not sighted during any of the NMFS shipboard surveys; their deep diving capabilities and long submergence times reduce the probability that observers could spot them during

marine surveys. One leatherback turtle was observed along the Hawaiian shoreline during monitoring surveys in 2006 (Rivers 2011).

In the eastern North Pacific Ocean, leatherback turtles are broadly distributed from the tropics to as far north as Alaska, where 19 occurrences were documented between 1960 and 2001 (Eckert 1993; Hodge and Wing 2000). Stinson (1984) concluded that the leatherback was the most common sea turtle in U.S. waters north of Mexico. Aerial surveys off California, Oregon, and Washington indicate that most leatherbacks occur in waters over the continental slope, with a few beyond the continental shelf (Eckert 1993). While the leatherback is known to occur throughout the California Current Large Marine Ecosystem, it is not known to nest anywhere along the U.S. Pacific Ocean coast. In general, turtle sightings increase during summer, as warm water moves northward along the coast (Stinson 1984). Sightings may also be more numerous in warm years than in cold years.

Leatherback turtles are regularly seen off the western coast of the United States, with the greatest densities found off central California. Off central California, sea surface temperatures are highest during the summer and fall, and oceanographic conditions create favorable habitat for leatherback turtle prey (jellyfish). Satellite telemetry data indicate that these animals are within the California Current Large Marine Ecosystem, as well as that portion of the Study Area that is included within it (Benson et al. 2007). There is some evidence that they follow the 61°F (16°C) isotherm into Monterey Bay, and the length of their stay apparently depends on prey availability (Starbird et al. 1993). Satellite telemetry studies link leatherback turtles off the U.S. west coast to one of the two largest remaining Pacific Ocean breeding populations in Jamursba Medi, Indonesia. Thus, nearshore waters off central California represent an important foraging region for the critically endangered Pacific Ocean leatherback turtle. There were 96 sightings of leatherbacks within 50 km of Monterey Bay from 1986 to 1991, mostly by recreational boaters (Starbird et al. 1993).

Numerous NMFS survey sightings of leatherbacks have been recorded in the waters of Southern California, with nearly all of those sightings occurring in deeper waters seaward of the Channel Islands. Satellite-tracking studies from 2002 have demonstrated that leatherbacks migrate south from nearshore waters off central and northern California (such as Monterey Bay) along the U.S. west coast before they head west toward nesting grounds (Dutton unpublished data).

The leatherback is the most oceanic and wide-ranging of sea turtles, undertaking extensive migrations along distinct depth contours for hundreds to thousands of kilometers (Hughes et al. 1998; Morreale et al. 1996). After they nest, female leatherbacks migrate from tropical waters to more temperate latitudes that support high densities of jellyfish in the summer. Late juvenile and adult leatherback turtles are known to range from mid-ocean to the continental shelf and nearshore waters (Frazier 2001), foraging in coastal areas in temperate waters and offshore areas in tropical waters (Frazier 2001). Their movements appear to be linked to the seasonal availability of their prey and the requirements of their reproductive cycle (Davenport and Balazs 1991). Trans-Pacific Ocean migrations have been reported, including a 6,385 mi. (10,276 km) migration from a nesting beach in Papua New Guinea to foraging grounds off the coast of Oregon (Benson et al. 2007).

Recent information on leatherbacks tagged off the U.S. west coast revealed an important migratory corridor, from central California to south of the Hawaiian Islands, that leads to western Pacific Ocean nesting beaches (Dutton unpublished data). Leatherback turtles have been sighted and reported stranded as far north as Alaska (60° N) and as far south as San Diego (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998d).

Eighty percent of the leatherback's time at sea is spent diving (Fossette et al. 2007). The leatherback is the deepest diving sea turtle, with recorded depths of at least 4,035 ft. (1,230 m) (Hays, Metcalfe et al. 2004), although most dives are much shallower, usually less than 655 ft. (200 m) (Hays, Houghton et al. 2004; Sale et al. 2006). Leatherbacks spend most of their time in the upper 215 ft. (66 m) of the water column (Jonsen et al. 2007). Diving is influenced by many factors, including water temperature and local availability and vertical distribution of food resources, resulting in variations in dive times and distances (James et al. 2006; Sale et al. 2006).

The dive time limit for the leatherback is estimated at between 33 and 67 minutes (Hays, Houghton, et al. 2004; Hays, Metcalfe, et al. 2004; Southwood et al. 1999), with typical durations of 6.9 to 14.5 minutes (Eckert et al. 1996). During migrations or long-distance movements, leatherbacks travel within 15 ft. (4.8 m) of the surface (Eckert 2002), making scouting dives to sample prey density and to feed on whatever is available (James et al. 2006; Jonsen et al. 2007).

In warm waters, leatherbacks dive deeper and longer (James et al. 2005), spending only short periods at the surface between dives (Eckert et al. 1986). While diving in colder waters, sometimes just above freezing, leatherbacks make shorter dives and spend up to 50 percent of their time at or near the surface (James et al. 2006; Jonsen et al. 2007).

3.5.2.8.3 Population and Abundance

The major nesting populations of the Eastern Pacific Ocean stock occur in Mexico Costa Rica, Panama, Colombia, Ecuador, and Nicaragua (Chaloupka et al. 2004; Dutton et al. 1999; Eckert and Sarti-Martinez 1997; Márquez M. 1990; Sarti-Martinez et al. 1996; Spotila et al. 1996), with the largest ones in Mexico and Costa Rica. There are 28 known nesting sites for the western Pacific Ocean stock, with an estimated 5,000 to 9,100 leatherback nests annually across the western tropical Pacific Ocean, from Australia and Melanesia (Papua New Guinea, Solomon Islands, Fiji, and Vanuatu) to Indonesia, Thailand, and China (Chaloupka et al. 2004; Chua 1988; Dutton 2006; Hirth et al. 1993; Suarez et al. 2000).

Leatherback hatchlings are approximately 2 to 3 in. (5 to 7.6 cm) long and weigh approximately 1.4 to 1.8 oz. (40 to 51 g). As with other sea turtle species, limited information is available on the open ocean habitats used by hatchling and early juvenile leatherbacks (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992). Leatherbacks whose shell length is less than 40 in. (102 cm) have only been sighted in waters at least 79°F (26°C), restricting their habitat primarily to the tropics (Eckert 2002; Sarti-Martinez 2000). Other than a general association with warm waters, the distribution of hatchling and early juvenile leatherbacks is not known. Upwelling areas, such as equatorial convergence zones, are nursery grounds for hatchling and early juvenile leatherbacks, because these areas provide a good supply of prey (Musick and Limpus 1997). Individuals with a curved shell length of less than 57 in. (145 cm) are considered to be juveniles (Eckert 2002; NMFS 2001).

Leatherbacks are likely the fastest developing of all sea turtle species, reaching adulthood at 13 to 14 years (range 2 to 22 years) (Turtle Expert Working Group 2007; Zug and Parham 1996), and can live to 30 years or more (Sarti-Martinez 2000). Throughout their lives, leatherbacks are essentially oceanic, yet they enter coastal waters to forage and reproduce (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992). The species is not typically associated with coral reefs, but is occasionally encountered in deep ocean waters near prominent island chains, such as deep waters off the Hawaiian Island chain (Eckert 1993). There is evidence that leatherbacks are associated with oceanic front systems, such as shelf breaks and the edges of oceanic gyre systems, where their prey is concentrated (Eckert 1993).

The leatherback's unique anatomy and metabolism, compared to all other turtle species (Bradshaw et al. 2007; Goff and Stenson 1988; Greer et al. 1973; Mrosovsky and Pritchard 1971; Neill and Stevens 1974; Paladino et al. 1990), allows them to maintain a core body temperature higher than that of the surrounding water, thereby allowing them to tolerate colder waters (Frair et al. 1972; James and Mrosovsky 2004). As juveniles grow, this ability is enhanced, allowing leatherbacks to expand their ranges into the cooler waters (Eckert 2002).

Nesting leatherbacks prefer wide sandy beaches backed with vegetation (Eckert 1987; Hirth and Ogren 1987). In the water, they prefer habitat characterized by steep drop-offs or mud banks without coral or rock formations (Turtle Expert Working Group 2007). For both the western and eastern Pacific Ocean populations, the nesting season extends from October through March, with a peak in December. The single exception is the Jamursba-Medi (Papua) stock, which nests from April to October, with a peak in August (Chaloupka et al. 2004). Typical clutches are 50 to more than 150 eggs, with the incubation period lasting around 65 days. Females lay an average of five to seven clutches in a single season (with a maximum of 11) with intervals of 8 to 10 days or longer (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992). Females remain in the general vicinity of the nesting habitat for their breeding period, which can last up to four months (Eckert, Eckert, Adams, et al. 1989; Keinath and Musick 1993), although they may nest on several islands in a chain during a single nesting season (Pritchard 1982). Mating is thought to occur before or during the migration from temperate to tropical waters (Eckert and Eckert 1988).

3.5.2.8.4 Predator/Prey Interactions

Leatherbacks lack the crushing and chewing plates characteristic of sea turtles that feed on hard-bodied prey (National Marine Fisheries Service 2010b). Instead, they have pointed tooth-like cusps and sharp-edged jaws that are perfectly adapted for a diet of soft-bodied prey, such as jellyfish and salps (Bjorndal 1997; Grant and Ferrell 1993; James and Herman 2001; National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992; Salmon et al. 2004). Leatherbacks feed from the surface as well as at depth, diving to 4,035 ft. (1,240 m) (Davenport 1988; Eckert et al. 1989; Eisenberg and Frazier 1983; Grant and Ferrell 1993; Hays et al. 2004; James et al. 2005; Salmon et al. 2004). Leatherbacks in the Caribbean may synchronize their diving patterns with the daily vertical migration of a deep-water ecosystem of fishes, crustaceans, gelatinous salps, and siphonophores, known as the deep scattering layer, which moves toward the surface of the ocean at dusk and rapidly descends in the morning (Eckert et al. 1989; Eckert et al. 1986). A similar vertical migration of small fish and crustacean species has been studied in the Insular Pacific-Hawaiian Large Marine Ecosystem, which migrates from approximately 1,300 to 2,300 ft. (396 to 701 m) during the day to near the surface at night (Benoit-Bird et al. 2001). It is unknown whether this type of foraging is widespread for leatherbacks (Eckert et al. 1989). Those individuals studying known feeding grounds have observed leatherbacks foraging on jellyfish at the surface (Grant and Ferrell 1993; James and Herman 2001; Starbird et al. 1993). Leatherbacks are subject to predation by the same predators as other sea turtles, such as sharks, certain fish preying on hatchlings, and various land predators preying on hatchlings (e.g., ants, crabs, birds, and mammals) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009).

3.5.3 ENVIRONMENTAL CONSEQUENCES

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) could impact sea turtles known to occur within the Study Area. Tables 2.8-1 through 2.8-5 present the baseline and proposed training and testing activity locations for each alternative (including number of events and ordnance expended). Each sea turtle substressor is

introduced, analyzed by alternative, and analyzed for training activities and testing activities, and then an ESA determination is made by substressor. Stressors applicable to sea turtles in the Study Area analyzed below include the following:

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

Each of these stressors is analyzed for its potential impacts on sea turtles. The specific analyses of the training and testing activities consider these stressors within the context of the geographic range of the species.

3.5.3.1 Acoustic Stressors

3.5.3.1.1 Sound Producing and Explosive Activities

Assessing whether sounds may disturb or injure an animal involves understanding the characteristics of the acoustic sources, the animals that may be present near the sound, and the effects that sound may have on the physiology and behavior of those animals.

The methods used to predict acoustic effects on sea turtles build upon the Conceptual Framework for Assessing Effects from Sound-Producing Activities (Section 3.0.5.7.1). Additional research specific to sea turtles is presented where available.

3.5.3.1.2 Analysis Background and Framework

A range of impacts on sea turtles could occur depending on the sound source. The impacts of exposure to non-explosive, sound-producing activities or to sounds produced by an explosive detonation could include permanent or temporary hearing loss, changes in behavior, and physiological stress. In addition, potential impacts of an explosive impulse can range from physical discomfort to non-lethal and lethal injuries. Immediate non-lethal injury includes slight injury to internal organs and injury to the auditory system, which could reduce long-term fitness. Immediate lethal injury would be a result of massive combined trauma to internal organs as a direct result of proximity to the point of detonation.

3.5.3.1.2.1 Direct Injury

Direct injury from non-impulsive sound sources, such as sonar, is unlikely because of relatively lower peak pressures and slower rise times than potentially injurious sources such as explosives and impact pile driving. Non-impulsive sources also lack the strong shock waves that are associated with explosions. Therefore, primary blast injury and barotrauma would not result from exposure to non-impulsive sources such as sonar, and are only considered for explosive detonations.

The potential for trauma in sea turtles exposed to impulsive sources (e.g., explosions) has been inferred from tests of submerged terrestrial mammals exposed to underwater explosions (Ketten et al. 1993; Richmond et al. 1973; Yelverton et al. 1973). The effects of an underwater explosion on a sea turtle depend upon several factors, including size, type, and depth of both the animal and the explosive, depth

of the water column, and distance from the charge to the animal. Smaller sea turtles would generally be more susceptible to injury. The compression of blast-sensitive, gas-containing organs when a sea turtle increases depth reduces likelihood of injury to these organs. The location of the explosion in the water column and the underwater environment determines whether most energy is released into the water or the air and influences the propagation of the blast wave.

Primary Blast Injury and Barotrauma

The greatest potential for direct, non-auditory tissue impacts is primary blast injury and barotrauma after exposure to the shock waves of high-amplitude impulsive sources, such as explosions. Primary blast injury refers to those injuries that result from the initial compression of a body exposed to the high pressure of a blast or shock wave. Primary blast injury is usually limited to gas-containing structures (e.g., lung and gut) and the pressure-sensitive components of the auditory system (discussed below) (Office of the Surgeon General 1991; Craig and Hearn 1998), although additional injuries could include concussive brain damage and cranial, skeletal, or shell fractures (Ketten 1995). Barotrauma refers to injuries caused when large pressure changes occur across tissue interfaces, normally at the boundaries of air-filled tissues such as the lungs. Primary blast injury to the respiratory system, as measured in terrestrial mammals, may consist of lung bruising, collapsed lung, traumatic lung cysts, or air in the chest cavity or other tissues (Office of the Surgeon General 1991). These injuries may be fatal depending on the severity of the trauma. Rupture of the lung may introduce air into the vascular system, possibly producing air blockage that can cause a stroke or heart attack by restricting oxygen delivery to these organs. Although often secondary in life-threatening severity to pulmonary blast trauma, the gastrointestinal tract can also suffer bruising and tearing from blast exposure, particularly in air-containing regions of the tract. Potential traumas include internal bleeding, bowel perforation, tissue tears, and ruptures of the hollow abdominal organs. Although hemorrhage of solid organs (e.g., liver, spleen, and kidney) from blast exposure is possible, rupture of these organs is rarely encountered. Non-lethal injuries could increase a sea turtle's risk of predation, disease, or infection.

Auditory Trauma

Components of the auditory system that detect smaller or more gradual pressure changes can also be damaged when overloaded at high pressures with rapid rise times. Rupture of the eardrum, while not necessarily a serious or life-threatening injury, may lead to permanent hearing loss (Ketten 1995, 1998). No data exist to correlate the sensitivity of the sea turtle eardrum and middle and inner ear to trauma from shock waves from underwater explosions (Viada et al. 2008).

The specific impacts of bulk cavitation on sea turtles are unknown (see Section 3.0.4.1.4.2 for an explanation of cavitation following an explosive detonation). The presence of a sea turtle within the cavitation region created by the detonation of small charges could annoy, injure, or increase the severity of the injuries caused by the shock wave, including injuries to the auditory system or lungs. The area of cavitation from a large charge, such as those used in ship shock trials, is expected to be an area of almost complete total physical trauma for smaller animals (Craig and Rye 2008). An animal located at (or near) the cavitation closure depth would be subjected to a short duration ("water hammer") pressure pulse; however, direct shock wave impacts alone would be expected to cause auditory system injuries and could cause internal organ injuries.

3.5.3.1.2.2 Hearing Loss

Hearing loss could effectively reduce the distance over which sea turtles can detect biologically relevant sounds. Both auditory trauma (a direct injury discussed above) and auditory fatigue may result in hearing loss, but the mechanisms responsible for auditory fatigue differ from auditory trauma. Hearing

loss due to auditory fatigue is also known as threshold shift, a reduction in hearing sensitivity at certain frequencies. Threshold shift is the difference between hearing thresholds measured before and after an intense, fatiguing sound exposure. Threshold shift occurs when hair cells in the ear fatigue, causing them to become less sensitive over a small range of frequencies related to the sound source to which an animal was exposed. The actual amount of threshold shift depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure. No studies are published on inducing threshold shift in sea turtles; therefore, the potential for the impact on sea turtles is inferred from studies of threshold shift in other animals.

Temporary threshold shift (TTS) is a hearing loss that recovers to the original hearing threshold over a period. An animal may not even be aware of a TTS. It does not become deaf, but requires a louder sound stimulus (relative to the amount of TTS) to detect a sound within the affected frequencies. TTS may last several minutes to several days, depending on the intensity and duration of the sound exposure that induced the threshold shift (including multiple exposures).

Permanent threshold shift (PTS) is a permanent loss of hearing sensitivity at a certain frequency range. PTS is non-recoverable due to the destruction of tissues within the auditory system. The animal does not become deaf, but requires a louder sound stimulus (relative to the amount of PTS) to detect a sound within the affected frequencies. As the name suggests, the effect is permanent.

3.5.3.1.2.3 Auditory Masking

Auditory masking occurs when a sound prevents or limits the distance over which an animal detects other biologically relevant sounds. When a noise has a sound level above the sound of interest, and in a similar frequency band, auditory masking could occur (see Section 3.0.5.7.1, Conceptual Framework for Assessing Effects from Sound-Producing Activities). Any sound above ambient noise levels and within an animal's hearing range could cause masking. The degree of masking increases with increasing noise levels; a noise that is just-detectable over ambient levels is unlikely to actually cause any substantial masking, whereas a louder noise may mask sounds over a wider frequency range. In addition, a continuous sound would have more potential for masking than a sound with a low duty cycle. In the open ocean, ambient noise levels are between about 60 and 80 dB re 1 µPa, especially at lower frequencies (below 100 Hz) and inshore, ambient noise levels, especially around busy ports, can exceed 120 dB re 1 µPa.

Unlike auditory fatigue, which always results in a localized stress response, behavioral changes resulting from auditory masking may not be coupled with a stress response. Another important distinction between masking and hearing loss is that masking only occurs in the presence of the sound stimulus, whereas hearing loss can persist after the stimulus is gone.

Little is known about how sea turtles use sound in their environment. Based on knowledge of their sensory biology (Bartol and Ketten 2006; Levenson et al. 2004; Bartol and Musick 2003), sea turtles may be able to detect objects within the water column (e.g., vessels, prey, predators) via some combination of auditory and visual cues. However, research examining the ability of sea turtles to avoid collisions with vessels shows they may rely more on their vision than auditory cues (Hazel et al. 2007). Similarly, while sea turtles may rely on acoustic cues to identify nesting beaches, they appear to rely on other non-acoustic cues for navigation, such as magnetic fields (Lohmann and Lohmann 1996) and light (Avens and Lohman 2003). Additionally, they are not known to produce sounds underwater for communication. As a result, sound may play a limited role in a sea turtle's environment. Therefore, the potential for masking may be limited.

3.5.3.1.2.4 Physiological Stress

Sea turtles may exhibit a behavioral response or combinations of behavioral responses upon exposure to anthropogenic sounds. If a sound is detected, a stress response (i.e., startle or annoyance) or a cueing response (based on a past stressful experience) can occur. Sea turtles naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with members of the same species, nesting, and interactions with predators all contribute to stress. Anthropogenic activities could provide additional stressors above and beyond those that occur in the absence of human activity.

Immature Kemp's ridley sea turtles show physiological responses to the acute stress of capture and handling through increased levels of the stress hormone corticosterone, along with biting and rapid flipper movement (Gregory and Schmid 2001). Kemp's ridley sea turtles are not found in the HSTT Study Area; however, they are closely related to olive ridley sea turtles, which are found in the Study Area. Studies involving Kemp's ridley sea turtles are applicable to olive ridleys when comparative studies for olive ridley sea turtles are lacking. Captive olive ridley hatchlings showed heightened blood glucose levels indicating physiological stress (Rees et al. 2008, Zenteno 2008). Repeated exposure to stressors, including human disturbance such as vessel disturbance and anthropogenic sound, may result in negative consequences to the health and viability of an individual or population (Gregory and Schmid 2001). Factors to consider when predicting a stress or cueing response is whether an animal is naïve or has prior experience with a stressor. Prior experience with a stressor may be of particular importance as repeated experience with a stressor may dull the stress response via acclimation.

3.5.3.1.2.5 Behavioral Reactions

The response of a sea turtle to an anthropogenic sound will depend on the frequency, duration, temporal pattern, and amplitude of the sound, as well as the animal's prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). Distance from the sound source and whether it is perceived as approaching or moving away could also affect the way a sea turtle responds to a sound. Potential behavioral responses to anthropogenic sound could include startle reactions, disruption of feeding, disruption of migration, changes in respiration, alteration of swim speed, alteration of swim direction, and area avoidance.

Studies of sea turtle responses to sounds are limited. A few studies examined sea turtle reactions to airguns, which produce broadband impulsive sound. O'Hara and Wilcox (1990) attempted to create a sound barrier at the end of a canal using seismic airguns. They reported that loggerhead turtles kept in a 984 ft. by 148 ft. (300 m by 45 m) enclosure in a 10 m deep canal maintained a standoff range of 98 ft. (30 m) from airguns fired simultaneously at intervals of 15 seconds, with strongest sound components within the 25 to 1,000 Hz frequency range. McCauley et al. (2000) estimated that the received level at which turtles avoided sound in the O'Hara and Wilcox (1990) experiment was 175 to 176 dB re 1 µPa root mean square.

Moein Bartol et al. (1995) investigated the use of air guns to repel juvenile loggerhead sea turtles from hopper dredges. Sound frequencies of the airguns ranged from 100 to 1,000 Hz at three levels: 175, 177, and 179 dB re 1 µPa at 1 m. The turtles avoided the airguns during the initial exposures (mean range of 24 m), but additional trials several days afterward did not elicit statistically significant avoidance. They concluded that this was due to either habituation or a temporary shift in the turtles' hearing capability.

McCauley et al. (2000) exposed caged green and loggerhead sea turtles to an approaching-departing single air gun to gauge behavioral responses. The trials showed that above a received level of 166 dB re 1 µPa (root mean square), the turtles noticeably increased their swimming activity compared to non-operational periods, with swimming time increasing as air gun levels increased during approach. Above 175 dB re 1 µPa (root mean square), behavior became more erratic, possibly indicating the turtles were in an agitated state (McCauley et al. 2000). The authors noted that the point at which the turtles showed the more erratic behavior and exhibited possible agitation would be expected to approximately equal the point at which active avoidance would occur for unrestrained turtles (McCauley et al. 2000).

No obvious avoidance reactions by free-ranging sea turtles, such as swimming away, were observed during a multi-month seismic survey using airgun arrays, although fewer sea turtles were observed when the seismic airguns were active than when they were inactive (Weir 2007). The author noted that sea state and the time of day affected both airgun operations and sea turtle surface basking behavior, making it difficult to draw conclusions from the data.

No studies have been performed to examine the response of sea turtles to sonar. However, based on their limited range of hearing, they may respond to sources operating below 2 kHz but are unlikely to sense higher frequency sounds (see Section 3.5.3.1.2, Analysis Background and Framework).

3.5.3.1.2.6 Repeated Exposures

Repeated exposures of an individual to sound-producing activities over a season, year, or life stage could cause reactions with energetic costs that can accumulate over time to cause long-term consequences for the individual. Conversely, some sea turtles may habituate to or become tolerant of repeated exposures over time, learning to ignore a stimulus that in the past was not accompanied by any overt threat, such as high levels of ambient noise found in areas of high vessel traffic (Hazel et al. 2007). In an experiment, after initial avoidance reactions, loggerhead sea turtles habituated to repeated exposures to airguns of up to a source level of 179 dB re 1 µPa in an enclosure. The habituation behavior was retained by the sea turtles when exposures were separated by several days (Moein Bartol et al. 1995).

3.5.3.1.3 Acoustic Impacts Thresholds and Criteria

The Navy considers two primary categories of sound sources in its analyses of sound impacts to sea turtles: impulsive sources (e.g., explosives, airguns, weapons firing, and impact pile driving) and non-impulsive sources (e.g., sonar, pingers, and countermeasure devices). General definitions of impulsive and non-impulsive sound sources are provided below. Acoustic impacts criteria and thresholds were developed in cooperation with NMFS for sea turtle exposures to various sound sources. These acoustic impacts criteria are summarized in Table 3.5-2 and Table 3.5-3.

Table 3.5-2: Sea Turtle Impact Threshold Criteria for Non-Impulsive Sources

Physiological Thresholds		
Onset[1] PTS	Onset[1] TTS	Injury (Vibratory Pile Driving)
198 dB SEL (T)	178 dB SEL (T)	190 dB re 1 µPa SPL root mean square

[1] (T): Turtle Weighting Function. When the cetacean criteria were weighted to correlate with Type II frequency weighting, the turtle threshold was inadvertently lowered by 17 dB, even though Type II weighting is not applied to sea turtle hearing. This resulted in an increased number of model-predicted turtle impacts, although the actual impacts are expected to be substantially lower.
Notes: dB = decibels, PTS = permanent threshold shift, TTS = temporary threshold shift, SEL = sound exposure level, SPL = sound pressure level

These criteria can be used to estimate the number of sea turtles impacted by testing and training activities that emit sound or explosive energy, as well as the severity of the immediate impacts. These

criteria are used to quantify impacts from explosives, airguns, pile driving, sonar, and other active acoustic sources. These criteria are also useful for qualitatively assessing activities that indirectly impart sound to water, such as firing of weapons and aircraft flights.

Table 3.5-3: Sea Turtle Impact Threshold Criteria for Impulsive Sources

Impulsive Sound Exposure Impact	Threshold Value
Onset Mortality[1] (1% Mortality Based on Extensive Lung Injury)	$= 91.4M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1/2} Pa-s$
Onset Slight Lung Injury[1]	$= 39.1M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1/2} Pa-s$
Onset Slight Gastrointestinal Tract Injury	237 dB re 1 μPa SPL (104 psi)
Onset PTS	187 dB re 1 μPa^2-s SEL (T^2) or 230 dB re 1 μPa Peak SPL
Onset TTS	172 dB re 1 μPa^2-s SEL (T^2) or 224 dB re 1 μPa Peak SPL
Impact Pile Driving (Injury)	190 dB re 1 μPa SPL root mean square[3]

[1] M = mass of animals (kg) as shown for each species in Table 3.5-4, D_{Rm} = depth of animal (m). Impulse calculated over a delivery time that is the lesser of the initial positive pressure duration or 20 percent of the natural period of the assumed-spherical lung adjusted for animal size and depth.
[2] Turtle Weighting Function. When the cetacean criteria were weighted to correlate with Type II frequency weighting, the turtle threshold was inadvertently lowered by 17 dB, even though Type II weighting is not applied to sea turtle hearing. This resulted in an increased number of model-predicted turtle impacts, although the actual impacts are expected to be substantially lower.
[3] The interval for determining the root mean square is that which contains 90% of the total energy within the envelope of the pulse. This windowing procedure for impulse signals removes uncertainty about where to set the exact temporal beginning or end of the signal, which may be obscured by ambient noise.
Notes: kg = kilograms, m = meters, PTS = permanent threshold shift, TTS = temporary threshold shift, SEL = sound exposure level, SPL = sound pressure level

3.5.3.1.3.1 Categories of Sounds as Defined for Thresholds and Criteria

Categories of sound are discussed in Section 3.0.4 (Acoustic and Explosives Primer). Impulsive and non-impulsive sounds are described again below with details specific to assigning acoustic and explosive criteria for predicting impacts to sea turtles.

3.5.3.1.3.2 Impulsive Sounds

Impulsive sounds (including explosions) have a steep pressure rise or rapid pressure oscillation, which is the primary reason the impacts of these sounds are considered separately from non-impulsive sounds. Impulsive sounds usually rapidly decay with only one or two peak oscillations and are of very short duration (usually 0.1 second or shorter). Rapid pressure changes may produce mechanical damage to the ear or other structures that would not occur with slower rise times found in non-impulsive signals. Impulsive sources analyzed in this document include explosives, airguns, sonic booms, weapons firing, and impact pile-driving.

3.5.3.1.3.3 Non-Impulsive Sounds

Non-impulsive sounds typically contain multiple pressure oscillations without a rapid rise time, although the total duration of the signal may still be quite short (0.1 second or shorter for some high-frequency sources). Such sounds are typically characterized by a root mean square average sound pressure level or

energy level over a specified period. Sonar and other active acoustic sources (e.g., pingers) are analyzed as non-impulsive sources in this document.

Intermittent non-impulsive sound sources produce sound for only a small fraction of the time that the source is in use (a few seconds or a fraction of a second, e.g., sonar and pingers), with longer silent periods in between the sound. Continuous sources are those that transmit sound for all of the time they are being used, often for many minutes, hours, or days. Vibratory pile driving, vessel noise, and aircraft noise are continuous noise sources analyzed in this document.

3.5.3.1.3.4 Criteria for Mortality and Injury from Explosives

There is a considerable body of laboratory data on actual injuries from impulsive sounds, usually from explosive pulses, obtained from tests with a variety of vertebrate species (e.g., Goertner et al. 1994; Richmond et al. 1973; Yelverton et al. 1973). Based on these studies, potential impacts, with decreasing likelihood of serious injury or lethality, include onset of mortality, onset of slight lung injury, and onset of slight gastrointestinal injury.

In the absence of data specific to sea turtles, criteria developed to assess impacts to protected marine mammals are also used to assess impacts to protected sea turtles. These criteria are discussed below.

3.5.3.1.3.5 Criteria for Mortality and Slight Lung Injury

In air or submerged, the most commonly reported internal bodily injury to sea turtles from explosive detonations is hemorrhaging in the fine structure of the lungs. The likelihood of internal bodily injury is related to the received impulse of the underwater blast (pressure integrated over time), not peak pressure or energy (Richmond et al. 1973; Yelverton and Richmond 1981; Yelverton et al. 1973; Yelverton et al. 1975). Therefore, impulse is used as a metric upon which internal organ injury can be predicted. Onset mortality and onset slight lung injury are defined as the impulse level that would result in one percent mortality (most survivors have moderate blast injuries and should survive) and zero percent mortality (recoverable, slight blast injuries) in the exposed population, respectively. Criteria for onset mortality and onset slight lung injury were developed using data from explosive impacts on mammals (Yelverton and Richmond 1981).

The impulse required to cause lung damage is related to the volume of the lungs. The lung volume is related to both the size (mass) of the animal and compression of gas-filled spaces at increasing water depth. Turtles have relatively low lung volume to body mass and a relatively stronger anatomical structure compared to mammals; therefore application of the criteria derived from studies of impacts of explosives on mammals is conservative.

Table 3.5-4 provides a nominal conservative body mass for each sea turtle species, based on juvenile mass. Juvenile body masses were selected for analysis given the early rapid growth of these reptiles (newborn turtles weigh less than 0.5 percent of maximum adult body mass). In addition, small turtles tend to remain at shallow depths in the surface pressure release zone, reducing potential exposure to injurious impulses. Therefore, use of hatchling weight would provide unrealistically low thresholds for estimating injury to sea turtles. The use of juvenile body mass rather than hatchling body mass was chosen to produce reasonably conservative estimates of injury.

The scaling of lung volume to depth is conducted for all species because data come from experiments with terrestrial animals held near the water's surface. The calculation of impulse thresholds consider depth of the animal to account for compression of gas-filled spaces that are most sensitive to impulse

injury. The impulse required for a specific level of injury (impulse tolerance) is assumed to increase proportionally to the square root of the ratio of the combined atmospheric and hydrostatic pressures at a specific depth with the atmospheric pressure at the surface (Goertner 1982). Additionally, to reach the threshold for onset slight lung injury or onset mortality, the critical impulse value must be delivered during a period that is the lesser of the initial positive pressure duration or 20 percent of the natural period of the assumed-spherical lung adjusted for size and depth of the animal. Therefore, as depth increases or animal size decreases, impulse delivery time decreases (Goertner 1982).

Table 3.5-4: Species-Specific Masses for Determining Onset of Extensive and Slight Lung Injury Thresholds

Common Name	Juvenile Mass (kilograms)	Reference
Loggerhead turtle	8.4	Southwood et al (1999)
Green turtle	8.7	Wood and Wood (1993)
Hawksbill turtle	7.4	Okuyama et al. (2010)
Olive ridley turtle	6.3	McVey and Wibbels (1984) and Caillouet et al. (1995)[1]
Leatherback turtle	34.8	Jones (2009)

[1] McVey and Wibbles (1984) and Caillouet et al. (1995) measured masses for Kemp's ridley turtles, a closely related species to the olive ridley.

Very little information exists about the impacts of underwater detonations on sea turtles. Impacts of explosive removal operations on sea turtles range from non-injurious impacts (e.g., acoustic annoyance, mild tactile detection, or physical discomfort) to varying levels of injury (i.e., non-lethal and lethal injuries) (Klima et al. 1988; Viada et al. 2008). Often, impacts of explosive events on turtles must be inferred from documented impacts on other vertebrates with lungs or other-gas containing organs, such as mammals and most fishes (Viada et al. 2008). The methods used by Goertner (1982) to develop lung injury criteria for marine mammals may not be directly applicable to sea turtles, as it is not known what degree of protection to internal organs from the shock waves is provided to sea turtles by their shell (Viada et al. 2008). However, the general principles of the Goertner model are applicable, and should provide a protective approach to assessing potential impacts on sea turtles. The Goertner method predicts a minimum primary positive impulse value for onset of slight lung injury and onset of mortality, adjusted for assumed lung volume (correlated to animal mass) and depth of the animal. These equations are shown in Table 3.5-3.

3.5.3.1.3.6 Criteria for Onset of Gastrointestinal Tract Injury

Without data specific to sea turtles, data from tests with terrestrial animals are used to predict onset of gastrointestinal tract injury. Gas-containing internal organs, such as lungs and intestines, were the principle damage sites from shock waves in submerged terrestrial mammals (Clark and Ward 1943, Greaves et al. 1943, Richmond et al. 1973, Yelverton et al. 1973). Furthermore, slight injury to the gastrointestinal tract may be related to the magnitude of the peak shock wave pressure over the hydrostatic pressure, and would be independent of the animal's size and mass (Goertner 1982). Slight contusions to the gastrointestinal tract were reported during small charge tests (Richmond et al. 1973), when the peak was 237 dB re 1 µPa. Therefore, this value is used to predict onset of gastrointestinal tract injury in sea turtles exposed to explosions.

Frequency Weighting

Animals generally do not hear equally well across their entire hearing range. Several studies using green, loggerhead, and Kemp's ridley turtles suggest sea turtles are most sensitive to low-frequency sounds, although this sensitivity varies slightly by species and age class (Bartol and Ketten 2006, Bartol et al. 1999, Lenhardt 1994, Ridgway et al. 1969). Sea turtles possess an overall hearing range of approximately 100 Hz to 1 kHz, with an upper limit of 2 kHz (Bartol and Ketten 2006, Bartol et al. 1999, Lenhardt 1994, Ridgway et al. 1969).

Because hearing thresholds are frequency-dependent, an auditory weighting function was developed for sea turtles (turtle-weighting, or T-weighting). The T-weighting function simply defines lower and upper frequency boundaries beyond which sea turtle hearing sensitivity decreases. The single frequency cutoffs at each end of the frequency range where hearing sensitivity begins to decrease are based on the most liberal interpretations of sea turtle hearing abilities (10 Hz and 2 kHz). These boundaries are precautionary and exceed the demonstrated or anatomy-based hypothetical upper and lower limits of sea turtle hearing. Figure 3.5-1 shows the sea turtle auditory weighting function with lower and upper boundaries of 10 Hz and 2 kHz, respectively.

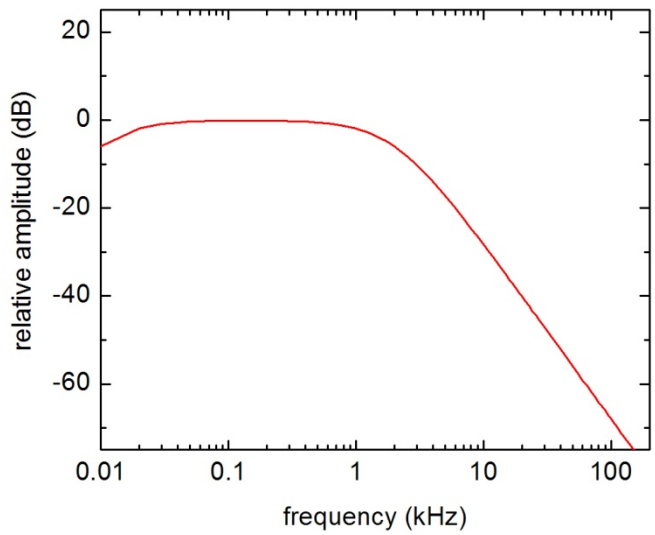

Figure 3.5-1: Auditory Weighting Function for Sea Turtles (T-weighting)

The T-weighting function adjusts the received sound level, based on sensitivity to different frequencies, emphasizing frequencies to which sea turtles are most sensitive and reducing emphasis on frequencies outside of their estimated useful range of hearing. For example, a 160 dB re 1 µPa tone at 10 kHz, far outside sea turtle best range of hearing, is estimated to be perceived by a sea turtle as a 130 dB re 1 µPa sound (i.e., 30 dB lower). Stated another way, a sound outside of the range of best hearing would have to be more intense to have the same impact as a sound within the range of best hearing. Weighting functions are further explained in Section 3.0.4, Acoustic and Explosives Primer.

3.5.3.1.3.7 Criteria for Hearing Loss – Temporary and Permanent Threshold Shift

Whereas TTS represents a temporary reduction of hearing sensitivity, PTS represents tissue damage that does not recover and permanent reduced sensitivity to sounds over specific frequency ranges (see Section 3.5.3.1.2.2, Hearing Loss). To date, no known data are available on potential hearing impairments (i.e., TTS and PTS) in sea turtles. Sea turtles, based on their auditory anatomy (Bartol and Musick 2003; Lenhardt et al. 1985; Wartzok and Ketten 1999; Wever 1978; Wyneken 2001), almost

certainly have poorer absolute sensitivity (i.e., higher thresholds) across much of their hearing range than do the mid-frequency cetacean species. Therefore, applying TTS and PTS criteria derived from mid-frequency cetaceans to sea turtles should provide a protective approach to estimating acoustic impacts to sea turtles (PTS and TTS data are not available for low-frequency cetaceans). Criteria for hearing loss due to onset of TTS and PTS are based on sound exposure level (for non-impulsive and impulsive sources) and peak pressure (for impulsive sources only).

To determine the sound exposure level, the turtle weighting function is applied to the acoustic exposure to emphasize only those frequencies within a sea turtle's hearing range. Multiple exposures within any 24-hour period are considered one continuous exposure for the purposes of calculating the received sound exposure level for a given individual. This conservatively assumes no recovery of hearing between exposures during a 24-hour period. The weighted sound exposure level is then compared to weighted threshold values for TTS and PTS. If the weighted exposure level meets or exceeds the weighted threshold, then the physiological impact (TTS or PTS) is assumed to occur. For impacts from exposures to impulsive sources, the metric (peak pressure or sound exposure level) and threshold level that results in the longest range to impact is used to predict impacts. Exposures are not calculated for sound sources with a nominal frequency outside the upper and lower frequency hearing limits for sea turtles.

In addition to being discussed below, thresholds for onset of TTS and PTS for impulsive and non-impulsive sounds are summarized in Tables 3.5-2 and 3.5-3.

3.5.3.1.3.8 Criteria for Non-Impulsive Temporary Threshold Shift

Based on best available science regarding TTS in marine vertebrates (Finneran et al. 2002; Southall et al. 2007) and the lack of information regarding TTS in sea turtles, the total T-weighted sound exposure level of 178 dB re 1 micro Pascal squared second (μPa^2-s) is used to estimate exposures resulting in TTS for sea turtles. The T-weighting function is used in conjunction with this non-pulse criterion, which effectively provides an upper cutoff of 2 kHz.

The T-weighted non-impulsive TTS threshold of 178 dB re 1 μPa^2-s sound exposure level was inadvertently based on Type II weighted cetacean TTS data rather than Type I weighted cetacean TTS data. This resulted in incorrectly lowering the turtle TTS threshold by 17 dB. The sea turtle non-impulsive TTS threshold, based on mid-frequency cetacean data, should be 17 dB higher than 178 dB re 1 μPa^2-s. Because an incorrectly lowered threshold was used to quantitatively analyze acoustic impacts on sea turtles in this EIS/OEIS, the quantitative impacts presented herein for non-impulsive TTS are conservative (i.e., over-predicted).

3.5.3.1.3.9 Criteria for Impulsive Temporary Threshold Shift

Based on best available science regarding TTS in marine vertebrates (Finneran et al. 2005; Finneran et al. 2000; Finneran et al. 2002; Nachtigall et al. 2003; Nachtigall et al. 2004; Schlundt et al. 2000) and the lack of information regarding TTS in sea turtles, the respective total T-weighted sound exposure level of 172 dB re 1 μPa^2-s or peak pressure of 224 dB re 1 μPa (23 pounds per square inch [psi]) is used to estimate exposures resulting in TTS for sea turtles. The T-weighting function is applied when using the sound exposure level-based thresholds to predict TTS.

3.5.3.1.3.10 Criteria for Non-Impulsive Permanent Threshold Shift

Since no studies were designed to intentionally induce PTS in sea turtles, levels for onset of PTS for these animals must be estimated using TTS data and relationships between TTS and PTS established in terrestrial mammals. Permanent threshold shift can be estimated based on the growth rate of a

threshold shift and the level of threshold shift required to potentially become non-recoverable. A variety of terrestrial and marine mammal data show that threshold shifts up to 40 to 50 dB may be recoverable, and that 40 dB is a reasonable upper limit of a threshold shift that does not induce PTS (Southall et al. 2007; Ward et al. 1958; Ward et al. 1959). This analysis assumes that continuous-type exposures producing threshold shifts of 40 dB or more always result in some amount of PTS.

Data from terrestrial mammal testing (Ward et al. 1958, 1959) show TTS growth of 1.5 to 1.6 dB for every 1 dB increase in sound exposure level. The difference between minimum measureable TTS onset (6 dB) and the 40 dB upper safe limit of TTS yields a difference of 34 dB. When divided by a TTS growth rate of 1.6 dB TTS per dB sound exposure level, there is an indication that an increase in exposure of a 21.25 dB sound exposure level would result in 40 dB of TTS. For simplicity and conservatism, the number was rounded down to 20 dB sound exposure level.

Therefore, non-impulsive exposures of 20 dB sound exposure level above those producing a TTS may be assumed to produce a PTS. The onset of TTS threshold of 195 dB re 1 μPa^2-s for sea turtles has a corresponding onset of PTS threshold of 198 dB re 1 μPa^2-s. The T-weighting function is applied when using the sound exposure level-based thresholds to predict PTS (see Table 3.5-2).

The T-weighted non-impulsive TTS threshold of 178 dB re 1 μPa^2-s sound exposure level was inadvertently based on Type II weighted cetacean TTS data rather than Type I weighted cetacean TTS data. This resulted in incorrectly lowering the turtle TTS threshold by 17 dB; consequently, also incorrectly lowering the sea turtle PTS threshold by 17 dB. The sea turtle non-impulsive PTS threshold, based on mid-frequency cetacean data, should be 17 dB higher than 198 dB re 1 μPa^2-s. Because an incorrectly lowered threshold was used to quantitatively analyze acoustic impacts to sea turtles in this EIS/OEIS, the quantitative impacts presented herein for non-impulsive PTS are conservative (i.e., over-predicted).

3.5.3.1.3.11 Criteria for Impulsive Permanent Threshold Shift

Because marine mammal and sea turtle PTS data from impulsive exposures do not exist, onset of PTS levels for these animals are estimated by adding 15 dB to the sound exposure level-based TTS threshold and adding 6 dB to the peak pressure-based thresholds. These relationships were derived by Southall et al. (2007) from impulsive noise TTS growth rates in chinchillas. This results in onset of PTS thresholds of total weighted sound exposure level of 187 dB re 1 μPa^2-s or peak pressure of 230 dB re 1 μPa for sea turtles. The T-weighting function is applied when using the sound exposure level-based thresholds to predict PTS. As with non-impulsive permanent threshold shift, the incorrect TTS data for cetaceans were applied for sea turtles when measuring permanent threshold shift from impulsive sources. Because an incorrectly lowered threshold was used to quantitatively analyze acoustic impacts to sea turtles in this EIS/OEIS, the quantitative impacts presented herein for impulsive TTS are conservative (i.e., over-predicted).

3.5.3.1.3.12 Criteria for Behavioral Responses

A sea turtle's behavioral responses to sound are assumed to be variable and context specific. For instance, a single impulse may cause a brief startle reaction. A sea turtle may swim farther away from the sound source, increase swimming speed, change surfacing time, and decrease foraging if the stressor continues to occur. For each potential behavioral change, the magnitude of the change ultimately would determine the severity of the response; most responses would be short-term avoidance reactions.

A few studies reviewed in Section 3.5.3.1.2.5 (Behavioral Reactions), investigated behavioral responses of sea turtles to impulsive sounds emitted by airguns (McCauley et al. 2000; Moein Bartol et al. 1995; O'Hara and Wilcox 1990). There are no studies of sea turtle behavioral responses to sonar. Cumulatively, available airgun studies indicate that perception and a behavioral reaction to a repeated sound may occur with sound pressure levels greater than 166 dB re 1 µPa root mean square, and that more erratic behavior and avoidance may occur at higher thresholds around 175 to 179 dB re 1 µPa root mean square (McCauley et al. 2000; Moein Bartol et al. 1995; O'Hara and Wilcox 1990). A received level of 175 dB re 1 µPa root mean square is more likely to be the point at which avoidance may occur in unrestrained turtles, with a comparable sound exposure level of 160 dB re 1 μPa^2-s (McCauley et al. 2000).

Airgun studies used sources that fired repeatedly over some duration. For single impulses at received levels below threshold shift (hearing loss) levels, the most likely behavioral response is assumed to be a startle response. Since no further sounds follow the initial brief impulse, the biological significance is considered to be minimal.

Based on the limited information regarding significant behavioral reactions of sea turtles to sound, behavioral responses to sounds are qualitatively assessed for sea turtles.

3.5.3.1.3.13 Criteria for Pile-Driving and Swimmer Defense Airguns

Existing NMFS risk criteria are applied to the unique sounds generated by pile-driving and swimmer defense airguns. Because there are no data specific to sea turtles upon which to base criteria, the Navy's analysis used criteria developed for injury to pinnipeds from impact pile-driving as criteria for injury to sea turtles (National Marine Fisheries Service 2005). Therefore, the threshold value for injury to sea turtles from impact and vibratory pile driving and airguns is 190 dB re 1 µPa sound pressure level root mean square.

3.5.3.1.4 Quantitative Analysis

A number of computer models and mathematical equations can be used to predict how energy spreads from a sound source (e.g., sonar or underwater detonation) to a receiver (e.g., sea turtle). See the Acoustic Primer Section (Section 3.0.4) for background information about how sound travels through the water. All modeling is an estimation of reality, with simplifications made both to facilitate calculations by focusing on the most important factors and to account for unknowns. For analysis of underwater sound impacts, basic models calculate the overlap of energy and marine life using assumptions that account for the many, variable, and often unknown factors that can greatly influence the result. Assumptions in previous Navy models intentionally erred on the side of overestimation when there were unknowns or when the addition of other variables was not likely to substantively change the final analysis. For example, because the ocean environment is extremely dynamic and information is often limited to a synthesis of data gathered over wide areas requiring many years of research, known information tends to be an average of the wide seasonal or annual variation that is actually present. The Equatorial Pacific El Niño disruption of the ocean-atmosphere system is an example of dynamic change where unusually warm ocean temperatures are likely to result in the redistribution of marine life and alter the propagation of underwater sound energy. Previous Navy modeling, therefore, made some assumptions indicative of a maximum theoretical propagation for sound energy (such as a perfectly reflective ocean surface and a flat seafloor). More complex computer models build upon basic modeling by factoring in additional variables in an effort to be more accurate by accounting for such things as bathymetry and an animal's likely presence at various depths.

For quantification of estimated marine mammal and sea turtle impacts resulting from sounds produced during Navy activities, the Navy developed a set of data and new software tools. This new approach is the resulting evolution of the basic modeling approaches used by the Navy previously, and reflects a much more complex and comprehensive modeling approach as described below.

3.5.3.1.5 Navy Acoustic Effects Model

For this analysis of Navy training and testing activities at sea, the Navy developed a set of software tools and compiled data for estimating acoustic impacts. These databases and tools collectively form the Navy Acoustics Effects Model. Details of the Navy Acoustics Effects Model processes and the description and derivation of the inputs are presented in the Technical Report (Determination of Acoustic Effects on Marine Mammals and Sea Turtles for Navy Training and Testing Events). The following paragraphs provide an overview of the Navy Acoustics Effects Model process and its more critical data inputs.

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

Using the best available information on the estimated density of sea turtles in the area being modeled, the Navy Acoustics Effects Model derives an abundance (total number individuals) and distributes the resulting number of virtual animals (“animats”) into an area bounded by the maximum distance that energy propagates out to a criterion threshold value (energy footprint). These animats are distributed based on density differences across the area and known depth distributions (dive profiles). Animats change depths every 4 minutes but do not otherwise mimic actual animal behaviors (such as avoidance or attraction to a stimulus).

Schecklman et al. (2011) argue that static distributions underestimate acoustic exposure compared to a model with fully three-dimensionally moving animals. However, their static method is different from the Navy Acoustic Effects Model in several ways. First, they distribute the entire population at depth with respect to the species-typical depth distribution histogram, and those animats remain static at that position throughout the entire simulation. In the Navy Acoustic Effects Model, animats are placed horizontally dependent upon non-uniform density information, and then move up and down over time within the water column by interrogating species-typical depth distribution information. Second, for the static method they calculate acoustic received level for designated volumes of the ocean and then sum the animats that occur within that volume, rather than using the animats themselves as dosimeters, as in the Navy Acoustic Effects Model. Third, Schecklman et al. (2011) run 50 iterations of the moving distribution to arrive at an average number of exposures, but because they rely on uniform horizontal density (and static depth density), only a single iteration of the static distribution is realized. In addition

to moving the animats vertically, the Navy Acoustic Effects Model overpopulates the animats over a non-uniform density and then resamples the population a number of times to arrive at an average number of exposures as well. Tests comparing fully moving distributions and static distributions with vertical position changes at varying rates were compared during development of the Navy Acoustic Effects Model. For position updates occurring more frequently than every 5 minutes, the number of estimated exposures were similar between the Navy Acoustic Effects Model and the fully moving distribution, however, computational time was much longer for the fully moving distribution.

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

The Navy Acoustics Effects Model then tracks the energy received by each animat within the energy footprint of the event and calculates the number of animats having received levels of energy exposures that fall within defined impact thresholds. Predicted effects to the animats within a scenario are then tallied and the highest order effect (based on severity of criteria; e.g., PTS over TTS) predicted for a given animat is assumed. Each scenario or each 24-hour period for scenarios lasting greater than 24 hours is independent of all others, and therefore, the same individual marine animal could be impacted during each independent scenario or 24-hour period. In a few instances, although the activities occur within the Study Area, sound may propagate beyond the boundary of the Study Area. Any exposures occurring outside the boundary of the Study Area are counted as if they occurred within the Study Area.

3.5.3.1.6 Model Assumptions and Limitations

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

- Animats are modeled as being underwater and facing the source and therefore always predicted to receive the maximum sound level at their position within the water column (e.g., the model does not account for conditions such as body shading or an animal raising its head above water).
- Multiple exposures within any 24-hour period are considered one continuous exposure for the purposes of calculating temporary or permanent hearing loss, because there are insufficient data to estimate a hearing recovery function for the time between exposures.
- Animats do not move horizontally (but change their position vertically within the water column), which may overestimate physiological impacts such as hearing loss, especially for slow-moving or stationary sound sources in the model.

- Animats are stationary horizontally and therefore do not avoid the sound source, unlike in the wild where animals would most often avoid exposures at higher sound levels, especially those exposures that may result in permanent hearing loss (PTS).
- Animats receive the full impulse of the initial positive pressure wave due to an explosion, although the impulse-based thresholds (onset mortality and onset slight lung injury) assume an impulse delivery time adjusted for animal size and depth. Therefore, these impacts are overestimated at greater distances and increased depths.
- Mitigation measures implemented during training and testing activities that reduce the likelihood of exposing a sea turtle to higher levels of acoustic energy near the most powerful sound sources (see Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) were not considered in the model.

3.5.3.1.6.1 Sea Turtle Densities

The Navy used the best available density estimates for green sea turtles available within nearshore waters of Hawaii and California. Because of the lack of density estimates for other sea turtle species within the Study Area more associated with open ocean habitats, sea turtle species were combined into a “Pacific guild” for modeling. In other words, green, hawksbill, loggerhead, leatherback, and olive ridley sea turtles were all included as a group to account for open ocean occurrences of sea turtle species in all life stages. A similar approach was taken for marine mammal modeling where certain cetacean species lacked continuous density estimates throughout the Study Area. All species density distributions matched the expected distributions from published literature and NMFS stock assessments.

A quantitative analysis of impacts on a species requires data on the abundance and concentration of the species population in the potentially impacted area. The most appropriate metric for this type of analysis is density, which is the number of animals present per unit area. There is no single source of density data for every area of the world, species, and season because of the fiscal costs, resources, and effort involved in providing survey coverage to sufficiently estimate density. Therefore, to characterize the marine species density for large areas such as the Study Area, the Navy compiled data from several sources. To compile and structure the most appropriate database of marine species density data, the Navy developed a protocol to select the best available data sources based on species, area, and time (season). The resulting Geographic Information System database called the Navy Marine Species Density Database includes seasonal density values for every marine mammal and sea turtle species present within the Study Area (U.S. Department of the Navy 2011). All species density distributions matched the expected distributions from published literature and the NMFS stock assessments.

In this analysis, sea turtle density data were used as an input in the Navy Acoustic Effects Model in their original temporal and spatial resolution. Seasons are defined as winter (December through February), spring (March through May), summer (June through August), and fall (September through November). The density grid cell spatial resolution varied, depending on the original data source used. Where data sources overlap, there might be a sudden increase or decrease in density due to different derivation methods or survey data utilized. This is an artifact of attempting to use the best available data for each geographic region. Any attempt to smooth the datasets would either increase or decrease adjacent values, and would inflate the error of those values.

3.5.3.1.7 Impacts from Sonar and Other Active Acoustic Sources

Sonar and other active acoustic sound sources emit sound waves into the water to detect objects, safely navigate, and communicate. These systems are used for anti-submarine warfare, mine warfare,

navigation, sensing of oceanographic conditions (e.g., sound speed profile), and communication. General categories of sonar systems are described in Section 2.3 and Section 3.0.5.3.1 (Acoustic Stressors).

Potential direct impacts on sea turtles from exposure to sonar or other non-impulsive underwater active acoustic sources include hearing loss from threshold shift (permanent or temporary), masking of other biologically relevant sounds, physiological stress, or changes in behavior (see Section 3.5.3.1.2, Analysis Background and Framework). Direct injury or barotrauma from a primary blast would not occur from exposure to these sources due to slower rise times and lower peak pressures. As stated above, a TTS can be mild and recovery can take place within a matter of minutes to days and, therefore, is unlikely to cause long-term consequences to individuals or populations. There is no research to indicate whether sea turtles with PTS would suffer long-term consequences. Sea turtles probably do not rely on their auditory systems as a primary sense, although little is known about how sea turtles use the narrow range of low-frequency sounds they might perceive in their environment (see Section 3.5.3.1.2.3, Auditory Masking). Some individuals that experience some degree of permanent hearing loss may have decreased abilities to find resources such as prey or nesting beaches or detect other relevant sounds such as vessel noise, which may lead to long-term consequences for the individual. Similarly, the effect of masking on sea turtles is difficult to assess.

There is little information about sea turtle responses to sound. The intensity of their behavioral response to a perceived sound could depend on several factors, including species, the animal's age, reproductive condition, past experience with the sound exposure, behavior (foraging or reproductive), the received level from the exposure, and the type of sound (impulse or non-impulse) and duration of the sound (see Section 3.0.5.7.1, Conceptual Framework for Assessing Effects from Sound-Producing Activities). Behavioral responses may be short-term (seconds to minutes) and of little immediate consequence for the animal, such as simply orienting to the sound source. Alternatively, there may be a longer term response over several hours such as moving away from the sound source. However, exposure to loud sounds resulting from Navy testing and training at sea would likely be brief because ships and other participants are constantly moving and the animal would likely be moving as well. Animals that are resident during all or part of the year near Navy ports, piers, and near-shore facilities or on fixed Navy ranges are the most likely to experience multiple or repeated exposures. A sea turtle could be exposed to sonar or other active acoustic sources several times in its lifetime, but the potential for habituation is unknown. Most exposures would be intermittent and short-term when considered over the duration of a sea turtle's life span. In addition, most sources emit sound at frequencies that are higher than the best hearing range of sea turtles.

Most sonar and other active acoustic sources used during testing and training use frequency ranges that are higher than the estimated hearing range of sea turtles (10 Hz-2 kHz). Therefore, most of these sources have no impact on sea turtle hearing. Only sonar with source levels greater than 160 dB re 1 µPa using frequencies within the hearing range of sea turtles were modeled for potential acoustic impacts on sea turtles. Other active acoustic sources with low source level, narrow beam width, downward-directed transmission, short pulse lengths, frequencies above known hearing ranges, or some combination of these factors are not anticipated to result in impacts to sea turtles. These sources are the same or analogous to sound sources analyzed by other agencies and ruled on by NMFS to not result in impacts to protected species, including sea turtles, and therefore were not modeled and are addressed qualitatively in this EIS/OEIS (see Section 2.3.7.2 for a review of NMFS past rules regarding these sources). These sources generally have frequencies greater than 200 kHz and source levels less

than 160 dB re 1 µPa. The types of sources with source levels less than 160 dB are primarily hand-held sonar, range pingers, transponders, and acoustic communication devices.

Within this acoustics analysis, the numbers of sea turtles that may experience some form of hearing loss were predicted using the Navy Acoustics Effects Model (Section 3.5.3.1.5, Navy Acoustic Effects Model). To quantify the impacts of acoustic exposures to sea turtles, testing and training activities were modeled that employ acoustic sources using frequencies in the hearing range of sea turtles. These activities and the acoustic source classes used are listed in Table 3.5-5. Most sonar and active acoustic sources used during testing and training use frequencies outside of the estimated hearing range of turtles.

Table 3.5-5: Activities and Active Acoustic Sources Modeled and Quantitatively Analyzed for Acoustic Impacts on Sea Turtles

Activity	Acoustic Source Class[1]
Training Activity	
ASW for Composite Training Unit Exercise	ASW2
ASW for Joint Task Force Exercise	ASW2
ASW for Rim of the Pacific Exercise	ASW2
Multi-Strike Group Exercise	ASW2
Integrated ASW Course	ASW2
Group Sail	ASW2
Undersea Warfare Exercise	ASW2
Ship ASW Readiness and Evaluation Measuring	ASW2
TRACKEX/TORPEX-Surface	ASW1, MF12
TRACKEX-Maritime Patrol Aircraft (EER Sonobuoys)	ASW2
Testing Activity	
ASW Tracking Test - Maritime Patrol Aircraft	ASW2
Sonobuoy Lot Acceptance Test	ASW2
Surface Combatant Sea Trial: Pierside Sonar Testing	MF9, MF10
Surface Combatant Sea Trial: ASW Testing	MF9, MF10
Littoral Combat Ship Mission Package Testing: ASW	MF12
Surface Ship Sonar Testing/Maintenance (in OPAREAs and Ports)	MF9, MF10
Special Warfare Testing	MF9
Pierside Integrated Swimmer Defense Testing	LF4, MF8
Passive Mobile ISR Sensor Systems	LF5
Unmanned Vehicle Development and Payload Testing	MF9

[1] Characteristics of acoustic source classes are described in Section 2.3.7.

Notes: ASW = anti-submarine warfare; TRACKEX = tracking exercise; TORPEX = torpedo exercise; EER = Extended Echo Ranging; ISR = Intelligence, Surveillance, and Reconnaissance; OPAREAs = Operating Areas; LF = Low Frequency; MF = Mid Frequency

3.5.3.1.7.1 Model-Predicted Impacts

Table 3.5-6 and Table 3.5-7 show impacts on sea turtles predicted by the Navy Acoustics Effects Model. The exposure estimates for each alternative represent the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed several times during a year. The predicted acoustic impacts do not account for avoidance behavior or mitigation measures, such as establishing shut-down zones for certain sonar systems (see Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

Table 3.5-6: Annual Total Model-Predicted Impacts on Sea Turtles for Training Activities Using Sonar and other Active Non-Impulsive Acoustic Sources

Sea Turtle Species/Guild[1]	No Action Alternative		Alternative 1		Alternative 2	
	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]
Green sea turtle	0	0	0	0	0	0
Pacific Guild	397	0	412	0	412	0

[1] A Pacific guild of sea turtles was created for modeling purposes, due to the lack of density data for species other than green sea turtles. A similar approach was taken for marine mammal modeling.
[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.7 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).
Notes: The timing, locations, and numbers of these activities would not substantially differ from year to year under each alternative.

Table 3.5-7: Annual Total Model-Predicted Impacts on Sea Turtles for Testing Activities Using Sonar and other Active Non-Impulsive Acoustic Sources

Sea Turtle Species/Guild[1]	No Action Alternative		Alternative 1		Alternative 2	
	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]
Green sea turtle	549	119	616	97	616	97
Pacific Guild	185	0	400	0	400	0

[1] A Pacific guild of sea turtles was created for modeling purposes, due to the lack of density data for species other than green sea turtles. A similar approach was taken for marine mammal modeling.
[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.7 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).
Notes: The timing, locations, and numbers of these activities would not substantially differ from year to year under each alternative.

3.5.3.1.7.2 No Action Alternative

Training Activities

Training activities under the No Action Alternative include activities that produce non-impulsive noise from the use of sonar and other active acoustic sources that fall within the hearing range of sea turtles. These activities could occur throughout the HSTT Study Area open ocean areas. A more-detailed description of these activities, the number of events, and their proposed locations is presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). Use of sonar and other active acoustic sources during training activities is discussed in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources).

Model-predicted acoustic impacts on sea turtles from exposure to sonar and other active acoustic sources for annually recurring training activities under the No Action Alternative are shown in Table 3.5-6. Because these sound sources would typically be used beyond 12 nm from shore, they are unlikely to impact sea turtles near nesting beaches in Hawaii or sea turtles in coastal waters of Southern California.

If a source uses a frequency within a sea turtle's hearing range, and if the sea turtle is close enough to perceive the sound, the sea turtle may exhibit short-term behavioral reactions, such as swimming away or diving to avoid the area around the source; or it may exhibit no reaction at all. A small number of sea turtles may experience TTS, which could temporarily affect perception of sound within a limited

frequency range. Sea turtles that reside during all or part of the year on a Navy range complex may be exposed several times throughout the year to sound from sonar and other active acoustic sources. Exposures to sonar and other active acoustic sources in open water areas would be intermittent and geographically variable. Pronounced reactions to acoustic stimuli could lead to a sea turtle expending energy and missing opportunities to forage or breed. In most cases acoustic exposures are intermittent, allowing time to recover from an incurred energetic cost, resulting in no long-term consequence.

Because model-predicted impacts are conservative and most impacts would be short-term, potential impacts are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level impacts. Although some individuals may experience long-term impacts, population-level impacts are not expected.

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities under the No Action Alternative may affect, and is likely to adversely affect, green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

Testing Activities

Testing activities under the No Action Alternative include activities that produce in-water noise from sonar or other active non-impulsive acoustic sources that falls within the hearing range of sea turtles. These activities are anti-submarine warfare, surface combatant sea trials, anti-submarine warfare testing, unmanned underwater vehicles demonstrations, special warfare testing, towed equipment testing, unmanned underwater vehicles testing, semi-stationary equipment testing, and pierside integrated swimmer defense testing. These activities, the number of events, and their proposed locations are described in Tables 2.8-2 to 2.8-5 of Chapter 2 (Description of Proposed Action and Alternatives). Model-predicted acoustic impacts on sea turtles from exposure to sonar and other active acoustic sources under the No Action Alternative are shown in Table 3.5-7 for annually recurring testing activities for one year of testing activities.

The model predicts that only green sea turtles experience PTS because of testing with sonar and other active acoustic sources; PTS would permanently reduce sea turtle perception of sound within a limited frequency range. This long-term consequence could impact a turtle's ability to sense biologically important sounds, such as predators or prey, reducing that animal's fitness. A larger number of sea turtles are predicted to experience TTS, which would reduce their perception of sound within a limited frequency range, for a period of minutes to days, depending on the exposure. The predicted impacts do not account for avoidance behavior at close range or for high sound levels approaching those that could cause PTS. Furthermore, cues preceding the event (e.g., vessel presence and movement, aircraft overflight) may cause some animals to leave the area before active sound sources begin transmitting. Avoidance behavior could reduce the sound exposure level experienced by a sea turtle, and therefore reduce the likelihood and degree of PTS and TTS predicted near sound sources. In addition, PTS and TTS threshold criteria for sea turtles are conservatively based on criteria developed for mid-frequency marine mammals. Therefore, actual PTS and TTS impacts are expected to be substantially less than the predicted quantities.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities under the No Action Alternative may affect, and is likely to adversely affect, green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.5.3.1.7.3 Alternative 1

Training Activities

The number of annual training activities that produce in-water noise from sonar or other active acoustic sources that falls within the hearing range of sea turtles would increase under Alternative 1 relative to the No Action Alternative. Use of sonar and other active acoustic sources during training activities is discussed in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources).

Model-predicted acoustic impacts of exposure to sonar and other active acoustic sources on sea turtles for annually recurring training activities under Alternative 1 are shown in Table 3.5-7. The results shown are the impacts on sea turtles predicted for one year of training. The impacts are predicted to increase compared to the No Action Alternative. The increase in proposed activities under Alternative 1 over the No Action Alternative would increase predicted impacts on sea turtles (TTS only) by approximately 10 percent. Most of the increase in predicted impacts over the No Action Alternative would result from additional anti-submarine warfare training during major training activities. These events would occur a few times per year, but each event would last for several days. Therefore, some animals may be exposed several times.

The increase in predicted impacts on sea turtles could increase the number of individual animals exposed per year or increase the number of times per year some animals are exposed, when compared to the No Action Alternative. However, the expected impacts on any individual sea turtle remain the same. Similarly, the model may over-predict acoustic impacts because it does not consider avoidance and the criteria for predicting impacts are conservative. For the same reasons provided in Section 3.5.3.1.7.2 (No Action Alternative), potential impacts are not expected to result in substantial changes in behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness) for most individuals. Although some individuals may experience long-term impacts, population-level impacts are not expected.

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities under Alternative 1 may affect, and is likely to adversely affect, green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

Testing Activities

Testing activities under Alternative 1 include activities that produce in-water noise from sonar or other active non-impulsive acoustic sources that fall within the hearing range of sea turtles. These activities, the number of events, and their proposed locations are described in Tables 2.8-2 to 2.8-5 of Chapter 2.

Model-predicted acoustic impacts of exposure to sonar and other active acoustic sources on sea turtles under Alternative 1 are shown in Table 3.5-7 for annually recurring testing activities. The results shown in Table 3.5-7 are predicted impacts for one year of testing activities. Model-predicted acoustic impacts resulting in temporary threshold shift increased; however, impacts resulting in permanent threshold shift decreased under Alternative 1 when compared to the No Action Alternative.

Although impacts could occur across all of the range complexes and training ranges because of various types of testing involving active acoustic sources, the portion of total predicted impacts are greater for certain activities, either because of the types of sources or because of the hours of use. Testing events using sonar and other active acoustic sources are often multi-day events during which active sources are used intermittently; therefore, some animals may be exposed several times over a few days. While most testing using anti-submarine warfare sonar would occur beyond 12 nm from shore, other testing

activities using active acoustic sources may occur closer to shore, specifically within nearshore SOCAL testing locations.

The increase in predicted impacts on sea turtles could increase the number of individual animals exposed per year or increase the number of times per year some animals are exposed, when compared to the No Action Alternative. Relative to the No Action Alternative, sea turtles experiencing TTS are expected to increase by approximately 10 percent under Alternative 1, and the number of green sea turtles experiencing PTS are expected to decrease by approximately 10 percent (the model did not predict PTS in other sea turtle species). Despite the overall increase in the number of exposures relative to the No Action Alternative, the expected impacts on any individual sea turtle would remain the same. Similarly, the model may over-predict acoustic impacts because it does not consider avoidance and the criteria for predicting impacts are conservative. For the same reasons provided in Section 3.5.3.1.7.2 (No Action Alternative), potential impacts are not expected to substantially change behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness) in most individuals. Although some individuals may experience long-term impacts, population-level impacts are not expected.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities under Alternative 1 may affect, and is likely to adversely affect, green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.5.3.1.7.4 Alternative 2

Training Activities

The number and location of training activities under Alternative 2 would be identical to those of training activities under Alternative 1. Therefore, impacts on and comparisons to the No Action Alternative would also be identical, as described in Section 3.5.3.1.7.2 (No Action Alternative).

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities as described under Alternative 2 may affect, and is likely to adversely affect, green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

Testing Activities

Alternative 2 testing activities would increase the number of hours of active acoustic sonar use within the Study Area. As shown in Table 3.0-8, the largest increases in the number of hours would be within the low-frequency active range (producing signals under 1 kHz). Despite the increases in the number of hours of active acoustic sonar use, there is no difference in the Navy's acoustic modeling for Alternative 2 impacts to sea turtles, relative to Alternative 1 (see Table 3.5-7). Therefore, impacts on and comparisons to the No Action Alternative would also be identical, as described in Section 3.5.3.1.7.2 (No Action Alternative).

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities as described under Alternative 2 may affect, and is likely to adversely affect, green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.5.3.1.8 Impacts from Explosives

Explosions in the water or near the water's surface can introduce loud, impulsive, broadband sounds into the marine environment. These sounds are likely to be within the audible range of most sea turtles,

but the duration of individual sounds is very short. Energy from explosives is capable of causing mortalities, injuries to the lungs or gastrointestinal tract (Section 3.5.3.1.2.1, Direct Injury), TTS or PTS (Section 3.5.3.1.2.2, Hearing Loss), or behavioral responses (Section 3.5.3.1.2.5, Behavioral Reactions). The impacts on sea turtles of at-sea explosions depend on the net explosive weight of the charge, the depth of the charge, the properties of detonations underwater, the animal's distance from the charge, the animal's location in the water column, and environmental factors such as water depth, water temperature, and bottom type. The net explosive weight accounts for the weight and the type of explosive material. Criteria for determining physiological impacts of impulsive sound on sea turtles are discussed in Section 3.5.3.1.3 (Acoustic and Explosive Thresholds and Criteria). The limited information on sea turtle behavioral responses to sounds is discussed in Section 3.5.3.1.2.5 (Behavioral Reactions).

Exposures that result in injuries such as non-lethal trauma and PTS may limit an animal's ability to find or obtain food, communicate with other animals, avoid predators, or interpret the environment around them. Impairment of these abilities can decrease an individual's chance of survival or impact its ability to successfully reproduce. Mortality of an animal will remove the animal entirely from the population as well as eliminate its future reproductive potential.

There is some limited information on sea turtle behavioral responses to impulsive noise from airgun studies (Section 3.5.3.1.3.12, Behavioral Responses), that can be used as a surrogate for explosive impact analysis. Any behavioral response to a single detonation would likely be a short-term startle response, if the animal responds at all. Multiple detonations over a short period may cause an animal to exhibit other behavioral reactions, such as interruption of feeding or avoiding the area.

3.5.3.1.8.1 Model-Predicted Impacts

The average ranges of impacts from explosives of different charge weights for each of the specific criteria (onset mortality, onset slight lung injury, onset slight GI tract injury, PTS, and TTS) are shown in Table 3.5-8. Sea turtles within these ranges are predicted by the model to receive the associated impact. Information about the ranges of impacts is important, not only for predicting acoustic impacts, but also for verifying the accuracy of model results against real-world situations and determining adequate mitigation ranges to avoid higher level impacts, especially physiological impacts on sea turtles. Because propagation of the acoustic waves is affected by environmental factors at different locations and because some criteria are partially based on sea turtle mass, the range of impacts for particular criteria will vary.

Based on the estimate of sound exposure level that could induce a sea turtle to exhibit avoidance behavior when exposed to repeated impulsive sounds (see Section 3.5.3.1.3.12, Criteria for Behavioral Responses), the distance from an explosion at which a sea turtle may behaviorally react (e.g., avoid by moving farther away) can be estimated. These ranges are also shown in Table 3.5-8. If exposed to a single impulsive sound, a sea turtle is assumed to exhibit a brief startle reaction that would likely be biologically insignificant.

Table 3.5-9 through Table 3.5-13 present impacts of explosive detonations on sea turtles predicted by the Navy Acoustic Effects Model, applying the impact threshold criteria shown in Table 3.5-3.

The impact estimates for each alternative represent the total number of impacts and not necessarily the number of individuals exposed, because a single individual may be exposed several times over the course of a year.

Table 3.5-8: Ranges of Impacts from In-water Explosions on Sea Turtles for Representative Sources

Criteria Predicted Impact[1]	Impact Predicted to Occur When Sea Turtle is at this Range (m) or Closer to a Detonation			
	Source Class E2 (0.5 lb. NEW)	Source Class E5 (10 lb. NEW)	Source Class E9 (250 lb. NEW)	Source Class E12 (1,000 lb. NEW)
Onset Mortality (1% Mortality)	12	47	137	204
Onset Slight Lung Injury	25	87	240	352
Onset Slight GI Tract Injury	25	71	147	274
Permanent Threshold Shift[2]	79	222	587	1,602
Temporary Threshold Shift[2]	178	598	1,711	3,615
Avoidance Behavior (for multiple impulses)	344	1,125	2,971	6,709

[1] Criteria for impacts are discussed in Section 3.5.3.1.3, Acoustic and Explosive Thresholds and Criteria.
[2] Modeling for sound exposure level-based impulsive criteria assumed explosive event durations of one second. Actual durations may be less, resulting in smaller ranges to impact.
Notes: (1) NEW = net explosive weight, m = meters, lb. = pound, GI = gastrointestinal; (2) Ranges determined using REFMS, Navy's explosive propagation model

Table 3.5-9: Annual Model-Predicted Impacts from Explosives on Sea Turtles for Training Activities Under the No Action Alternative

Sea Turtle Species or Group	Temporary Threshold Shift	Permanent Threshold Shift	GI Tract Injury	Slight Lung Injury	Mortality
Green sea turtles	0	0	0	0	0
Pacific guild turtles[1]	152[2]	18[2]	0	10[2]	4[2]

[1] A Pacific guild of sea turtles was created for modeling purposes, due to the lack of density data for species other than green sea turtles. A similar approach was taken for marine mammal modeling.
[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.7 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).

Table 3.5-10: Annual Model-Predicted Impacts from Explosives on Sea Turtles for Training Activities Under Alternatives 1 and 2

Sea Turtle Species or Group	Temporary Threshold Shift	Permanent Threshold Shift	GI Tract Injury	Slight Lung Injury	Mortality
Green sea turtles	0	0	0	0	0
Pacific guild turtles[1]	182[2]	21[2]	0	13[2]	4[2]

[1] A Pacific guild of sea turtles was created for modeling purposes, due to the lack of density data for species other than green sea turtles. A similar approach was taken for marine mammal modeling.
[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.7 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).
Notes: The timing, locations, and numbers of these activities would not substantially differ from year to year under each alternative. Non-annual training activities are not included in this table; the model-predicted impacts for non-annual training activities are four TTS exposures.

Table 3.5-11: Annual Model-Predicted Impacts from Explosives on Sea Turtles for Testing Activities Under the No Action Alternative

Sea Turtle Species or Groups	Temporary Threshold Shift	Permanent Threshold Shift	GI Tract Injury	Slight Lung Injury	Mortality
Green sea turtles	0	0	0	0	0
Pacific guild turtles[1]	0	0	0	0	0

[1] A Pacific guild of sea turtles was created for modeling purposes, due to the lack of density data for species other than green sea turtles. A similar approach was taken for marine mammal modeling.

Table 3.5-12: Annual Model-Predicted Impacts from Explosives on Sea Turtles for Testing Activities Under Alternative 1

Sea Turtle Species or Groups	Temporary Threshold Shift	Permanent Threshold Shift	GI Tract Injury	Slight Lung Injury	Mortality
Green sea turtles	0	0	0	0	0
Pacific guild turtles[1]	0	3[2]	0	0	0

[1] A Pacific guild of sea turtles was created for modeling purposes, due to the lack of density data for species other than green sea turtles. A similar approach was taken for marine mammal modeling.
[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.7 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).

Table 3.5-13: Annual Model-Predicted Impacts from Explosives on Sea Turtles for Testing Activities Under Alternative 2

Sea Turtle Species	Temporary Threshold Shift	Permanent Threshold Shift	GI Tract Injury	Slight Lung Injury	Mortality
Green sea turtles	0	0	0	0	0
Pacific guild turtles[1]	1[2]	5[2]	0	0	0

[1] A Pacific guild of sea turtles was created for modeling purposes, due to the lack of density data for species other than green sea turtles. A similar approach was taken for marine mammal modeling.
[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.7 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).

Some of the conservative assumptions made for the impact modeling and criteria may cause the impact predictions to be overestimated, as follows:

- Many explosions from ordnance such as bombs and missiles actually explode upon impact with above-water targets. For this analysis, sources such as these were modeled as exploding at depths of 1 m, overestimating the amount of explosive and acoustic energy entering the water.
- For predicting TTS and PTS based on sound exposure level, the duration of an explosion is assumed to be one second. Actual detonation durations may be much shorter, so the actual sound exposure level at a particular distance may be lower.
- Mortality and slight lung injury criteria are based on juvenile turtle masses, which substantially increases that range to which these impacts are predicted to occur compared to the ranges that would be predicted using adult turtle masses.
- Animats are assumed to receive the full impulse of the initial positive pressure wave due to an explosion, although the impulse-based thresholds (onset mortality and onset slight lung injury) assume an impulse delivery time adjusted for animal size and depth. Therefore, these impacts are overestimated at farther distances and increased depths.
- The predicted acoustic impacts do not take into account mitigation measures implemented during many training and testing activities, such as exclusion zones around detonations. Smaller

hatchling and early juvenile hardshell turtles tend to be near the surface, which is subject to avoidance mitigation measures (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

Most training and testing activities using explosives occur every year. Results for non-annual training events (such as shock trials) are considered separate in the modeling analysis from annual activities.

3.5.3.1.8.2 No Action Alternative

Training Activities

Training activities under the No Action Alternative using explosives at or beneath the water surface would expose sea turtles to underwater impulsive sound. The largest source class used during training under the No Action Alternative would be E13 (1,000 to 1,740 lb. net explosive weight). Explosives would be used at or beneath the water surface in all training range complexes. Some areas within training ranges are not used for explosives, such as San Diego Bay. The number of training events using explosives and their proposed locations are presented in Table 2.8-1 of Chapter 2. Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives).

Model-predicted impacts on sea turtles of explosives used in annually recurring training activities under the No Action Alternative are shown in Table 3.5-9. The results shown are the impacts on sea turtles predicted for one year of training. Under the No Action Alternative, the majority of predicted impacts are from Bombing Exercises (Air-to-Surface) using source class E12 (651 to 1,000 lb. net explosive weight), Missile Exercises (Air-to-Surface) using source class E6 (11 to 20 lb. net explosive weight) and E10 (251 to 500 lb. net explosive weight), tracking and torpedo exercise – Maritime Patrol Aircraft-sonobuoys using source class E4 (2.6 to 5 lb. net explosive weight), Naval Surface Fire Support – At Sea using source class E5 (6 to 10 lb. net explosive weight), and Gunnery Exercise (Air-to-Surface) – Rocket using source class E5 (6 to 10 lb. net explosive weight).

Detonations would typically occur beyond approximately 3 nm from shore, minimizing impacts near nesting beaches within the HRC or coastal habitats of green sea turtles in SOCAL. A few near-shore (within 3 nm) training events could occur within SOCAL and HRC, however, potentially exposing some sea turtles approaching nesting beaches to impulsive sounds over a short duration, if the training occurred during nesting season, or to sea turtles in SOCAL nearshore habitats. Modeling predicted no PTS, TTS, gastrointestinal, lung injury, or mortality for sea turtles in coastal habitats.

A small number of sea turtles within the Pacific Guild group are predicted to be exposed to impulse levels associated with the onset of mortality (four sea turtles) and slight lung injury (10 sea turtles) over any training year for explosives use in open ocean habitats. Temporary threshold shift is predicted to occur in 152 sea turtles and permanent threshold shift in 18 sea turtles. Any injured sea turtles could suffer reduced fitness and long-term survival. Sea turtles that experience PTS would have permanently reduced perception of sound within a limited frequency range. It is uncertain whether some permanent hearing loss over a part of a sea turtle's hearing range would have long-term consequences for that individual, because the sea turtle hearing range is already limited. Because detonations impact only a small portion of the frequency range and most sounds are broadband, sea turtles may be able to compensate for the loss of sensitivity because they can still hear the stimulus over the broader audible hearing range. A long-term consequence could be an impact on an individual turtle's ability to sense biologically important sounds, such as predators or prey, reducing that animal's fitness. A larger number of sea turtles are predicted to experience TTS, which would reduce their perception of sound within a limited frequency range for a period of minutes to days, depending on the exposure. PTS and TTS

threshold criteria for sea turtles are conservatively based on criteria developed for mid-frequency marine mammals, so actual PTS and TTS impacts may be less than the predicted quantities.

Some sea turtles beyond the ranges of the above impacts may behaviorally react if they hear a detonation. Events with single detonations, such as a bombing and missile exercise, are expected to only elicit short-term startle reactions. If a sea turtle hears several detonations in a short period, such as during gunnery, firing, or sonobuoy exercises, it may react by avoiding the area. Any significant behavioral reactions could lead to a sea turtle expending energy and missing opportunities to secure resources. However, because most events would consist of a limited number of detonations and exposures would not occur over long periods, the sea turtle would have an opportunity to recover from an incurred energetic cost.

Because model-predicted impacts are conservative and most impacts would be short-term, potential impacts are not expected to result in substantial changes in behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Although a few individuals (green sea turtles) may experience long-term impacts such as potential injury and mortality, population-level impacts are not expected.

Pursuant to the ESA, the use of underwater explosives during training activities under the No Action Alternative may affect, and is likely to adversely affect, green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

Testing Activities

Testing activities under the No Action Alternative using explosives at or beneath the water surface would expose sea turtles to underwater impulsive sound. The largest source class used during training under the No Action Alternative would be E11 (501 to 650 lb. net explosive weight). Explosives would be used at or beneath the water surface in all training range complexes. Some areas within training ranges are not used for explosives, such as San Diego Bay. The number of training events using explosives and their proposed locations are presented in Tables 2.8-2 through 2.8-5 in Chapter 2. Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives).

Detonations would typically occur beyond approximately 3 nm (5.6 km) from shore, minimizing impacts near nesting beaches within the HRC or coastal habitats of green sea turtles in SOCAL. A few near-shore (within 3 nm) training events, however, could occur within SOCAL and HRC, potentially exposing some sea turtles approaching nesting beaches to impulsive sounds over a short period, if the training occurred during nesting season, or to sea turtles in SOCAL nearshore habitats. Modeling predicted no TTS, gastrointestinal, lung injury, or mortality for sea turtles in coastal habitats.

For Pacific Guild species that occur in open ocean habitats, no sea turtles are predicted to be exposed to impulse levels associated with the onset of mortality, gastrointestinal injury, slight lung injury, TTS, or PTS over any training year. Any injured sea turtles could suffer reduced fitness and long-term survival. Some sea turtles beyond the ranges of the above impacts may behaviorally react if they hear a detonation. Events with single detonations, such as a bombing and missile exercise, are expected to only elicit short-term startle reactions. If a sea turtle hears several detonations in a short period, such as during gunnery, firing, or sonobuoy exercises, it may react by avoiding the area. Any significant behavioral reactions could lead to a sea turtle expending energy and missing opportunities to secure resources. However, because most events would consist of a limited number of detonations and

exposures would not occur over long periods, the sea turtle would have an opportunity to recover from an incurred energetic cost.

Because model-predicted impacts are conservative and most impacts would be short-term, potential impacts are not expected to result in substantial changes in behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected.

Pursuant to the ESA, the use of underwater explosives during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.5.3.1.8.3 Alternative 1

Training Activities

Training activities under Alternative 1 using explosives at or beneath the water surface would expose sea turtles to underwater impulsive sound. The largest source class used during training under Alternative 1 would be E13 (1,000 to 1,740 lb. net explosive weight). Explosives would be used at or beneath the water surface in all training range complexes. Some areas within training ranges are not used for explosives, such as San Diego Bay. The number of training events using explosives and their proposed locations are presented in Table 2.8-1 of Chapter 2. Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives).

Model-predicted impacts on sea turtles from explosives used in annually recurring training activities under Alternative 1 are shown in Table 3.5-10. The results shown are the impacts on sea turtles predicted for one year of training. Under Alternative 1, the majority of predicted impacts are from Bombing Exercises (Air-to-Surface) using source class E12 (651 to 1,000 lb. net explosive weight), Missile Exercises (Air-to-Surface) using source class E6 (11 to 20 lb. net explosive weight) and E10 (251 to 500 lb. net explosive weight), tracking and torpedo exercises with Maritime Patrol Aircraft-sonobuoys using source class E4 (2.6 to 5 lb. net explosive weight), Naval Surface Fire Support – At Sea using source class E5 (6 to 10 lb. net explosive weight), and Gunnery Exercise (Air-to-Surface) – rocket using source class E5 (6 to 10 lb. net explosive weight).

Detonations would typically occur beyond approximately 3 nm from shore, minimizing impacts near nesting beaches within the HRC or coastal habitats of green sea turtles in SOCAL. A few near-shore (within 3 nm) training events could occur within SOCAL and HRC, however, potentially exposing some sea turtles approaching nesting beaches to impulsive sounds over a short period, if the training occurred during nesting season, or to sea turtles in SOCAL nearshore habitats. Modeling predicted no PTS, TTS, gastrointestinal, lung injury, or mortality for sea turtles in coastal habitats.

As with the No Action Alternative, a small number of sea turtles within the Pacific Guild group are predicted to be exposed to impulse levels associated with the onset of mortality and slight lung injury over any training year for explosives use in open ocean habitats. Exposures modeled under Alternative 1 are expected to increase by approximately 17 percent, relative to the No Action Alternative. Model-predicted results for non-annual training activities under Alternative 1 amount to four TTS exposures in open ocean areas (Pacific Guild modeling group). Any injured sea turtles could suffer reduced fitness and long-term survival. Sea turtles that experience PTS would have permanently reduced perception of sound within a limited frequency range. It is uncertain whether some permanent

hearing loss over a part of a sea turtle's hearing range would have long-term consequences for that individual, because the sea turtle hearing range is already limited. A long-term consequence could be an impact on an individual turtle's ability to sense biologically important sounds, such as predators or prey, reducing that animal's fitness. A larger number of sea turtles are predicted to experience TTS, which would reduce their perception of sound within a limited frequency range for a period of minutes to days, depending on the exposure. PTS and TTS threshold criteria for sea turtles are conservatively based on criteria developed for mid-frequency marine mammals, so actual PTS and TTS impacts may be less than the predicted quantities.

Some sea turtles beyond the ranges of the above impacts may behaviorally react if they hear a detonation. Events with single detonations, such as a bombing and missile exercise, are expected to only elicit short-term startle reactions. If a sea turtle hears several detonations in a short period, such as during gunnery, firing, or sonobuoy exercises, it may react by avoiding the area. Any significant behavioral reactions could lead to a sea turtle expending energy and missing opportunities to secure resources. However, because most events would consist of a limited number of detonations and exposures would not occur over long periods, the sea turtle would have an opportunity to recover from an incurred energetic cost.

Because model-predicted impacts are conservative and most impacts would be short-term, potential impacts are not expected to result in substantial changes in behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Although a few individuals (green sea turtles) may experience long-term impacts such as potential injury and mortality, population-level impacts are not expected.

Pursuant to the ESA, the use of underwater explosives during training activities under Alternative 1 may affect, and is likely to adversely affect, green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

Testing Activities

Testing activities under Alternative 1 using explosives at or beneath the water surface would expose sea turtles to underwater impulsive sound. The largest source class used during testing under Alternative 1 is E11 (500 to 650 lb. net explosive weight). Explosives at or beneath the water surface would be used in all training range complexes. Some areas within training ranges are not used for explosives, such as San Diego Bay. The number of testing activities using explosives and their proposed locations are presented in Tables 2.8-2 and 2.8-3 of Chapter 2. Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives).

Model-predicted acoustic impacts from explosives on sea turtles during annually recurring testing activities under Alternative 1 are shown in Table 3.5-12. The results shown are the impacts on sea turtles predicted for one year of testing. Model-predicted results for testing activities under Alternative 1 amount to three PTS exposures in the open ocean portions of the Study Area (zero exposures were predicted under the No Action Alternative for testing activities). Because model-predicted impacts are conservative and most impacts would be short-term, potential impacts are not expected to result in substantial changes in behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected.

Pursuant to the ESA, the use of underwater explosives during testing activities under Alternative 1 may affect, and is likely to adversely affect green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.5.3.1.8.4 Alternative 2

Training Activities

Training activities under Alternative 2 using explosives at or beneath the water surface would expose sea turtles to underwater impulsive sound. The largest source class used during training under Alternative 2 would be E13 (1,001 to 1,740 lb. net explosive weight). Explosives would be used at or beneath the water surface in all training range complexes. Some areas within training ranges are not used for explosives, such as San Diego Bay. The number of training events using explosives and their proposed locations are presented in Table 2.8-1 of Chapter 2. Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives).

Model-predicted impacts on sea turtles of explosives used in annually recurring training activities under Alternative 2 are shown in Table 3.5-10. The results shown are the impacts on sea turtles predicted for one year of training. Under Alternative 2, the model-predicted results are the same as for annual and non-annual training activities as Alternative 1; therefore, the impacts under Alternative 2 are expected to be the same as Alternative 1.

Pursuant to the ESA, the use of underwater explosions during training activities under Alternative 2 may affect, and is likely to adversely affect, green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

Testing Activities

Testing activities under Alternative 2 using explosives at or beneath the water surface would expose sea turtles to underwater impulsive sound. The largest source class used during testing under the No Action Alternative would be E11 (500 to 650 lb. net explosive weight). Explosives would be used at or beneath the water surface in all training range complexes. Some areas within training ranges are not used for explosives, such as San Diego Bay. The number of testing events using explosives and their proposed locations are presented in Table 2.8-2 and Table 2.8-3 of Chapter 2. Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives).

Model-predicted results for testing activities under Alternative 2 amount to five PTS exposures and one TTS exposure in the open ocean portions of the Study Area (zero exposures were predicted under the No Action Alternative for testing activities). Because model-predicted impacts are conservative and most impacts would be short-term, potential impacts are not expected to result in substantial changes in behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected.

Pursuant to the ESA, the use of underwater explosives during testing activities under Alternative 2 may affect, and is likely to adversely affect, green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.5.3.1.9 Impacts from Pile-Driving

Pile-driving activities could include impact or vibratory pile driving and vibratory pile removal, which would produce impulsive and continuous sounds underwater. This activity would involve intermittent impact pile driving of 24 in. (60.9 cm), uncapped, steel pipe piles over approximately two weeks at a rate of approximately eight piles per day. Each pile takes about 10 minutes to drive. When training events that use the elevated causeway system are complete, the structure would be removed. The piles would be removed using vibratory methods over approximately six days. Crews can remove about 14 piles per day, each taking about six minutes to remove.

Impulses from an impact hammer are broadband, and emit most of their energy in the lower frequencies. The impulses are within the hearing range of most sea turtles, and can produce a shock wave that is transmitted to the sediment and water column (Reinhall and Dahl 2011). The impulses produced would be less than a second each, occur at a rate of 30 to50 impulses per minute, and have a source level of around 194 dB re 1 µPa root mean square and 207 dB re 1 µPa peak at 10 m (32.8 ft.) from the pile (California Department of Transportation 2009). Assuming that sound propagates in accordance with the practical spreading loss (see Section 3.0.4, Acoustic and Explosive Primer), sound pressure levels from impact pile driving would be above the injury criteria threshold value (190 dB re 1 µPa root mean square) only a short distance from the pile. Sound pressure levels that could injure sea turtles would only occur within a radius of 19 m (62.3 ft.) from the pile. Because of the small size of the potential injury zone and the densities of sea turtle in the proposed project locations, no injurious exposures are predicted to occur from impact pile driving activities associated with Navy training.

Sound from a vibratory hammer is similar in its frequency range to that of an impact hammer, except that the source levels are much lower than for the impact hammer. The vibrations typically oscillate at a rate of about 1,700 cycles per minute, so the sound source is treated as a continuous sound source. The source level for vibratory removal of the size and type of piles that would be used during Navy training, assuming vibratory removal source levels are similar to vibratory driving source levels, would be around 164 dB re 1 µPa root mean square at 10 m (32.8 ft.) from the pile, less than the criteria threshold value for injury.

Despite the short duration of driving and removing a single pile, there is the potential for auditory masking in sea turtles and some temporary physiological stress. In addition, sea turtles may exhibit behavioral responses to impact or vibratory pile driving, including short-term startle responses or avoidance of the area around the pile driving. Because of the presence of vessels and shore construction activity, sea turtles may avoid the areas around proposed construction before pile driving activities begin, decreasing any potential impacts.

Pile driving would occur under all alternatives. Each alternative proposes four training events per year that involve pile driving, all occurring within Silver Strand Training Complex (SSTC). Because the numbers and locations do not vary among the alternatives, impacts are assessed together in one section and apply to all alternatives. Pile driving also occurs at Camp Pendleton as part of Joint Logistics Over the Shore training activities, and is discussed in Chapter 4 (Cumulative Impacts).

3.5.3.1.9.1 No Action Alternative, Alternative 1, and Alternative 2

Training Activities

Under the No Action Alternative, Alternative 1, and Alternative 2, four Elevated Causeway System training events would occur every year in SSTC Boat Lanes 1 to 10 and in the bayside Bravo Beach training lane. Based on the sound fields produced during the impact installation and vibratory removal

of 24 in. (60.1 cm) steel pipe piles, no injuries to sea turtles are predicted from sound exposures during pile-driving and removal activities associated with Navy training. However, sea turtles may behaviorally respond to pile-driving and removal. As part of previous consultations between the Navy and the NMFS on elevated causeway training activities, mitigation measures have been developed so that the Navy does not drive piles when sea turtles are observed within waters ensonified (an area filled with sound) by 180 dB 1 µPa, which is approximately 50 m (164.04 ft.) from the pile. To accomplish this, the Navy will continue with mitigation measures agreed to as part of previous Elevated Causeway training activities. These measures include the monitoring of a 150 ft. (45.7 m) safety buffer zone for the presence of sea turtles before, during, and after pile removal activities. If sea turtles are found in the area, pile removal activities would be halted until the sea turtles have voluntarily left the safety buffer.

The anticipated effects on sea turtles are avoidance of waters that are ensonified by the pile driving. Impacts on sea turtles on the bayside can be more precisely defined based on the temporary ensonfication of important eelgrass habitats (foraging areas for green sea turtles) within San Diego Bay during pile driving activities. Only a small percentage of piles would be driven within eelgrass habitat and eelgrass. The Bravo lane eelgrass habitat is an area of only 17.5 ac. (0.1 km^2). Furthermore, piles would be driven within a 1.13 acres (ac.) (0.004 km^2) defined training lane within Bravo.

Piles would be driven infrequently. Given the extent of adjacent habitat and the population of turtles known to exist in adjacent habitat, effects on turtles of driving piles are expected to be temporary and local. Based on the limited occurrence (four events per year) and constrained nature of pile driving within turtle foraging areas (low intensity of the activity), the probability of impacts on turtles is low. Disturbance of sea turtles by Elevated Causeway System activities would include startle responses, avoidance behaviors, and removal of available eelgrass foraging habitats within San Diego Bay during Elevated Causeway System training events.

Pursuant to the ESA, pile driving as part of training activities for the No Action Alternative, Alternative 1, and Alternative 2 may affect, but is not likely to adversely affect, green sea turtles within SSTC (where this training type occurs). Pile driving during training activities would have no effect on hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Testing activities under the No Action Alternative, Alternative 1, and Alternative 2 do not include pile driving activities.

3.5.3.1.10 Impacts from Swimmer Defense Airguns

Airguns can introduce brief impulsive, broadband sounds into the marine environment. These sounds are probably within the audible range of most sea turtles. Sounds from airguns are capable of causing PTS or TTS (see Section 3.5.3.1.2.2) or behavioral responses (see Section 3.5.3.1.2.5). Single, small swimmer defense airguns would not cause direct trauma to sea turtles. Impulses from these small airguns lack the strong shock wave and rapid pressure increases from explosives that can cause primary blast injury or barotraumas (criteria for determining impacts to sea turtles from impulsive sound are discussed in Section 3.5.3.1.3.2). The limited information on assessing sea turtle behavioral responses to impulsive sounds is discussed in Section 3.5.3.1.2.5.

The behavioral response of sea turtles to the repeated firing of airguns has been studied for seismic survey airguns (e.g., oil and gas exploration) (Section 3.5.3.1.2.5). Sea turtles were shown to avoid higher-level exposures or to agitate when exposed to higher-level sources. However, the airguns

proposed for use in Navy testing are smaller, and fire a limited number of times, so reactions would likely be lesser than those observed in studies.

Activities that use swimmer defense airguns as part of Navy testing activities would only occur at pierside locations in San Diego Bay; therefore, sea turtles outside of these areas would not be affected. Only the green sea turtles in San Diego Bay are carried forward for analysis.

3.5.3.1.10.1 Model-Predicted Impacts

For the analysis of hearing loss, airguns are treated as any other impulsive sound source. Estimates of the number of sea turtles exposed to levels capable of causing these impacts were calculated using the Navy Acoustic Effects Model. For all testing activities using airguns, no PTS or TTS impacts were predicted.

3.5.3.1.10.2 No Action Alternative

Training Activities

Training activities under the No Action Alternative do not use airguns.

Testing Activities

Testing activities that impart underwater impulsive noise from airguns under the No Action Alternative include pierside integrated swimmer defense testing activities at pierside locations, as described in Table 2.8-3. Small airguns (60 in.^{3}) would release a limited number of impulses into waters around Navy piers in San Diego Bay. These areas are industrial, and the waterways carry a high volume of vessel traffic in addition to Navy vessels. These areas tend to have high ambient noise levels and limited numbers of sea turtles present because of the high levels of human activity. Green sea turtles, the only species of sea turtle expected to occur in San Diego Bay, are not expected to occur around Navy piers in San Diego Bay. If sea turtles are present, they may alert, startle, avoid the immediate area, or not respond at all while the airgun is firing. Substantial behavioral impacts in these areas from the proposed use of the swimmer defense airgun are unlikely. Impulses from swimmer defense airguns are not predicted to cause any PTS or TTS impacts on sea turtles. The increase in the number of sea turtles that may experience behavioral effects between the alternatives is small compared to the size of sea turtle populations, and would not result in long-term consequences to the species.

Pursuant to the ESA, the use of swimmer defense airguns during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, green sea turtles. The use of swimmer defense airguns would have no effect on hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.1.10.3 Alternative 1

Training Activities

Training activities under Alternative 1 do not use airguns.

Testing Activities

Testing activities that impart underwater impulsive noise from airguns under Alternative 1 include a small decrease in pierside integrated swimmer defense testing activities over the No Action Alternative, as described in Table 2.8-3. Despite the decrease, the types of impacts on sea turtles from exposures to airguns under Alternative 1 are the same as those described under the No Action Alternative. As with the No Action Alternative, green sea turtles are not expected to occur around Navy piers in San Diego Bay. If sea turtles are present, they may alert, startle, avoid the immediate area, or not respond at all while the airgun is firing. Substantial behavioral impacts in these areas from the proposed use of the

swimmer defense airgun are unlikely. Impulses from swimmer defense airguns are not predicted to cause any PTS or TTS impacts on sea turtles.

Pursuant to the ESA, the use of swimmer defense airguns during testing activities under Alternative 1 may affect, but is not likely to adversely affect, green sea turtles. The use of swimmer defense airguns would have no effect on hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.1.10.4 Alternative 2

Training Activities

Training activities under Alternative 2 do not use airguns.

Testing Activities

Testing activities that impart underwater impulsive noise from airguns under Alternative 2 result in only five PTS exposures in pierside integrated swimmer defense testing activities over the No Action Alternative, as described in Table 2.8-3. The number of activities that use swimmer defense airguns proposed under Alternative 2 is the same as the No Action Alternative. Therefore, the types of impacts on sea turtles from exposures to airguns under Alternative 2 are the same as those described under the No Action Alternative.

Pursuant to the ESA, the use of swimmer defense airguns during testing activities under Alternative 2 may affect, and is likely to adversely affect, green sea turtles. The use of swimmer defense airguns would have no effect on hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.1.11 Impacts from Weapons Firing, Launch, and Impact Noise

Sea turtles may be exposed to weapons firing and launch noise and sound from the impact of non-explosive ordnance on the water's surface. The sounds produced by these activities are described in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise). Reactions by sea turtles to these specific stressors have not been recorded; however, sea turtles may be expected to react to weapons firing, launch, and non-explosive impact noise as they would other transient sounds (see Section 3.5.3.1.2.5, Behavioral Reactions).

Sea turtles exposed to firing, launch, and non-explosive impact noise may exhibit brief startle reactions, avoidance, diving, or no reaction at all. Gunfire noise would typically consist of a series of impulsive sounds. Because of the short term, transient nature of gunfire noise, animals may be exposed to multiple sounds over a short period. Launch noise would be transient and of short duration, lasting no more than a few seconds at any given location as a projectile travels. Many missiles and targets are launched from aircraft, which produces minimal noise in the water because of the altitude of the aircraft at launch. Any launch noise transmitted into the water would likely be due only to launches from vessels. Most events would consist of single launches. Non-explosive bombs, missiles, and targets could impact the water with great force and produce a short duration impulsive sound underwater that would depend on the size, weight, and speed of the object at impact.

Sea turtles that are exposed to any of these sounds would likely alert, startle, dive, or avoid the immediate area. An animal near the surface directly beneath the firing of a large gun could experience sound exposure levels sufficient to cause a threshold shift: however, this potential impact may be unlikely if a sea turtle reacts to the presence of the vessel prior to a large gunfire event.

3.5.3.1.11.1 No Action Alternative

Training Activities

Training under the No Action Alternative includes activities that produce in-water noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface. Activities could occur throughout the Study Area.

A sea turtle very near a launch or impact location could experience hearing impacts, although the potential for this effect has not been studied and a sea turtle may avoid vessel interactions prior to the firing of a gun. It is uncertain whether some permanent hearing loss over a part of a sea turtle's hearing range would have long-term consequences for that individual, as the sea turtle hearing range is already limited. A long-term consequence could be an impact on an individual turtle's ability to sense biologically important sounds, such as predators or prey, reducing that animal's fitness. TTS would reduce the sea turtle's perception of sound within a limited frequency range for a period of minutes to days, depending on the exposure.

Any behavioral reactions would likely be short-term, and consist of brief startle reactions, avoidance, or diving. Any significant behavioral reactions could lead to a sea turtle expending energy and missing opportunities to secure resources. However, because most events would consist of a limited number of firings or launches and would not occur over long periods, the sea turtle would have an opportunity to recover from an incurred energetic cost. Although some individuals may be impacted by activities that include weapons firing, launch, and non-explosive impact, population-level impacts are not expected.

Pursuant to the ESA, noise from weapons firing, launch, and non-explosive impact during training activities under the No Action Alternative may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

Testing Activities

Testing activities under the No Action Alternative include activities that produce in water noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface. Activities are spread throughout the Study Area, as described in Tables 2.8-2 to 2.8-5 of Chapter 2.

A sea turtle very near a launch or impact location could experience hearing impacts, although the potential for this effect has not been studied and a sea turtle may avoid vessel interactions prior to the firing of a gun. It is uncertain whether some permanent hearing loss over a part of a sea turtle's hearing range would have long-term consequences for that individual, as the sea turtle hearing range is already limited. A long-term consequence could be an impact on an individual turtle's ability to sense biologically important sounds, such as predators or prey, reducing that animal's fitness. TTS would reduce the sea turtle's perception of sound within a limited frequency range for a period of minutes to days, depending on the exposure.

Any behavioral reactions would likely be short-term, and consist of brief startle reactions, avoidance, or diving. Any significant behavioral reactions could lead to a sea turtle expending energy and missing opportunities to secure resources. However, because most events would consist of a limited number of firings or launches and would not occur over long durations, the sea turtle would have an opportunity to recover from an incurred energetic cost. Although some individuals may be impacted by activities that include weapons firing, launch, and non-explosive impact, population-level impacts are not expected.

Pursuant to the ESA, noise from weapons firing, launch, and non-explosive impact during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.1.11.2 Alternative 1

Training Activities

Training activities under Alternative 1 that produce in-water noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface would increase compared to the No Action Alternative. The locations and types of activities would be similar to those under the No Action Alternative. The number of events and their proposed locations are described in Table 2.8-1 of Chapter 2.

Although impacts on sea turtles are expected to increase under Alternative 1 compared to the No Action Alternative, the expected impacts on any individual sea turtle would remain the same. For the same reasons provided in Section 3.5.3.1.11.1 (No Action Alternative), although some individuals may be impacted by activities that include weapons firing, launch, and non-explosive impact, population-level impacts are not expected.

Pursuant to the ESA, noise from weapons firing, launch, and non-explosive impact during training activities under Alternative 1 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Testing activities under Alternative 1 that produce in-water noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface would increase under Alternative 1 compared to the No Action Alternative. Activities involving weapons noise would increase from the No Action Alternative, including a large increase associated with aircraft carrier sea trials, mission package testing, combat system ship qualification trials, and anti-surface/anti-submarine warfare activities. Activities would be spread throughout the Study Area, as described in Tables 2.8-2 to 2.8-5 of Chapter 2.

Sea turtles exposed to noise from weapons firing, launch, or non-explosive ordnance impact with the water's surface could exhibit brief startle reactions, avoidance, diving, or no reaction at all. An animal very near a launch or impact location could experience hearing impacts. Because of the short-term, transient nature of weapons firing, launch, and non-explosive impact noise, animals would likely not be exposed several times within a short period. Behavioral reactions would likely be short-term, and would not lead to significant energy costs or long-term consequences for individuals or populations.

Although the impacts on sea turtles are expected to increase under Alternative 1 compared to the No Action Alternative, the expected impacts on any individual sea turtle would remain the same. For the same reasons provided in Section 3.5.3.1.11.1 (No Action Alternative), although some individuals may be impacted by activities that include weapons firing, launch, and non-explosive impact, population-level impacts are not expected.

Pursuant to the ESA, noise from weapons firing, launch, and non-explosive impact during testing activities under Alternative 1 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.1.11.3 Alternative 2

Training Activities

The number and location of training activities under Alternative 2 are identical to those of training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative would also be identical, as described in Section 3.5.3.1.11.1 (No Action Alternative).

Pursuant to the ESA, noise from weapons firing, launch, and non-explosive impact during training activities under Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Testing activities under Alternative 2 that produce in-water noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface would increase from the No Action Alternative. Locations and types of activities would be the same as those under Alternative 1, although the number of activities that produce in-water noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface would increase by approximately 10 percent. The number of events and their proposed locations are described in Tables 2.8-2 and 2.8-3 of Chapter 2.

Although impacts on sea turtles are expected to increase under Alternative 2 compared to the No Action Alternative, the expected impacts on any individual sea turtle would remain the same. For the same reasons provided in Section 3.5.3.1.11.1 (No Action Alternative), although some individuals may be impacted by activities that include weapons firing, launch, and non-explosive impact, population-level impacts are not expected.

Pursuant to the ESA, noise from weapons firing, launch, and non-explosive impact during testing activities under Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.1.12 Impacts from Vessel and Aircraft Noise

Vessel Noise

Vessels could move throughout the Study Area, although some portions would have limited or no activity. Many ongoing and proposed training and testing activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels). Operations involving vessel movements occur intermittently, and are variable in duration, ranging from a few hours up to two weeks. Additionally, a variety of smaller craft are operated within the Study Area. Small craft types, sizes, and speeds vary. During training, speeds generally range from 10 to 14 knots; however, ships and craft can and will, on occasion, operate within the entire spectrum of their specific operational capabilities. Vessel noise is described in Section 3.0.5.3.1.6 (Vessel Noise).

Vessel noise could disturb sea turtles, and potentially elicit an alerting, avoidance, or other behavioral reaction. Sea turtles are frequently exposed to research, ecotourism, commercial, government, and private vessel traffic. Some sea turtles may have habituated to vessel noise, and may be more likely to respond to the sight of a vessel rather than the sound of a vessel, although both may play a role in prompting reactions (Hazel et al. 2007). Any reactions are likely to be minor and short-term avoidance reactions, leading to no long-term consequences for the individual or population.

Auditory masking can occur from vessel noise, potentially masking biologically important sounds (e.g., sounds of prey or predators) upon which sea turtles may rely. Potential for masking can vary depending on the ambient noise level within the environment (Section 3.0.4.5, Ambient Noise); the received level and frequency of the vessel noise; and the received level and frequency of the sound of biological interest. Masking by ships or other sound sources transiting the Study Area would be short-term and intermittent, and therefore unlikely to result in any substantial energetic costs or consequences to individual animals or populations. Areas with increased levels of ambient noise from anthropogenic noise sources, such as busy shipping lanes and near harbors and ports, may have sustained levels of auditory masking for sea turtles, which could reduce an animal's ability to find prey, find mates, avoid predators, or navigate. However, Navy vessels make up a very small percentage of the overall vessel traffic, and the rise of ambient noise levels in these areas is a problem related to all ocean users, including commercial and recreational vessels and shoreline development and industrialization.

Surface combatant ships (e.g., guided missile destroyer, guided missile cruiser, and Littoral Combat Ship) and submarines are designed to be very quiet to evade enemy detection. While surface combatants and submarines may be detectable by sea turtles over ambient noise levels at distances of up to a few kilometers, any auditory masking would be minor and temporary. Other Navy ships and small craft have higher source levels, similar to equivalently sized commercial ships and private vessels. Ship noise tends to be low-frequency and broadband; therefore, it may have the largest potential to mask all sea turtle hearing. Noise from large vessels and outboard motors on small craft can produce source levels of 160 to over 200 dB re 1 µPa at 1 m for some large commercial vessels and outboard engines. Therefore, in the open ocean, noise from non-combatant Navy vessels may be detectable over ambient levels for tens of kilometers, and some auditory masking is possible. In noisier inshore areas around Navy ports and ranges, vessel noise may be detectable above ambient for only several hundred meters. Some auditory masking to sea turtles is likely from non-combatant Navy vessels, especially in quieter, open-ocean environments.

An approaching vessel may produce a sound shadow when the propulsion system is located at the rear of the vessel. The vessels that pose the greatest risk to sea turtles are small, fast-moving vessels typically used in coastal waters where sea turtle abundance is the greatest (Chaloupka et al. 2008a). These boats typically have propeller configurations above the depth of the keel, shielding sound waves from projecting forward of the vessel (Gerstein et al. 2009). Sound levels in front of the approaching vessel are lower because the ship's hull blocks the sound produced by the propulsion system (Gerstein et al. 2009). Low-frequency sounds are refracted around the ship's hull, as shown by Gerstein et al. (2009), while mid-frequency and high frequency sounds are refracted outward from the vessel trajectory. In response, marine animals that hear in the middle and high frequencies may move to a position closer to the approaching vessel's bow trajectory, increasing the potential for a strike. Low-frequency specialists, such as sea turtles, are less likely to be confused by a sound shadow produced by an approaching vessel because the sound shadow contains low-frequency sounds. The potential for vessel strikes is discussed in more detail in Section 3.5.3.3. (Physical Disturbance and Strike Stressors).

Navy ports such as San Diego and Pearl Harbor are heavily trafficked by private and commercial vessels, in addition to naval vessels. Because Navy ships make up a small portion of the total ship traffic, even in the most concentrated port and inshore areas, proposed Navy vessel transits are unlikely to cause long-term abandonment of habitat by sea turtles.

Aircraft Noise

Fixed and rotary-wing aircraft are used for a variety of training and testing activities throughout the Study Area. Sea turtles may be exposed to aircraft noise wherever aircraft overfly the Study Area. Most of these sounds would be centered around airbases and fixed ranges within each range complex. Aircraft produce extensive airborne noise from either turbofan or turbojet engines. Rotary-wing aircraft (helicopters) produce low-frequency sound and vibration (Pepper et al. 2003). A severe but infrequent type of aircraft noise is the sonic boom, produced when the aircraft exceeds the speed of sound. Aircraft noise as a stressor is described in Section 3.0.4.4.2 (Air-Water Interface).

Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors, but significant acoustic energy is primarily transmitted into the water directly below the craft in a narrow cone area, as discussed in greater detail in Section 3.0.3.2 (Acoustic and Explosives Primer). Underwater sounds from aircraft are strongest just below the surface and directly under the aircraft. The maximum sound levels in water from aircraft overflights are approximately 150 dB re 1 µPa for an F/A-18 aircraft at 980 ft. altitude; approximately 125 dB re 1 µPa for an H-60 helicopter hovering at 50 ft.; and under ideal conditions, sonic booms from aircraft at 3,280 ft. (999.7 m) could reach up to 178 dB re 1 µPa at the water's surface (see Section 3.0.4.4.3 for additional information on aircraft sonic booms).

Sea turtles may respond to both the physical presence and to the noise generated by aircraft, making causation by one or the other stimulus difficult to determine. In addition to noise, all low-flying aircraft create shadows, to which animals at the surface may react. Helicopters may also produce strong downdrafts, a vertical flow of air that becomes a surface wind, which can also affect an animal's behavior at or near the surface.

In most cases, exposure of a sea turtle to fixed-wing or rotary-wing aircraft would last for only seconds as the aircraft quickly passes overhead. Animals would have to be at or near the surface at the time of an overflight to be exposed to appreciable sound levels. Take-offs and landings occur at established airfields as well as on vessels at sea across the Study Area. Take-offs and landings from Navy vessels could startle sea turtles; however, these events only produce in-water noise at any given location for a brief period as the aircraft climbs to cruising altitude. Some sonic booms from aircraft could startle sea turtles, but these events are transient and happen infrequently at any given location within the Study Area. Repeated exposure to most individuals over short periods (days) is unlikely, except for animals that reside in inshore areas around Navy ports, or on Navy fixed-ranges, or during major training exercises.

Low flight altitudes of helicopters during some activities, which often occur under 100 ft. (30.5 m) altitude, may elicit a somewhat stronger behavioral response because of the proximity to the water; the slower airspeed and therefore longer exposure duration; and the downdraft created by the helicopter's rotor. Sea turtles would likely avoid the area under the helicopter. An individual likely would not be exposed repeatedly for long periods because these events typically transit open ocean areas within the Study Area.

3.5.3.1.12.1 No Action Alternative

Training Activities

Training activities under the No Action Alternative include noise from vessel movements and fixed- and rotary-wing aircraft overflights. Navy vessel and aircraft traffic could be associated with training in all of the range complexes, and throughout the Study Area while in transit.

Within HRC, vessel traffic would be concentrated in waters near Naval port facilities (e.g., Pearl Harbor) and other installations (e.g., Pacific Missile Range Facility), as well as smaller craft concentrations near training areas on Oahu (e.g., Marine Corps Training Area Bellows). Within SOCAL, most vessel traffic would be concentrated in San Diego Bay, as well as in oceanside training areas within SSTC (e.g., Boat Lanes and oceanside training beaches), and waters off San Clemente Island within Navy training areas. Therefore, the majority of sound introduced into the water by vessel movements would be concentrated in these areas.

Helicopters typically train closer to shore and at lower altitudes than fixed-wing aircraft. Within SOCAL, sea turtles foraging in shallow waters may be exposed to in-water noise from helicopter overflights near SSTC and San Clemente Island training locations. Within HRC, sea turtles foraging in shallow waters or approaching nesting beaches may be exposed to in-water noise from helicopter overflights near Pearl Harbor, Marine Corps Base Hawaii Kaneohe, Marine Corps Base Hawaii Bellows, and training areas off Kauai.

Sea turtles exposed to a passing Navy vessel or aircraft may not respond at all, or they may exhibit a short-term behavioral response such as avoidance or changing dive behavior. Short-term reactions to aircraft or vessels are not likely to disrupt major behavioral patterns or to result in serious injury to any sea turtles. Acoustic masking may result from vessel sounds, especially from non-combatant ships. Acoustic masking may prevent an animal from perceiving biologically relevant sounds during the period of exposure, potentially resulting in missed opportunities to obtain resources.

Long-term impacts from training activities are unlikely because the density of Navy ships in the Study Area is low overall and Navy combatant vessels are designed to be quiet. Abandonment of habitat because of proposed Navy activities is unlikely because of the low overall density of Navy vessel and aircraft in the Study Area. No long-term consequences for individuals or the population are expected.

Pursuant to the ESA, noise from vessels and aircraft during training activities under the No Action Alternative may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Testing activities under the No Action Alternative include noise from vessel movements and fixed- and rotor-wing aircraft overflights. Navy vessel and aircraft traffic could be associated with testing within HRC near Naval port facilities (e.g., Pearl Harbor) and other installations used for testing (e.g., Pacific Missile Range Facility, Shallow Water Training Range, and areas used for Hawaii Area Tracking System testing, test areas north of Maui). Within SOCAL, vessel and aircraft activities would be concentrated in areas used for testing, such as SSTC training areas, Southern California Anti-Submarine Warfare Range, waters off the Shore Bombardment Area, and other areas off San Clemente Island.

Sea turtles exposed to a passing Navy vessel or aircraft may not respond at all, or they may exhibit a short-term behavioral response such as avoidance or changing dive behavior. Short-term reactions to aircraft or vessels are not likely to disrupt major behavioral patterns or to result in serious injury to any sea turtles. Acoustic masking may occur due to vessel sounds, especially from non-combatant ships. Acoustic masking may prevent an animal from perceiving biologically relevant sounds during the period of exposure, potentially resulting in missed opportunities to obtain resources.

Long-term impacts from the proposed activities are unlikely because the density of Navy ships in the Study Area is low overall and many Navy ships are designed to be as quiet as possible. Abandonment of habitat in response to proposed Navy activities is unlikely because of the low overall density of Navy vessel and aircraft in the Study Area. No long-term consequences for individuals or the population would be expected.

Pursuant to the ESA, noise from vessels and aircraft during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.1.12.2 Alternative 1

Training Activities

Training activities proposed under Alternative 1 would increase vessel traffic and aircraft flight hours compared to the No Action Alternative, increasing overall amounts of aircraft and vessel noise. Certain portions of the Study Area, such as areas near Navy ports and airfields, installations, and training ranges, are used more heavily by vessels and aircraft than other portions of the Study Area, as described in further detail in Table 2.8-1 of Chapter 2, Section 3.0.5.3.1.6 (Vessel Noise), and Section 3.0.5.3.1.7 (Aircraft Overflight Noise). The types and locations of noise from vessels and aircraft would be similar to those under the No Action Alternative.

Although more sea turtle exposures to noise from vessels and aircraft could occur, predicted impacts from vessel or aircraft noise would not differ substantially from those under the No Action Alternative. Significant behavioral reactions by sea turtles in response to passing vessel or aircraft noise are not expected. For the same reasons stated in Section 3.5.3.1.12.1 (No Action Alternative), even though vessel noise may cause short-term impacts, no long-term consequences for individuals or populations would be expected.

Pursuant to the ESA, noise from vessels and aircraft during training activities under Alternative 1 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Testing Activities proposed under Alternative 1 would increase Navy vessel traffic and aircraft overflights compared to the No Action Alternative, increasing overall amounts of vessel and aircraft noise. Within HRC, vessel traffic would be concentrated in waters that are used for testing by various Navy systems commands. These areas within HRC are located near naval port facilities (e.g., Pearl Harbor) and other installations used for testing (e.g., Pacific Missile Range Facility, Shallow Water Training Range, areas used for Hawaii Area Tracking System testing, and test areas north of Maui). Within SOCAL, vessel traffic would be concentrated in areas used for testing, such as SSTC training areas, Southern California Anti-Submarine Warfare Range, waters off the Shore Bombardment Area, and other areas off San Clemente Island. New vessels proposed for testing under Alternative 1, such as the Littoral Combat Ship, the Joint High Speed Vessel, and the Expeditionary Fighting Vehicle, are all fast-moving and designed to operate in nearshore waters. Overall noise levels may increase in these environments. The number of events and proposed locations are discussed in further detail in Tables 2.8-2 through 2.8-5 of Chapter 2; Section 3.0.5.3.1.6 (Vessel Noise); and Section 3.0.5.3.1.7 (Aircraft Overflight Noise).

Although sea turtle exposures to noise from vessels and aircraft could increase under Alternative 1, predicted impacts from vessel or aircraft noise would not differ substantially from those under the No

Action Alternative. Significant behavioral reactions by sea turtles in response to passing vessel or aircraft noise are not expected. For the same reasons stated in Section 3.5.3.1.12.1 (No Action Alternative), even though vessel noise may cause short-term impacts, no long-term consequences for individuals or populations would be expected.

Pursuant to the ESA, noise from vessels and aircraft during testing activities under Alternative 1 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.1.12.3 Alternative 2

Training Activities

The number and location of training activities under Alternative 2 are identical to those of training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative would also be identical, as described in Section 3.5.3.1.12.1 (No Action Alternative).

Pursuant to the ESA, noise from vessels and aircraft during training activities under Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Testing Activities proposed under Alternative 2 would increase Navy vessel traffic and aircraft overflights compared to the No Action Alternative, increasing overall amounts of vessel and aircraft noise. The types of activities and their locations would similar to those under Alternative 1, although overall activities would increase by approximately 10 percent over Alternative 1. The number of events and proposed locations are discussed in further detail in Tables 2.8-2 through 2.8-4 of Chapter 2; Section 3.0.5.3.1.6 (Vessel Noise); and Section 3.0.5.3.1.7 (Aircraft Overflight Noise).

Although sea turtle exposures to noise from vessels and aircraft could increase under Alternative 2, predicted impacts from vessel or aircraft noise would not differ substantially from those under the No Action Alternative. Significant behavioral reactions by sea turtles in response to passing vessel or aircraft noise are not expected. For the same reasons stated in Section 3.5.3.1.12.1 (No Action Alternative), even though vessel noise may cause short-term impacts, no long-term consequences for individuals or populations would be expected.

Pursuant to the ESA, noise from vessels and aircraft during testing activities under Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.2 Energy Stressors

This section evaluates the potential for sea turtles to be impacted by electromagnetic devices used during training and testing activities in the Study Area. Lasers used as part of proposed training and testing activities would be low-energy lasers used for mine detection and targeting. These laser devices are described in Chapter 2. While all points on a sea turtle's body would have roughly the same probability of laser exposure, only eye exposure is of concern for low-energy lasers. Any heat that the laser generates would rapidly dissipate due to the large heat capacity of water and the large volume of water in which the laser is used. There is no suspected effect due to heat from the laser beam. Eye damage to sea turtles is unlikely because eye damage depends on wavelength with exposures of greater

than 10 seconds. With pulse durations less than 10 seconds, combined with the laser platform movement and animal motion, exposures of more than 10 seconds would not be possible. Furthermore, 96 percent of a laser beam projected into the ocean is absorbed, scattered, or otherwise lost (Guenther et al. 1996). Therefore, the use of low-energy lasers is discounted from the analysis of potential impacts on sea turtles.

3.5.3.2.1 Impacts from Electromagnetic Devices

Several different types of electromagnetic devices are used during training and testing activities. For a discussion of the types of activities that use electromagnetic devices, where they are used, and how many activities would occur under each alternative, please see Section 3.0.5.3.2.1 (Electromagnetic Devices). Aspects of electromagnetic stressors that are applicable to marine organisms in general are presented in Section 3.0.5.7.2 (Conceptual Framework for Assessing Effects from Energy-Producing Activities).

Well over a century ago, electromagnetic fields were introduced into the marine environment within the Study Area from a wide variety of sources (e.g., power transmission cables), yet little is known about the potential impacts of these sources. Studies on behavioral responses to magnetic fields have been conducted on green and loggerhead sea turtles. Loggerheads were found to be sensitive to field intensities ranging from 0.0047 to 4000 microteslas, and green sea turtles were found to be sensitive to field intensities from 29.3 to 200 microteslas (Normandeau et al. 2011). Because these data are the best available information, this analysis assumes that the responses would be similar for other sea turtle species.

Sea turtles use geomagnetic fields to navigate at sea, and therefore changes in those fields could impact their movement patterns (Lohmann and Lohmann 1996; Lohmann et al. 1997). Turtles in all life stages orient to the earth's magnetic field to position themselves in oceanic currents; this helps them locate seasonal feeding and breeding grounds and to return to their nesting sites (Lohmann and Lohmann 1996; Lohmann et al. 1997). Experiments show that sea turtles can detect changes in magnetic fields, which may cause them to deviate from their original direction (Lohmann and Lohmann 1996; Lohmann et al. 1997). For example, Lohmann and Lohmann (1996) found that loggerhead hatchlings tested in a magnetic field of 52,000 nanoteslas swam eastward, and when the field was decreased to 43,000 nanoteslas, the hatchlings swam westward. Sea turtles also use nonmagnetic cues for navigation and migration, and these additional cues may compensate for variations in magnetic fields.

3.5.3.2.1.1 No Action Alternative

Training Activities

Table 3.0-18 lists the number and location of training activities that generate electromagnetic fields. As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under the No Action Alternative, training activities involving electromagnetic devices occur in open ocean areas of HRC and SOCAL. All sea turtle species in the Study Area could occur in these locations, and could be exposed to the electromagnetic fields.

If located in the immediate area (within about 650 ft. [200 m]) where electromagnetic devices are being used, sea turtles could deviate from their original movements, but the extent of this disturbance is likely to be inconsequential. The electromagnetic devices used in training activities are not expected to cause more than a short-term behavioral disturbance to sea turtles because of the: (1) relatively low intensity of the magnetic fields generated (0.2 microtesla at 200 m [656.2 ft.] from the source), (2) very local potential impact area, and (3) temporary duration of the activities (hours). Potential impacts of

exposure to electromagnetic stressors are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level impacts.

Pursuant to the ESA, the use of electromagnetic devices during training activities under the No Action Alternative may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Table 3.0-18 lists the number and location of testing activities that generate electromagnetic fields. As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under the No Action Alternative, training activities involving electromagnetic devices occur in open ocean areas of HRC and SOCAL. All sea turtle species in the Study Area could occur in these locations, and could be exposed to the electromagnetic fields.

If located in the immediate area (within about 650 ft. [200 m]) where electromagnetic devices are being used, sea turtles could deviate from their original movements, but the extent of this disturbance is likely to be inconsequential. The electromagnetic devices used in training activities are not expected to cause more than a short-term behavioral disturbance to sea turtles because of the: (1) relatively low intensity of the magnetic fields generated (0.2 microtesla at 200 m [656.2 ft.] from the source), (2) very localized potential impact area, and (3) temporary duration of the activities (hours). Potential impacts of exposure to electromagnetic stressors are not expected to result in substantial changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level impacts.

Pursuant to the ESA, the use of electromagnetic devices during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.2.1.2 Alternative 1

Training Activities

Table 3.0-18 lists the number and location of training activities under Alternative 1 that generate electromagnetic fields. As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 1, testing activities involving electromagnetic devices occur in open ocean areas of HRC and SOCAL. All sea turtle species in the Study Area could occur in these locations, and could be exposed to the electromagnetic fields.

In comparison to the No Action Alternative, the increase in activities under Alternative 1 may increase the risk of sea turtle exposures to electromagnetic energy. However, the impact on sea turtles would remain the same. For the same reasons as stated in Section 3.5.3.2.1.1 (No Action Alternative), the use of electromagnetic devices is not expected to cause more than a short-term behavioral disturbance to sea turtles, or have any lasting effects on their survival, growth, recruitment, or reproduction.

Pursuant to the ESA, the use of electromagnetic devices during training activities under Alternative 1 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Table 3.0-18 lists the number and location of testing activities that generate electromagnetic fields. As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 1, testing activities involving electromagnetic devices occur in open ocean areas of HRC and SOCAL. All sea turtle species in the Study Area could occur in these locations, and could be exposed to the electromagnetic fields.

In comparison to the No Action Alternative, the approximately 30 percent increase in activities under Alternative 1 may increase the risk of sea turtles being exposed to electromagnetic energy. However, the expected impact on sea turtles remains the same. For the same reasons as stated in Section 3.5.3.2.1.1 (No Action Alternative), the use of electromagnetic devices is not expected to cause more than a short-term behavioral disturbance to sea turtles or have lasting effects on their survival, growth, recruitment, or reproduction.

Pursuant to the ESA, the use of electromagnetic devices during testing activities under Alternative 1 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.2.1.3 Alternative 2

Training Activities

The number and location of training activities under Alternative 2 are identical to those of training activities under Alternative 1. Therefore, impacts on and comparisons to the No Action Alternative would be identical to those described in Section 3.5.3.3.2.1.2 (Alternative 1).

Pursuant to the ESA, the use of electromagnetic devices used during training activities under Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Table 3.0-18 lists the number and location of electromagnetic energy activities. As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 2, electromagnetic device use would increase by approximately 40 percent in the Study Area, compared to the No Action Alternative, and would be approximately 10 percent more than under Alternative 1. The location of testing activities and species potentially impacted under Alternative 2 are identical to those specified under Alternative 1.

Pursuant to the ESA, the use of electromagnetic devices during testing activities under Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.3 Physical Disturbance and Strike Stressors

This section analyzes the potential impacts of the various types of physical disturbance and strike stressors used by Navy during training and testing activities within the Study Area. For a list of Navy activities that involve this stressor, refer to Table 3.0-7. The physical disturbance and strike stressors that may impact sea turtles include: (1) vessels, (2) in-water devices, (3) military expended materials, and (4) seafloor devices. Sections 3.5.3.1.1 (Impulse and Non-Impulse Sound Sources) through 3.5.3.1.11 (Impacts from Weapons Firing, Launch, and Impact Noise) contain the analysis of the potential for disturbance visual or acoustic cues. For a list of Navy activities that involve this stressor, refer to Table 3.0-7 (Stressors by Warfare and Testing Area).

The way a physical disturbance may affect a sea turtle would depend in part on the relative size of the object, the speed of the object, the location of the sea turtle in the water column, and the behavioral reaction of the sea turtle. It is not known at what point or through what combination of stimuli (visual, acoustic, or through detection in pressure changes) a sea turtle becomes aware of a vessel or other potential physical disturbances prior to reacting or being struck. Like marine mammals, if a sea turtle reacts to physical disturbance, the individual must stop its activity and divert its attention in response to the stressor. The energetic costs of reacting to a stressor depend on the specific situation, but one can assume that the caloric requirements of a response may reduce the amount of energy available for other biological functions. Given that the presentation of a physical disturbance should be very rare and brief, the cost of the response is likely to be within the normal variation experienced by a sea turtle during its daily routine unless the animal is struck. If a strike does occur, the cost to the individual could range from slight injury to death.

3.5.3.3.1 Impacts from Vessels

The majority of the training and testing activities under all alternatives involve some level of vessel activity. For a discussion of the types of activities that include the use of vessels, where they are used, and the speed and size characteristics of vessels used, see Section 3.0.5.3.3.1 (Vessels). Vessels include ships, submarines, and boats ranging in size from small, 22 ft. (6.7 m) rigid hull inflatable boats to aircraft carriers with lengths up to 1,092 ft. (332.8 m). Large Navy ships generally operate at speeds in the range of 10 to 15 knots, and submarines generally operate at speeds in the range of 8 to 13 knots. Small craft (for purposes of this discussion less than 40 ft. [12.2 m] in length) have much more variable speeds (dependent on the mission). While these speeds are representative of most activities, some vessels need to operate outside of these parameters. For example, to produce the required relative wind speed over the flight deck, an aircraft carrier vessel group engaged in flight operations must adjust its speed accordingly. Conversely, there are other instances, such as launch and recovery of a small rigid hull inflatable boat, vessel boarding, search, and seizure training activities or retrieval of a target, when vessels will be stopped or moving slowly ahead to maintain steerage. There are a few specific activities, including high speed tests of newly constructed vessels such as aircraft carriers, amphibious assault ships and the Joint High Speed Vessel (which will operate at an average speed of 35 knots), where vessels will operate at higher speeds.

The number of Navy vessels in the Study Area at any given time varies, and depends on local training or testing requirements. Most activities include either one or two vessels, and may last from a few hours up to two weeks. Vessel movement under the Proposed Action would be widely dispersed throughout the Study Area, but more concentrated in portions of the Study Area near ports, naval installations, range complexes, and testing ranges.

A study of sea turtle stranding events in the Hawaiian Archipelago from 1982 to 2003 showed that 97 percent of the 3,861 sea turtles stranded were green sea turtles. Over half (54.4 percent) of the strandings could not be attributed to any known or single cause. However, of the known causes, boat strikes (generally by small craft) contributed the fewest (2.5 percent), compared to shark attacks (2.7 percent), fishing gear (12 percent), and the tumor-forming disease, fibropapillomatosis (28 percent) (Chaloupka et al. 2008a).

Since green sea turtles were first documented in 1970 in San Diego Bay, little mortality has been attributed to vessel strikes through anecdotal observations (U.S. Department of the Navy 2011). Quantitative and consistent reporting of vessel strikes on turtles within San Diego Bay is lacking; however, vessel strike data for San Diego County indicates that nine vessel strikes occurred between

1986 and 2008 (National Marine Fisheries Service 2008). It is unknown if the mortalities related to vessel strikes occurred in San Diego Bay or at sea; currents and tides and winds bring debris into San Diego Bay. Navy vessel traffic within San Diego Bay is concentrated near navigational channels and berthing areas, and primarily occurs in daylight. Between 2009 and 2011, MacDonald et al. (2012) used acoustic telemetry to track 25 green sea turtles in San Diego Bay. Based on recent acoustic telemetry analyses of green sea turtle ranges in San Diego Bay, resident green sea turtles do not likely spend much, if any, time foraging in the central or northern portions of San Diego Bay (MacDonald et al. 2012). Most commercial and military vessel traffic is concentrated in the central and northern portions of San Diego Bay. A few sea turtles have been observed in northern San Diego Bay, but these are likely transient green sea turtles that enter the bay in warmer months (MacDonald et al. 2012). The majority of marine training and testing activities occur in the offshore training lanes, and small-boat training and testing events are a small portion of the total activities within SSTC. Navy vessels taking part in training and testing activities within San Diego Bay transit through a small portion of documented turtle resting and foraging habitat in the southern and south-central portions of San Diego Bay.

Minor strikes may cause temporary reversible impacts, such as diverting the turtle from its previous activity or causing minor injury. Major strikes are those that can cause permanent injury or death from bleeding or other trauma, paralysis and subsequent drowning, infection, or inability to feed. Apart from the severity of the physical strike, the likelihood and rate of a turtle's recovery from a strike may be influenced by its age, reproductive state, and general condition. Much of what is written about recovery from vessel strikes is inferred from observing individuals some time after a strike. Numerous sea turtles bear scars that appear to have been caused by propeller cuts or collisions with vessel hulls (Hazel et al. 2007; Lutcavage et al. 1997), suggesting that not all vessel strikes are lethal. Conversely, fresh wounds on some stranded animals may strongly suggest a vessel strike as the cause of death. The actual incidence of recovery versus death is not known, given available data.

Any of the sea turtle species found in the Study Area can occur at or near the surface in open ocean and coastal areas, whether feeding or periodically surfacing to breathe. Sea turtles spend a majority of their time submerged (Renaud and Carpenter 1994; Sasso and Witzell 2006). Leatherback turtles are more likely to feed at or near the surface in open ocean areas. Green, hawksbill, olive ridley, and loggerhead turtles are more likely to forage nearshore, and although they may feed along the seafloor, they surface periodically to breathe while feeding and moving between nearshore habitats. These species are distributed widely in all offshore portions of the Study Area.

To assess the risk or probability of a physical strike, the number, size, and speed of Navy vessels were considered, as well as the sensory capability of sea turtles to identify an approaching vessel. Because of the wide dispersal of large vessels in open ocean areas and the widespread, scattered distribution of turtles at sea, strikes during open-ocean transits of Navy vessels are unlikely. For very large vessels, the bow wave may even preclude a sea turtle strike. The probability of a strike is further reduced by Navy mitigation measures and standard operating procedures to avoid sea turtles (see Chapter 5). Smaller, faster vessels that operate in nearshore waters, where green, hawksbill, olive ridley, and loggerhead sea turtles can be more densely concentrated, pose a greater risk (Chaloupka et al. 2008). Some vessels associated with training and testing can travel at high speeds, which increase the strike risk to sea turtles (Table 3.0-19) (Hazel et al. 2007). Vessels transiting in shallow waters to and from ports travel at slower speed and pose less risk of strikes to sea turtles (see Section 3.0.5.3.3.1, Vessels).

3.5.3.3.1.1 No Action Alternative, Alternative 1, and Alternative 2

Training Activities

As indicated in Section 3.0.5.3.3.1 (Vessels), the majority of the training activities under all alternatives involve vessels. See Table 3.0-19 for a representative list of Navy vessel sizes and speeds. These activities could be widely dispersed throughout the Study Area, but would be more concentrated near naval ports, piers, and range areas. There is no seasonal differentiation in Navy vessel use. Large vessel movement primarily occurs within the U.S. Exclusive Economic Zone. Vessel strikes are more likely in nearshore areas than in the open ocean portions of the Study Area because of the concentration of vessel movements in those areas. Any of the sea turtle species found in the Study Area can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. These species are distributed widely in all offshore portions of the Study Area. Given the concentration of Navy vessel movements near naval ports, piers and range areas, this training activity could overlap with sea turtles occupying these waters.

Under the No Action Alternative, Alternative 1, and Alternative 2, exposure to vessels used in training activities may cause short-term disturbance to an individual turtle; however, these short-term disturbances may cause injury or mortality due to strikes. As demonstrated by scars on all species of sea turtles, they are not always able to avoid being struck; therefore, vessel strikes are a potential cause of mortality for these species. Although the likelihood of being struck is minimal, sea turtles that overlap with Navy exercises are more likely to encounter vessels. This overlap is expected to be infrequent and rare, with the highest risk to transient turtles entering San Diego Bay during warm months of the year. Exposure to vessels may change an individual's behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to vessels is not expected to result in population-level impacts. The stressor does not overlap with any designated sea turtle critical habitat.

Pursuant to the ESA, the use of vessels during training activities as described in the No Action Alternative, Alternative 1, and Alternative 2 may affect, and is likely to adversely affect, green, hawksbill, olive ridley, leatherback or loggerhead turtles.

Testing Activities

As indicated in Section 3.0.5.3.3.1 (Vessels), most testing activities involve the use of vessels. However, the number of vessels used for testing activities is comparatively lower than the number of vessels used for training (less than 10 percent). In addition, testing often occurs jointly with training, so the testing activity would probably occur on a training vessel. Vessel movement in conjunction with testing activities could be widely dispersed throughout the Study Area, but would be concentrated near naval ports, piers, and range complexes. The likelihood of vessel strikes would be higher in the nearshore portions of the Study Area because of the concentration of vessel movement in those areas.

Propulsion testing activities, also referred to as high-speed vessel trials, occur infrequently, but pose a higher strike risk because of the high-speeds at which the vessels need to transit to complete the testing activity. However, just a few of these activities are proposed per year, so the increased risk is nominal compared to all vessel use in the Proposed Action. Any of the sea turtle species found in the Study Area can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. These species are distributed widely in all offshore portions of the Study Area.

Under the No Action Alternative, Alternative 1 and Alternative 2, exposure to vessels used in testing activities may cause short-term disturbance to an individual turtle; however, these short-term disturbances may cause injury or mortality due to strikes. As demonstrated by scars on all species of sea

turtles, they are not always able to avoid being struck; therefore, vessel strikes are a potential cause of mortality for these species. Although the likelihood of being struck is minimal, sea turtles that overlap with Navy exercises are more likely to encounter vessels. Exposure to vessels may change an individual's behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to vessels is not expected to have population-level impacts. The stressor would not overlap with any designated sea turtle critical habitat.

Pursuant to the ESA, the use of vessels during testing activities as described in the No Action Alternative, Alternative 1, and Alternative 2 may affect, and is likely to adversely affect, green, hawksbill, olive ridley, leatherback and loggerhead turtles.

3.5.3.3.2 Impacts from In-Water Devices

In-water devices are generally smaller (several inches to 111 ft. [34 m]) than most Navy vessels. For a discussion of the types of activities that use in-water devices, where they are used, and how many activities would occur under each alternative, see Section 3.0.5.3.3.2 (In-Water Devices). See Table 3.0-31 for the types, sizes, and speeds of Navy in-water devices used in the Study Area.

Devices that pose the greatest collision risk to sea turtles are those that are towed or operated at high speeds and include: remotely operated high-speed targets and mine warfare systems. Devices that move slowly through the water column have a very limited potential to strike a sea turtle because sea turtles in the water could avoid a slow-moving object.

3.5.3.3.2.1 No Action Alternative, Alternative 1, and Alternative 2

Training Activities

Use of in-water devices is concentrated within the SOCAL Range Complex. The number of in-water device activities increases by less than 2 percent under Alternative 1 and Alternative 2 compared to the No Action Alternative. Any of the sea turtle species found in the Study Area can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. These species are distributed widely in all offshore portions of the Study Area.

Under the No Action Alternative, Alternative 1, and Alternative 2, exposure to in-water devices used in training activities may cause short-term disturbance to an individual turtle; however, these short-term disturbances may cause injury or mortality due to strikes. These devices move slowly through the water column and have a very limited potential to strike a sea turtle because sea turtles in the water could avoid a slow moving object. Exposure to in-water devices may change an individual's behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to vessels is not expected to result in population-level impacts.

Pursuant to the ESA, the use of in-water devices during training activities as described in the No Action Alternative, Alternative 1, and Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, olive ridley, leatherback, and loggerhead turtles.

Testing Activities

Under the No Action Alternative, Alternative 1, and Alternative 2, exposure to in-water devices used in testing activities may cause short-term disturbance to an individual turtle; however, these short-term disturbances may cause injury or mortality due to strikes. These devices move slowly through the water column and have a very limited potential to strike a sea turtle because sea turtles in the water could

avoid a slow moving object. Exposure to in-water devices may affect an individual's behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to vessels is not expected to result in population-level impacts. The stressor would not overlap with any designated sea turtle critical habitat.

Pursuant to the ESA, the use of in-water devices during testing activities as described in the No Action Alternative, Alternative 1, and Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, olive ridley, leatherback, and loggerhead turtles.

3.5.3.3.3 Impacts from Military Expended Materials

This section analyzes the strike potential to sea turtles from the following categories of military expended materials: (1) non-explosive practice munitions, (2) fragments from high-explosive munitions and (3) expended materials other than ordnance, such as sonobuoys, vessel hulks, and expendable targets. For a discussion of the types of activities that use military expended materials, where they are used, and how many activities would occur under each alternative, see Section 3.0.5.3.3.3 (Military Expended Materials Strikes).

While disturbance or strike from an item as it falls through the water column is possible, it is not likely because the objects generally sink through the water slowly and can be avoided by most sea turtles. Therefore, the discussion of military expended materials strikes will focus on the potential of a strike at the surface of the water.

There is a possibility that an individual turtle at or near the surface may be struck if they are in the target area at the point of physical impact at the time of non explosive ordnance delivery. Expended munitions may strike the water surface with sufficient force to cause injury or mortality. While any species of sea turtle may move through the open ocean, most sea turtles will only surface occasionally. Sea turtles are generally at the surface for short periods, and spend most of their time submerged (Renaud and Carpenter 1994; Sasso and Witzell 2006). The leatherback turtle is more likely to be foraging at or near the surface in the open ocean than other species, but the likelihood of being struck by a projectile remains very low. Furthermore, projectiles are aimed at targets, which will absorb the impact of the projectile. The probability of a strike is further reduced by Navy mitigation measures and standard operating procedures to avoid sea turtles (see Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

3.5.3.3.3.1 No Action Alternative, Alternative 1, and Alternative 2

Training Activities

Tables 3.0-63 and 3.0-64 list the number and location of military expended materials, most of which are small- and medium-caliber projectiles. Activities using military expended materials are concentrated within the SOCAL Range Complex. Any of the sea turtle species found in the Study Area can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. These species are distributed widely in all offshore portions of the Study Area.

Under the No Action Alternative, Alternative 1, and Alternative 2, exposures to military-expended materials used in training activities may cause short-term disturbance to an individual turtle; however, these short-term disturbances may cause injury or mortality due to strikes. Sea turtles are generally at the surface only for short periods and spend most of their time submerged, so the likelihood of being struck by a projectile is very low. Projectiles are aimed at targets, which will absorb the impact of the projectile. Exposure to military-expended materials may change an individual's behavior, growth,

survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to military-expended materials is not expected to result in population-level impacts.

Pursuant to the ESA, the use military expended materials during training activities as described in the No Action Alternative, Alternative 1, and Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, olive ridley, leatherback, and loggerhead turtles.

Testing Activities

Tables 3.0-63 and 3.0-64 list the number and location of military expended materials, most of which are small- and medium-caliber projectiles. Any of the sea turtle species found in the Study Area can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. These species are distributed widely in all offshore portions of the Study Area.

Under the No Action Alternative, Alternative 1, and Alternative 2, exposures to military-expended materials used in testing activities may cause short-term disturbance to an individual turtle; however, these short-term disturbances may cause injury or mortality due to strikes. Sea turtles are generally at the surface only for short periods and spend most of their time submerged, so the likelihood of being struck by a projectile is very low. Projectiles are aimed at targets, which will absorb the impact of the projectile. The model results indicate a high level of certainty that sea turtles would not be struck by military expended materials during testing activities. Exposure to military-expended materials could change an individual's behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to military-expended materials is not expected to result in population-level impacts.

Pursuant to the ESA, the use military expended materials during testing activities as described in the No Action Alternative, Alternative 1, and Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, olive ridley, leatherback, and loggerhead turtles.

3.5.3.3.4 Impacts from Seafloor Devices

For a discussion of the types of activities that use seafloor devices, where they are used, and how many activities would occur under each alternative, see Section 3.0.5.3.3.4 (Seafloor Devices). These include items that are placed on, dropped on, or moved along the seafloor such as mine shapes, anchor blocks, anchors, bottom-placed instruments, bottom-crawling unmanned undersea vehicles, and bottom-placed targets that are recovered (not expended). As discussed in the Section 3.5.3.3 (Physical Disturbance and Strike Stressors), objects falling through the water column will slow in velocity as they sink toward the bottom and could be avoided by most sea turtles.

3.5.3.3.4.1 No Action Alternative

Training Activities

Tables 3.0-66 and 3.0-67 list the number and location where seafloor devices are used. Any of the sea turtle species found in the Study Area can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. These species are distributed widely in all offshore portions of the Study Area.

Under the No Action Alternative, exposure to seafloor devices used in training activities may cause short-term disturbance to an individual turtle; however, these short-term disturbances may cause injury or mortality due to strikes. Objects falling through the water column will slow in velocity as they sink toward the bottom and could be avoided by most sea turtles. Further, the potential for a sea turtle to be

close to a seafloor device, and therefore be exposed, is very low, because of the relative position of sea turtles within the water column and the wide distribution of habitats. Exposure to seafloor devices is not expected to change an individual's behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to seafloor devices is not expected to result in population-level impacts.

Pursuant to the ESA, the use of seafloor devices during training activities as described under the No Action Alternative may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Tables 3.0-66 and 3.0-67 list the number and location where seafloor devices are used. Any of the sea turtle species found in the Study Area can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. These species are distributed widely in all offshore portions of the Study Area.

Under the No Action Alternative, exposure to seafloor devices used in testing activities may cause short-term disturbance to an individual turtle or, if struck, could lead to injury or death. Objects falling through the water column will slow in velocity as they sink toward the bottom and could be avoided by most sea turtles. Furthermore, the potential for a sea turtle to be close to a seafloor device, and therefore to be exposed, is very low, because of the relative position of sea turtles within the water column and the wide distribution of habitats. Exposure to seafloor devices is not expected to change an individual's behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to seafloor devices is not expected to result in population-level impacts.

Pursuant to the ESA, the use of seafloor devices during testing activities as described under the No Action Alternative may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.3.4.2 Alternative 1

Training Activities

Tables 3.0-66 and 3.0-67 list the number and location where seafloor devices are used. As indicated in Section 3.0.5.3.3.4 (Seafloor Devices), under Alternative 1, the number of activities using seafloor devices is more than twice that of the No Action Alternative. Any of the sea turtle species found in the Study Area can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. These species are distributed widely in all offshore portions of the Study Area.

Under Alternative 1, exposure to seafloor devices used in training activities may cause short-term disturbance to an individual turtle; however, these short-term disturbances may cause injury or mortality due to strikes. Objects falling through the water column will slow in velocity as they sink toward the bottom and could be avoided by most sea turtles. Furthermore, the potential for a sea turtle to be close to a seafloor device, and therefore to be exposed, is very low, because of the relative position of sea turtles within the water column and the wide distribution of habitats. Exposure to seafloor devices is not expected to change an individual's behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to seafloor devices is not expected to result in population-level impacts.

Pursuant to the ESA, the use of seafloor devices during training activities as described under Alternative 1 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Tables 3.0-66 and 3.0-67 list the number and location where seafloor devices are used. As indicated in Section 3.0.5.3.3.4 (Seafloor Devices), under Alternative 1, the number of activities using seafloor devices is approximately twice that of the No Action Alternative. The activities using seafloor devices under Alternative 1 would be expended in the same geographic locations as the No Action Alternative. Any of the sea turtle species found in the Study Area can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. These species are distributed widely in all offshore portions of the Study Area.

Under Alternative 1, exposure to seafloor devices used in testing activities may cause short-term disturbance to an individual turtle or, if struck, could lead to injury or death. Objects falling through the water column will slow in velocity as they sink toward the bottom and could be avoided by most sea turtles. Furthermore, the potential for a sea turtle to be close to a seafloor device, and therefore to be exposed, is very low, because of the relative position of sea turtles within the water column and the wide distribution of habitats. Exposure to seafloor devices is not expected to change an individual's behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to seafloor devices is not expected to result in population-level impacts.

Pursuant to the ESA, the use of seafloor devices during testing activities as described under Alternative 1 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.3.4.3 Alternative 2

Training Activities

The number and location of training activities under Alternative 2 are identical to those of the training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative would also be identical, as described in Section 3.5.3.3.4.2 (Alternative 1).

Pursuant to the ESA, the use seafloor devices used in training activities as described under Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Tables 3.0-66 and 3.0-67 list the number and location where seafloor devices are used. As indicated in Section 3.0.5.3.3.4 (Seafloor Devices), under Alternative 2, the number of activities using seafloor devices is approximately twice that of the No Action Alternative and Alternative 1. Any of the sea turtle species found in the Study Area can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. These species are distributed widely in all offshore portions of the Study Area.

Pursuant to the ESA, the use of seafloor devices during testing activities as described under Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.4 Entanglement Stressors

This section analyzes the potential entanglement impacts of the various types of expended materials used by the Navy during training and testing activities within the Study Area. This analysis includes the potential impacts of two types of military expended materials, including: (1) fiber optic cables and guidance wires, and (2) parachutes. Aspects of entanglement stressors that are applicable to marine organisms in general are presented in Section 3.0.5.7.4 (Conceptual Framework for Assessing Effects from Entanglement).

3.5.3.4.1 Impacts from Fiber Optic Cables and Guidance Wires

Fiber optic cables and guidance wires are used in several different training and testing activities. For a list of Navy activities that involve the use of fiber optic cables and wires, refer to Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires).. A sea turtle that becomes entangled in nets, lines, ropes, or other foreign objects under water may suffer only a temporary hindrance to movement before it frees itself. The turtle may suffer minor injuries but recover fully, or it may die as a result of the entanglement. Because of the physical characteristics of guidance wires and fiber optic cables, detailed in Section 3.0.5.3.4 (Entanglement Stressors), these items pose a potential, although unlikely, entanglement risk to sea turtles. The Navy analyzed the potential for entanglement of sea turtles by guidance wires and concluded that the potential for entanglement is low (U.S. Department of the Navy 1996). Except for a chance encounter with the guidance wire at the surface or in the water column while the cable or wire is sinking to the seafloor, a sea turtle would be vulnerable to entanglement only if its diving and feeding patterns place it in direct contact with the bottom. Bottom-feeding sea turtles tend to forage in nearshore areas, and these guidance wires are expended in deeper waters.

The likelihood of a sea turtle encountering and becoming entangled in a fiber-optic cable or guidance wire depends on several factors. The length of time that the fiber-optic cable or guidance wire is near a sea turtle can affect the likelihood of it posing an entanglement risk. Because these items would only be in the water column during the activity and while it sinks, the likelihood of a sea turtle encountering a fiber optic cable in the water column and becoming entangled is extremely low. Guidance wires sink to the sea floor at a rate of 0.7 ft. (0.2 m) per second; therefore, it is most likely that a sea turtle would encounter a guidance wire once it had settled to the sea floor. The length of the cable or wire may influence the potential for a sea turtle to encounter or become entangled in these items. The lengths of fiber-optic cables and guidance wires vary. Fiber-optic cables can range in size up to about 900 ft. (300 m). Greater lengths of these items may increase the likelihood that a sea turtle could become entangled. The behavior and feeding strategy of a species can also determine whether they may encounter items on the seafloor, where fiber-optic cables and guidance wires will most likely be available. There is a potential for those species that feed on the seafloor to encounter these items and become entangled; however, the relatively few fiber-optic cables and guidance wires being expended within the Study Area limits the potential for encounters. Lastly, the properties of the items themselves may limit the risk of entanglement. The physical characteristics of guidance wires and fiber-optic cables are detailed in Section 3.0.5.3.4 (Entanglement Stressors). This analysis indicates that these items pose a potential, although unlikely, entanglement risk to sea turtles. For instance, the physical characteristics of the fiber-optic material render the cable brittle and easily broken when kinked, twisted, or bent sharply (i.e., to a radius greater than 360 degrees). Thus, the fiber-optic cable would not loop, greatly reducing or eliminating any potential issues of entanglement with regard to marine life. In addition, based on degradation times, the guidance wires would break down within 1 to 2 years and therefore no longer pose an entanglement risk.

The Navy previously analyzed the potential for entanglement of sea turtles by guidance wires and concluded that the potential for entanglement is low (U.S. Department of the Navy 1996). Except for a chance encounter with the guidance wire at the surface or in the water column while the cable or wire is sinking to the seafloor, a sea turtle would be vulnerable to entanglement only if its diving and feeding patterns place it in direct contact with the bottom. Bottom-feeding sea turtles tend to forage in nearshore areas, and these wires are expended in deeper waters.

3.5.3.4.1.1 No Action Alternative

Training Activities

Tables 3.0-78 and 3.0-81 list the number and locations of activities that expend fiber optic cables and guidance wires. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under the No Action Alternative, no Airborne mine neutralization activities (with High Explosives neutralizers) expend fiber optic cables.

Any species of sea turtle that occurs in the Study Area could at some point encounter expended fiber optic cables and guidance wires. The sink rates of cables and wires would rule out the possibility of them drifting great distances into nearshore and coastal areas where green, hawksbill, olive ridley, and loggerhead turtles are more likely to occur and feed on the bottom. The leatherback is more likely to co-occur with these activities, given its preference for open ocean habitats, but this species is known to forage on jellyfish at or near the surface.

Under the No Action Alternative, exposure to cables and wires used in training activities may cause short-term or long-term disturbance to an individual turtle because if a sea turtle were to become entangled in a cable or wire, it could free itself or it could lead to injury or death. Exposure to cable or wire may change an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, cables and wires are generally not expected to cause disturbance to sea turtles because: (1) the number of cables and wires expended is relatively low, decreasing the likelihood of encounter; (2) the physical characteristics of the cables and wires; and (3) the behavior of the species, as sea turtles are unlikely to become entangled in an object that is resting on the seafloor. Exposure to cables and wires is not expected to result in population-level impacts.

Pursuant to the ESA, the use of fiber optic cables and guidance wires during training activities as proposed under the No Action Alternative may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Tables 3.0-78 and 3.0-81 list the number and locations of activities that expend fiber optic cables and guidance wires. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under the No Action Alternative, Airborne mine neutralization activities (with High Explosives neutralizers) would expend fiber optic cables and guidance wires in SOCAL and HRC.

Sea turtle species in the Study Area could at some point encounter expended fiber optic cables and guidance wires. The sink rates of cables and wires rule out the possibility of them drifting great distances into nearshore and coastal areas where green, hawksbill, olive ridley, and loggerhead turtles are more likely to occur and feed on the bottom. The leatherback is more likely to co-occur with these activities, given its preference for open ocean habitats, but this species is known to forage on jellyfish at or near the surface.

Under the No Action Alternative, exposure to cables and wires used in testing activities may cause short-term or long-term disturbance to an individual turtle because if a sea turtle were to become entangled in a cable or wire, it could free itself or it could lead to injury or death. Exposure to munitions may change an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, cables and wires are generally not expected to cause disturbance to sea turtles because: (1) the number of cables and wires expended is relatively low, decreasing the likelihood of encounter; (2) the physical characteristics of the cables and wires; and (3) the behavior of the species, as sea turtles are unlikely to become entangled in an object that is resting on the seafloor. Exposure to cables and wires is not expected to result in population-level impacts.

Pursuant to the ESA, the use of fiber optic cables and guidance wires during testing activities as proposed under the No Action Alternative may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.4.1.2 Alternative 1

Training Activities

Tables 3.0-78 and 3.0-81 list the number and locations of activities that expend fiber optic cables and guidance wires. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under Alternative 1, the number of activities that expend fiber optic cables is more than two-times higher than that of the No Action Alternative.

As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under Alternative 1, the number of torpedo activities that expend guidance wire is approximately two-times higher than that of the No Action Alternative. The torpedo activities using guidance wire under Alternative 1 would occur in the same geographic locations as the No Action Alternative.

Species of sea turtles that occur in the Study Area could encounter expended fiber-optic cables and guidance wires. The sink rates of cables and wires rule out the possibility of them drifting great distances into nearshore and coastal areas where green, hawksbill, olive ridley, and loggerhead turtles are more likely to occur and to feed on the bottom. The leatherback is more likely to co-occur with these activities, given its preference for open ocean habitats, but this species is known to forage on jellyfish at or near the surface.

In comparison to the No Action Alternative, the increase in activities presented in Alternative 1 may increase the risk of exposing sea turtles to cables and wires. However, the expected impact on any exposed sea turtle remains the same. For the same reasons as stated in Section 3.5.3.4.1.1 (No Action Alternative), the use of cables and wires in training activities may cause short-term or long-term disturbance to an individual turtle, because if a sea turtle were to become entangled in a cable or wire, it could free itself or it could lead to injury or death. Exposure to cable or wire may change an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Exposure to cables and wires is not expected to result in population-level impacts.

Pursuant to the ESA, the use of fiber optic cables and guidance wires during training activities as proposed under Alternative 1 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Tables 3.0-78 and 3.0-81 list the number and locations of activities that expend fiber optic cables and guidance wires. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under Alternative 1, the number of Airborne mine neutralization activities (with High Explosive neutralizers) that expend fiber optic cables is almost two times higher than that of the No Action Alternative. The activities using fiber optic cables and guidance wires under Alternative 1 would occur in the same geographic locations as the No Action Alternative.

Any species of sea turtle that occurs in the Study Area could encounter expended fiber-optic cables and guidance wires. The sink rates of cables and wires rule out the possibility of them drifting great distances into nearshore and coastal areas where green, hawksbill, olive ridley, and loggerhead turtles are more likely to occur and to feed on the bottom. The leatherback is more likely to co-occur with these activities, given its preference for open ocean habitats, but this species is known to forage on jellyfish at or near the surface.

In comparison to the No Action Alternative, the increase in activities presented in Alternative 1 may increase the risk of sea turtles being exposed to cables and wires; however, the expected impact to any exposed sea turtle remains the same. For the same reasons as stated in Section 3.5.3.4.1.1 (No Action Alternative), the use of cables and wires in testing activities may cause short-term or long-term disturbance to an individual turtle, because if a sea turtle were to become entangled in a cable or wire, it could free itself or it could lead to injury or death. Exposure to cable or wire may change an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Exposure to cables and wires is not expected to result in population-level impacts.

Pursuant to the ESA, the use of fiber optic cables and guidance wires during testing activities as proposed under Alternative 1 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.4.1.3 Alternative 2

Training Activities

Activities proposed under Alternative 2 are the same as those proposed under Alternative 1. Therefore, the impact conclusion for Alternative 2 training events is the same as for Alternative 1.

The entanglement of sea turtles by fiber optic cables is considered to be highly unlikely. If a sea turtle became entangled in a cable, however, the sea turtle could suffer a temporary or permanent impairment of normal activities. Impairment of some activities (e.g., foraging) could indirectly result in mortality while impairment of other activities (e.g., migration) could affect reproduction.

Pursuant to the ESA, the use of fiber optic cables and guidance wires during training activities as proposed under Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Tables 3.0-78 and 3.0-81 list the number and locations of activities that expend fiber optic cables and guidance wires. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under Alternative 2, the number of Airborne mine neutralization activities (with High Explosive neutralizers) that expend fiber optic cables is nearly two-times higher than that of the No Action Alternative, and is

approximately 10 percent higher than under Alternative 1. The activities using fiber optic cables under Alternative 2 would occur in the same geographic locations as the No Action Alternative.

As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under Alternative 2, the number of torpedo activities that expend guidance wire is nearly four-times that of the No Action Alternative. The torpedo activities using guidance wire under Alternative 2 would occur in the same geographic locations as the No Action Alternative.

Any species of sea turtle that occurs in the Study Area could encounter expended fiber optic cables and guidance wires. The sink rates of cables and wires rule out the possibility of them drifting great distances into nearshore and coastal areas where green, hawksbill, olive ridley, and loggerhead turtles are more likely to occur and to feed on the bottom. The leatherback is more likely to co-occur with these activities, given its preference for open ocean habitats, but this species is known to forage on jellyfish at or near the surface.

In comparison to the No Action Alternative and Alternative 1, the increase in activities presented in Alternative 2 may increase the risk of sea turtles being exposed to cables and wires; however, the expected impact to any exposed sea turtle remains the same. For the same reasons as stated in Section 3.5.3.4.1.1 (No Action Alternative), the use of cables and wires in testing activities may cause short-term or long-term disturbance to an individual turtle, because if a sea turtle were to become entangled in a cable or wire, it could free itself or it could lead to injury or death. Exposure to cable or wire may change an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Exposure to cables and wires is not expected to result in population-level impacts.

Pursuant to the ESA, the use of fiber-optic cables and guidance wires during testing activities as proposed under Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.4.2 Impacts from Parachutes

Sonobuoys, lightweight torpedoes, targets, and other devices deployed by aircraft use nylon parachutes of various sizes. For example, a typical sonobuoy parachute is about 8 ft. (2.4 m) in diameter, with nylon suspension lines about 20 ft. (6 m) long. These parachutes are not typically recovered after the activity (Appendix A). Once a sonobuoy hits the water surface, its parachute is designed to produce drag at the surface for 5 to 15 seconds, allowing for deployment of the sonobuoy, then the parachute separates and sinks. The parachute assembly contains metallic components, and could be at the surface for a short period before sinking to the seafloor. Sonobuoy parachutes are designed to sink within 15 minutes, but the rate of sinking depends upon sea conditions and the shape of the parachute, and the duration of the descent would depend on the water depth. Prior to reaching the seafloor, it could be carried along in a current, or snagged on a hard structure near the bottom. Conversely, it could settle to the bottom, where it would be buried by sediment in most softbottom areas. Parachutes or parachute lines may be a risk for sea turtles to become entangled, particularly while at the surface. A sea turtle would have to surface to breathe or grab prey from under the parachute, and swim into the parachute or its lines.

While in the water column, a sea turtle is less likely to become entangled because the parachute would have to land directly on the turtle, or the turtle would have to swim into the parachute before it sank. If the parachute and its lines sink to the seafloor in an area where the bottom is calm, it would remain there undisturbed. Over time, it may become covered by sediment in most areas or colonized by

attaching and encrusting organisms, which would further stabilize the material and reduce the potential for reintroduction as an entanglement risk.

If bottom currents are present, the canopy may billow and pose an entanglement threat to sea turtles that feed in benthic habitats (e.g., loggerhead sea turtles). Bottom-feeding sea turtles tend to forage in nearshore areas rather than offshore, where these parachutes are used; therefore, sea turtles are not likely to encounter parachutes once they reach the seafloor. The potential for a sea turtle to encounter an expended parachute at the surface or in the water column is extremely low, and is even less probable at the seafloor, given the general improbability of a sea turtle being near the deployed parachute, as well as the general behavior of sea turtles.

3.5.3.4.2.1 No Action Alternative

Training Activities

Under the No Action Alternative, activities that involve air-dropped sonobuoys, torpedoes, or targets (and therefore the expending of unrecoverable parachutes) include tracking and torpedo exercises involving helicopter platforms and fixed-wing aircraft. As detailed in Table 3.0-84, under the No Action Alternative, up to 44,500 parachutes would be expended in the Study Area during training activities.

The entanglement of sea turtles in parachute assemblies is considered to be highly unlikely. If a sea turtle became entangled in a parachute assembly, however, the sea turtle may suffer a temporary or permanent impairment of normal activities. Impairment of some activities (e.g., foraging) may indirectly result in mortality while impairment of other activities (e.g., migration) may impair reproduction.

Pursuant to the ESA, the use of parachutes during training activities as proposed under the No Action Alternative may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

As detailed in Table 3.0-84, under the No Action Alternative, up to 7,230 parachutes would be expended in the Study Area during testing activities.

As stated above, the entanglement of sea turtles in parachute assemblies is considered to be highly unlikely. If a sea turtle became entangled in a parachute assembly, however, the sea turtle could suffer a temporary or permanent impairment of normal activities. Impairment of some activities (e.g., foraging) could indirectly result in mortality while impairment of other activities (e.g., migration) could impair reproduction.

Pursuant to the ESA, the use of parachutes during testing activities as proposed under the No Action Alternative may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.4.2.2 Alternative 1

Training Activities

Under Alternative 1, 54,200 parachutes would be expended in the Study Area during training activities. This represents an approximate 20 percent increase under Alternative 1, relative to the No Action Alternative.

The increase in expended parachutes would increase the risk of entangling sea turtles. These exercises are widely dispersed in open ocean habitats, however, where sea turtles are lower in abundance than in nearshore habitats. Furthermore, entanglement of a sea turtle in a parachute assembly is unlikely because the parachute would have to land directly on a sea turtle, or a sea turtle would have to swim into it before it settles to the ocean floor, or the sea turtle would have to encounter the parachute on the ocean floor. The potential for sea turtles to encounter an expended parachute assembly is extremely low, given the generally low probability of a sea turtle being at the exact point where the parachute lands, and the negative buoyancy of parachute constituents (reducing the probability of contact with sea turtles near the surface). If bottom currents are present, the canopy could billow and pose an entanglement threat to bottom-feeding sea turtles. However, the probability of a sea turtle encountering a parachute assembly on the sea floor and the potential for accidental entanglement in the canopy or suspension lines are both considered low.

The entanglement of sea turtles in parachute assemblies is considered to be highly unlikely. If a sea turtle became entangled in a parachute assembly, however, the sea turtle would suffer a temporary or permanent impairment of normal activities. Impairment of some activities (e.g., foraging) could indirectly result in mortality while impairment of other activities (e.g., migration) could impair reproduction.

Pursuant to the ESA, the use of parachutes during training activities as proposed under Alternative 1 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Under Alternative 1, up to 12,578 parachutes would be expended in the Study Area during testing activities. This represents nearly a 54 percent increase in the use of parachutes under Alternative 1 testing activities, relative to the No Action Alternative.

The increase in expended parachutes would increase the risk of entangling sea turtles. These exercises are widely dispersed in open ocean habitats, however, where sea turtles are lower in abundance than in nearshore habitats. Furthermore, entanglement of a sea turtle in a parachute assembly is unlikely because the parachute would have to land directly on a sea turtle, or a sea turtle would have to swim into it before it settles to the ocean floor, or the sea turtle would have to encounter the parachute on the ocean floor. The potential for sea turtles to encounter an expended parachute assembly is extremely low, given the generally low probability of a sea turtle being at the exact point where the parachute lands, and the negative buoyancy of parachute constituents (reducing the probability of contact with sea turtles near the surface). If bottom currents are present, the canopy could billow and pose an entanglement threat to bottom-feeding sea turtles. However, the probability of a sea turtle encountering a parachute assembly on the sea floor and the potential for accidental entanglement in the canopy or suspension lines are both considered low.

The entanglement of sea turtles in parachute assemblies is considered to be highly unlikely. If a sea turtle became entangled in a parachute assembly, however, the sea turtle would suffer a temporary or permanent impairment of normal activities. Impairment of some activities (e.g., foraging) could indirectly result in mortality while impairment of other activities (e.g., migration) could impair reproduction.

Pursuant to the ESA, the use of parachutes during testing activities as proposed under Alternative 1 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.4.2.3 Alternative 2

Training Activities

Alternative 2 training events would use the same number of parachutes as are proposed under Alternative 1, therefore, the conclusions for parachute use under Alternative 2 are the same as under Alternative 1.

The entanglement of sea turtles in parachute assemblies is considered to be highly unlikely. If a sea turtle became entangled in a parachute assembly, however, the sea turtle would suffer a temporary or permanent impairment of normal activities. Impairment of some activities (e.g., foraging) could indirectly result in mortality while impairment of other activities (e.g., migration) could impair reproduction.

Pursuant to the ESA, the use of parachutes during training activities as proposed under Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

Testing Activities

Under Alternative 2, up to 13,776 parachutes would be expended in the Study Area during testing activities. This represents a 62 percent increase in the use of parachutes under Alternative 2 testing activities, relative to the No Action Alternative.

The entanglement of sea turtles in parachute assemblies is considered to be highly unlikely. If a sea turtle became entangled in a parachute assembly, however, the sea turtle may suffer a temporary or permanent impairment of normal activities. Impairment of some activities (e.g., foraging) may indirectly result in mortality while impairment of other activities (e.g., migration) may impair reproduction.

Pursuant to the ESA, the use of parachutes during testing activities as proposed under Alternative 2 may affect, but is not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.5 Ingestion Stressors

This section analyzes the potential ingestion impacts of expended materials used by the Navy during training and testing activities within the Study Area. This analysis includes two categories of military expended materials: (1) munitions (both non-explosive practice munitions and fragments from high-explosive munitions), which are expected to sink to the seafloor; and (2) military expended materials other than munitions (including fragments from targets, chaff, flares, and parachutes), which may remain at the surface or in the water column for some time prior to sinking. Sea turtles could ingest expended materials in all Large Marine Ecosystems and Open Ocean Areas, and can ingest items at the surface, in the water column, or at the seafloor, depending on the size and buoyancy of the expended object and the feeding behavior of the turtle. Floating material could be eaten by turtles such as leatherbacks that feed at or near the water surface, while materials that sink to the seafloor pose a risk to bottom-feeding turtles such as loggerheads (see Sections 3.5.2.4 through 3.5.2.8 for descriptions of feeding behavior by species).

Leatherbacks feed primarily on jellyfish throughout the water column, and may mistake floating debris for prey. Items found in a sample of leatherbacks that had ingested plastic included plastic bags, fishing line, twine, mylar balloon fragments, and a plastic spoon (Mrosovsky et al. 2009). Kemp's ridleys, loggerheads, and green sea turtles in coastal Florida were found to ingest bits of plastic, tar, rubber, and aluminum foil (Bjorndal et al. 1994). Oceanic-stage loggerhead turtles in the North Atlantic Ocean were found to ingest "small pieces of hard plastic," corks, and white Styrofoam pieces (Frick et al. 2009). Juvenile loggerheads in the Mediterranean ingested plastic most frequently, followed by tar, Styrofoam, wood, feathers, lines, and net fragments (Tomás et al. 2002). Similar trends in types of items ingested were observed in Kemp's ridley, loggerhead, and green sea turtles off the Texas coast (Stanley et al. 1988). Conditions for marine pollution in the Pacific are similar to conditions in the Atlantic, Mediterranean, and the Gulf of Mexico; therefore, sea turtle ingestion rates of non-prey items in the Pacific is expected to be similar to other sea turtle habitats. The variety of items ingested by turtles suggests that feeding is nondiscriminatory, and they are prone to ingesting nonprey items. Ingestion of these items may not be directly lethal; however, ingestion of plastic and other fragments can restrict food intake and have sub-lethal impacts by reducing nutrient intake (McCauley and Bjorndal 1999). Poor nutrient uptake can lead to decreased growth rates, depleted energy, reduced reproduction, and decreased survivorship. These long-term sublethal effects may lead to population level impacts, but this is difficult to assess because the affected individuals remain at sea and the trends may only arise after several generations have passed.

Because bottom-feeding occurs in nearshore areas, materials that sink to the seafloor in the open ocean are less likely to be ingested due to their location, as depth in areas where ordnance is fired ranges from approximately 20 to 200 m (65.6 to 656.2 ft.) in areas far offshore. The consequences of ingestion could range from temporary and inconsequential to long-term physical stress, or even death. Aspects of ingestion stressors that are applicable to marine organisms in general are presented in Section 3.0.5.7.5 (Conceptual Framework for Assessing Effects from Ingestion).

3.5.3.5.1 Impacts from Munitions

Types of non-explosive practice munitions generally include projectiles, missiles, and bombs. Of these items, only small- or medium-caliber projectiles would be small enough for a sea turtle to ingest. Small- and medium-caliber projectiles include all sizes up to and including 2.25 in. (57 millimeters [mm]) in diameter. These solid metal materials would quickly move through the water column and settle to the seafloor. Ingestion of non-explosive practice munitions is not expected to occur in the water column because the ordnance sinks quickly. Instead, they are most likely to be encountered by species that forage on the bottom. The types, numbers, and locations of activities using these devices under each alternative are discussed in Sections 3.0.5.3.5.1 (Non-explosive Practice Munitions) and 3.0.5.3.5.2 (Fragments from High-Explosive Munitions).

Because green, loggerhead, olive ridley, and hawksbill turtles feed along the seafloor, they are more likely to encounter munitions of ingestible size that settle on the bottom than leatherbacks that primarily feed at the surface. Furthermore, these four species typically use nearshore feeding areas, while leatherbacks are more likely to feed in the open ocean. Given the very low probability of a leatherback encountering and ingesting materials on the seafloor, this analysis will focus on green, loggerhead, olive ridley, and hawksbill turtles and ingestible materials expended nearshore, within range complexes and testing ranges.

3.5.3.5.1.1 No Action Alternative

Training Activities

Tables 3.0-63 and 3.0-64 list the number and location of small- and medium-caliber projectiles. As indicated in Section 3.0.5.3.5.1 (Non-explosive Practice Munitions), under the No Action Alternative, the areas with the greatest amount of small- and medium-caliber projectiles would occur SOCAL. For a discussion of the types of activities that use small- and medium-caliber projectiles, where they are used, and how many events will occur under each alternative, see Section 3.0.5.3.3.3 (Military Expended Materials Strikes). Any bottom-feeding sea turtle may occur in these range complexes.

Table 3.0-66 lists the number and location of activities that expend fragments of high-explosive ordnance and munitions (e.g., demolition charges, grenades, bombs, missiles, and rockets). As indicated in Section 3.0.5.3.5.2 (Fragments from High-Explosive Munitions), under the No Action Alternative, the areas with the greatest amounts of high-explosive ordnance and munitions would be open ocean portions of SOCAL. For a discussion of the types of activities that use high-explosive ordnance and munitions, where they are used, and how many events would occur under each alternative, see Section 3.0.5.3.3.3 (Military Expended Materials Strikes). Any bottom-feeding sea turtle may occur in these range complexes.

Sublethal effects from ingestion of munitions used in training activities may cause short-term or long-term disturbance to an individual turtle because: (1) if a sea turtle were to incidentally ingest and swallow a projectile or solid metal high-explosive fragment, it could disrupt its feeding behavior or digestive processes; and (2) if the item is particularly large in proportion to the turtle ingesting it, the projectile could become permanently encapsulated by the stomach lining, with a rare chance that this could impede the turtle's ability to feed or take in nutrients. Exposure to munitions may change an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, munitions used in training activities are generally not expected to cause disturbance to sea turtles because: (1) sea turtles are not expected to encounter most small- and medium-caliber projectiles or high-explosive fragments on the seafloor because of the depth at which these would be expended; and (2) in some cases, a turtle would likely pass the projectile through their digestive tract and expel the item without impacting the individual. Exposure to munitions is not expected to result in population-level impacts.

Pursuant to the ESA, the use of munitions of ingestible size during training activities under the No Action Alternative would have no effect on leatherback sea turtles. The use of materials of ingestible size may affect, but is not likely to adversely affect, green, hawksbill, loggerhead, or olive ridley sea turtles.

Testing

Tables 3.0-63 and 3.0-64 list the number and location of small- and medium-caliber projectiles. For a discussion of the types of activities that use small- and medium-caliber projectiles, where they are used, and how many events would occur under each alternative, see Section 3.0.5.3.3.3 (Military Expended Materials Strikes). Any bottom-feeding turtle may occur in these range complexes, but the most likely are green, olive ridley, and loggerhead sea turtles.

Table 3.0-66 lists the number and location of activities that expend fragments of high-explosive ordnance and munitions (e.g., demolition charges, grenades, bombs, missiles, and rockets). The types of activities that use high-explosive ordnance and munitions, where they are used, and how many events would occur under each alternative are discussed in Section 3.0.5.3.3.3 (Military Expended Materials

Strikes). Any bottom-feeding turtle may occur in these range complexes, but the most likely are green, olive ridley, and loggerhead sea turtles.

Sublethal effects from ingestion of munitions used in testing activities may cause short-term or long-term disturbance to an individual turtle because: (1) if a sea turtle were to incidentally ingest and swallow a projectile or solid metal high-explosive fragment, it could disrupt its feeding behavior or digestive processes; and (2) if the item is particularly large in proportion to the turtle ingesting it, the item could become permanently encapsulated by the stomach lining, with a rare chance that this could impede the turtle's ability to feed or take in nutrients. Exposure to munitions may change an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, munitions used in training activities are generally not expected to cause disturbance to sea turtles because: (1) sea turtles are not expected to encounter most small- and medium-caliber projectiles or high-explosive fragments on the seafloor because of the depth at which these would be expended; and (2) in some cases a turtle would likely pass the projectile through their digestive tract and expel the item without impacting the individual. Exposure to munitions is not expected to result in population-level impacts.

Pursuant to the ESA, the use of munitions of ingestible size during testing activities under the No Action Alternative would have no effect on leatherback sea turtles. The use of materials of ingestible size may affect, but is not likely to adversely affect, green, hawksbill, loggerhead, or olive ridley sea turtles.

3.5.3.5.1.2 Alternative 1

Training

Tables 3.0-63 and 3.0-64 list the number and location of small- and medium-caliber projectiles. As indicated in Section 3.0.5.3.5.1 (Non-explosive Practice Munitions), under Alternative 1, the amount of small- and medium-caliber projectiles is almost three-times that of the No Action Alternative. The types of activities that use small- and medium-caliber projectiles, where they are used, and the number of events under each alternative are discussed in Section 3.0.5.3.3.3 (Military Expended Materials Strikes). Any bottom-feeding sea turtle may occur in these range complexes.

Table 3.0-66 lists the number and location of activities that expend fragments of high-explosive ordnance and munitions (e.g., demolition charges, grenades, bombs, missiles, and rockets). As indicated in Section 3.0.5.3.5.2 (Fragments from High Explosive Munitions), under Alternative 1, the number of events that use high-explosive ordnance and munitions is more than four-times that of the No Action Alternative. The types of activities that use high-explosive ordnance and munitions, where they are used, and the number of events under each alternative are discussed in Section 3.0.5.3.3.3 (Military Expended Materials Strikes). Any bottom-feeding sea turtle may occur in these range complexes.

In comparison to the No Action Alternative, the increase in training activities under Alternative 1 increases the risk of sea turtles being exposed to munitions; however, the expected impact on any exposed sea turtle remains the same. For the same reasons stated in Section 3.5.3.5.1.1 (No Action Alternative), sub-lethal effects from ingestion of munitions used in training activities may cause short-term or long-term disturbance to an individual turtle. Exposure to munitions is not expected to result in population-level impacts.

Pursuant to the ESA, the use of munitions of ingestible size during testing activities under Alternative 1 would have no effect on leatherback sea turtles. The use of materials of ingestible size may affect, but is not likely to adversely affect, green, hawksbill, loggerhead, or olive ridley sea turtles.

Testing

Tables 3.0-63 and 3.0-64 list the number and location of small- and medium-caliber projectiles. As indicated in Section 3.0.5.3.5.1 (Non-explosive Practice Munitions), under Alternative 1, the amount of small- and medium-caliber projectiles is more than four-times that of the No Action Alternative. The types of activities that use small- and medium-caliber projectiles, where they are used, and the number of events under each alternative are discussed in Section 3.0.5.3.3.3 (Military Expended Materials Strikes). Any bottom-feeding sea turtle may occur in these range complexes.

Table 3.0-66 lists the number and location of activities that expend fragments of high-explosive ordnance and munitions (e.g., demolition charges, grenades, bombs, missiles, and rockets). As indicated in Section 3.0.5.3.5.2 (Fragments from High Explosive Munitions), under Alternative 1, the number of events that use high-explosive ordnance and munitions is more than 13-times that of the No Action Alternative. The activities using high-explosive ordnance and munitions under Alternative 1 would occur in the same geographic locations as the No Action Alternative. The types of activities that use high-explosive ordnance and munitions, where they are used, and how many events would occur under each alternative are discussed in Section 3.0.5.3.3.3 (Military Expended Materials Strikes). Any bottom-feeding sea turtle may occur in these range complexes.

In comparison to the No Action Alternative, the increase in testing activities under Alternative 1 increases the risk of sea turtles being exposed to munitions. However, the expected impact on any exposed sea turtle remains the same. For the same reasons stated in Section 3.5.3.5.1.1 (No Action Alternative), sub-lethal effects from ingestion of munitions used in testing activities may cause short-term or long-term disturbance to an individual turtle. Exposure to munitions is not expected to result in population-level impacts.

Pursuant to the ESA, the use of munitions of ingestible size during testing activities under Alternative 1 would have no effect on leatherback sea turtles. The use of materials of ingestible size may affect, but is not likely to adversely affect green, hawksbill, loggerhead, or olive ridley sea turtles.

3.5.3.5.1.3 Alternative 2

Training

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts of and comparisons to the No Action Alternative would also be identical, as described in Section 3.5.3.5.1.1 (No Action Alternative).

Pursuant to the ESA, the use of munitions of ingestible size during training activities under Alternative 2 would have no effect on leatherback sea turtles. The use of materials of ingestible size may affect, but is not likely to adversely affect, green, hawksbill, loggerhead, or olive ridley sea turtles.

Testing Activities

Tables 3.0-63 and 3.0-64 list the number and location of small- and medium-caliber projectiles. As indicated in Section 3.0.5.3.5.1 (Non-explosive Practice Munitions), under Alternative 2, the amount of small- and medium-caliber projectiles is nearly five-times that of the No Action Alternative. The activities using small- and medium-caliber projectiles under Alternative 2 would occur in the same geographic locations as the No Action Alternative. The types of activities that use small- and medium-caliber projectiles, where they are used, and how many events would occur under each alternative are discussed in Section 3.0.5.3.3.3 (Military Expended Materials Strikes). Any bottom-feeding sea turtle may occur in these range complexes.

Table 3.0-66 lists the number and location of activities that expend fragments of high-explosive ordnance and munitions (e.g., demolition charges, grenades, bombs, missiles, and rockets). As indicated in Section 3.0.5.3.5.2 (Fragments from High Explosive Munitions), under Alternative 2, the number of events that use high-explosive ordnance and munitions is more than 14-times that of the No Action Alternative, but is only approximately 10 percent more than under Alternative 1. The activities using high-explosive ordnance and munitions under Alternative 2 would occur in the same geographic locations as the No Action Alternative. The types of activities that use high-explosive ordnance and munitions, where they are used, and how many events would occur under each alternative are discussed in Section 3.0.5.3.3.3 (Military Expended Materials Strikes). Any bottom-feeding sea turtle may occur in these range complexes.

The increase in testing activities over the No Action Alternative increases the risk of sea turtles being exposed to munitions. However, the expected impact on any exposed sea turtle remains the same. For the same reasons stated in Section 3.5.3.5.1.1 (No Action Alternative), sub-lethal effects from ingestion of munitions used in testing activities may cause short-term or long-term disturbance to an individual turtle. Exposure to munitions is not expected to result in population-level impacts.

Pursuant to the ESA, the use of munitions of ingestible size during testing activities under Alternative 2 would have no effect on leatherback sea turtles. The use of materials of ingestible size may affect, but is not likely to adversely affect, green, hawksbill, loggerhead, or olive ridley sea turtles.

3.5.3.5.2 Impacts from Military Expended Materials Other than Munitions

Fragments of targets, chaff, flare casings, and parachutes are ingestion stressors introduced during training and testing activities, and are being analyzed for sea turtles. The types, numbers, and locations of activities using these devices under each alternative are discussed in Sections 3.0.5.3.4.2 (Parachutes), 3.0.5.3.5.1 (Non-explosive Practice Munitions), 3.0.5.3.5.2 (Fragments from High-Explosive Munitions), and 3.0.5.3.5.3 (Military Expended Materials Other than Munitions).

Leatherbacks are more likely to feed at or near the surface, so they are more likely to encounter materials at the surface than other species of turtles that primarily feed on the seafloor. Furthermore, leatherbacks typically feed in the open ocean, while other species are more likely to feed in nearshore areas. Though they are bottom-feeding species that generally feed nearshore, green, hawksbill, olive ridley, and loggerhead sea turtles may occur in the open ocean during migrations. Given the very low probability of nearshore, bottom-feeding species encountering and ingesting materials at the surface, leatherback sea turtles are more likely to be exposed.

3.5.3.5.2.1 No Action Alternative

Training Activities

Under the No Action Alternative, some training activities deploy sonobuoys that use parachutes of ingestible size. Under the No Action Alternative, 42,250 sonobuoys would be expended in the Study Area during training activities. The sonobuoy parachutes sink, so they are not expected to drift into another portion of the Study Area. Because of the low number of sonobuoys expended in the open ocean and the rapid sink rate of the parachute, the likelihood of a leatherback encountering and ingesting a parachute is extremely low. Because of the water depth over which these parachutes are deployed, other sea turtle species are not likely to encounter a parachute after it sinks through the water column.

Under the No Action Alternative, 10,050 flares would be expended annually in the Study Area during training activities, most of them (8,300) in SOCAL Range Complex. The flare consists of a cylindrical cartridge 1.4 in. in diameter and 5.8 in. long. Flare components that may be ingested include plastic end caps and pistons, which may float in the water column for some period. For estimation purposes, the SOCAL Range Complex is approximately 120,000 square nautical miles (nm^2), which equates to less than one cartridge per nm^2. The likelihood of a leatherback encountering and ingesting an end cap anywhere is very low.

Under the No Action Alternative, 20,950 chaff cartridges would be expended by ships and aircraft during training activities. Although these fibers are too small for sea turtles to confuse with prey and forage, there is some potential for chaff to be incidentally ingested along with other prey items. If ingested, chaff is not expected to impact sea turtles, due to the low concentration that would be ingested and the small size of the fibers. For instance, 20,000 chaff cartridges expended within the sea space of HRC and SOCAL would equate to one cartridge per two square nm within the Study Area.

Sublethal effects from ingestion of military expended materials other than munitions used in training activities may cause short-term or long-term disturbance to an individual turtle because: (1) if a sea turtle were to incidentally ingest and swallow any of these materials, it could disrupt its feeding behavior or digestive processes; and (2) if the item is particularly large in proportion to the turtle ingesting it, the material could become permanently encapsulated by the stomach lining, with a rare chance that this could impede the turtle's ability to feed or take in nutrients. Exposure to these materials may change an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, military expended materials other than munitions used in training activities are generally not expected to cause disturbance to sea turtles because: (1) sea turtles are not expected to encounter these materials on the seafloor because of the depth at which these would be expended; (2) sea turtles are not expected to encounter these materials in the water column because of the brief time that any of these materials would be suspended; and (3) in some cases, a turtle would likely pass any military expended materials through its digestive tract and expel the item without impacting the individual. Exposure to military expended materials other than munitions is not expected to result in population-level impacts.

Pursuant to the ESA, the ingestion of military expended materials other than munitions during training activities under the No Action Alternative may affect, but is not likely to adversely affect leatherback, green, hawksbill, loggerhead, or olive ridley sea turtles.

Testing Activities

Under the No Action Alternative, 7,139 sonobuoys would be expended in the Study Area during testing activities. The risk of ingestion by sea turtles is described under training activities above, but the risk to sea turtles during testing activities is lower due to the lower number of sonobuoys expended.

Under the No Action Alternative, no flares would be expended annually in the Study Area during testing activities.

Under the No Action Alternative, no chaff cartridges would be expended during testing activities.

Sublethal effects from ingestion of military expended materials other than munitions used in testing activities may cause short-term or long-term disturbance to an individual turtle because: (1) if a sea turtle were to incidentally ingest and swallow any of these materials, it could disrupt its feeding

behavior or digestive processes; and (2) if the item is particularly large in proportion to the turtle ingesting it, the material could become permanently encapsulated by the stomach lining, with a rare chance that this could impede the turtle's ability to feed or take in nutrients. Exposure to these materials may change an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, military expended materials other than munitions used in testing activities are generally not expected to cause disturbance to sea turtles because: (1) sea turtles are not expected to encounter these materials on the seafloor because of the depth at which these would be expended; (2) sea turtles are not expected to encounter these materials in the water column because of the brief time that any of these materials would be suspended; and (3) in some cases a turtle would likely pass any military expended materials through its digestive tract and expel the item without impacting the individual. Exposure to military expended materials other than munitions is not expected to result in population-level impacts.

Pursuant to the ESA, the ingestion of military expended materials other than munitions during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, leatherback, green, hawksbill, loggerhead, or olive ridley sea turtles.

3.5.3.5.2.2 Alternative 1

Training Activities

Tables 3.0-65, 3.0-82, 3.0-84, and 3.0-85 list the number and locations of activities that expend target materials, parachutes, chaff, and flares, respectively.

As indicated in Section 3.0.5.3.4.2 (Parachutes), the number of parachutes expended under Alternative 1 would be approximately 22 percent higher than under the No Action Alternative.

As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), the number of activities that expend target-related materials under Alternative 1, would be about four-times that of the No Action Alternative.

As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), the number of activities that expend chaff under Alternative 1 would be approximately 11 percent more than under the No Action Alternative, while the number of flares would not change relative to the No Action Alternative. The activities using chaff under Alternative 1 would occur in the same geographic locations as under the No Action Alternative.

All sea turtle species could be exposed to parachutes, target materials, chaff, or flares in the areas listed above, but given the very low probability of nearshore, bottom-feeding species encountering and ingesting materials at the surface, leatherback sea turtles are more likely to be exposed.

In comparison to the No Action Alternative, the increase in training activities under Alternative 1 would increase the risk of sea turtles being exposed to parachutes, target materials, and flares; however, the expected impact on any exposed sea turtle would remain the same. For the same reasons stated in Section 3.5.3.5.2.1 (No Action Alternative), sub-lethal effects from ingestion of military expended materials other than munitions used in training activities may cause short-term or long-term disturbance to an individual turtle.

Pursuant to the ESA, the ingestion of military expended materials other than munitions during training activities under Alternative 1 may affect, but is not likely to adversely affect, leatherback, green, hawksbill, loggerhead, or olive ridley sea turtles.

Testing Activities

Tables 3.0-65, 3.0-82, 3.0-84, and 3.0-85 list the number and locations of activities that expend target materials, parachutes, chaff, and flares, respectively.

As indicated in Section 3.0.5.3.4.2 (Parachutes), the number of parachutes expended under Alternative 1 would be approximately 74 percent more than under the No Action Alternative. The activities using parachutes under Alternative 1 would occur in the same geographic locations as the No Action Alternative, with the exception of introducing flares into SOCAL training areas as part of Alternative 1 testing activities. As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), the number of testing activities that would expend target-related materials under Alternative 1 is about 10 times that of the No Action Alternative.

As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), approximately 600 chaff cartridges and flares would be expended under Alternative 1.

Any sea turtle species could be exposed to parachutes, target materials, chaff, or flares in the areas listed above, but given the very low probability of nearshore, bottom-feeding species encountering and ingesting materials at the surface, leatherback sea turtles are more likely to be exposed.

In comparison to the No Action Alternative, the increase in testing activities under Alternative 1 would increase the risk of sea turtles being exposed to parachutes, target materials, chaff, and flares; however, the expected impact on any exposed sea turtle would remain the same. For the same reasons stated in Section 3.5.3.5.2.1 (No Action Alternative), sub-lethal effects from ingestion of military expended materials other than munitions used in testing activities may cause short-term or long-term disturbance to an individual turtle. Exposure to munitions is not expected to result in population-level impacts.

Pursuant to the ESA, the ingestion of military expended materials other than munitions during testing activities under Alternative 1 may affect, but is not likely to adversely affect, leatherback, green, hawksbill, loggerhead, or olive ridley sea turtles.

3.5.3.5.2.3 Alternative 2

Training Activities

Tables 3.0-65, 3.0-82, 3.0-84, and 3.0-85 list the number and locations of activities that expend target materials, parachutes, chaff, and flares, respectively. As indicated in Section 3.0.5.3.4.2 (Parachutes), under Alternative 2 the number of parachutes expended is approximately 22 percent higher than under the No Action Alternative. As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), under Alternative 2, the number of activities that expend target-related materials would be about four-times that under the No Action Alternative. As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), under Alternative 2, the number of activities that expend chaff would increase by approximately 10 percent from the No Action Alternative, while the number of flares would not change relative to the No Action Alternative. The activities using chaff under Alternative 2 would occur in the same geographic locations as the No Action Alternative.

Any sea turtle species could be exposed to parachutes, target materials, chaff, or flares in the areas listed above, but given the very low probability of nearshore, bottom-feeding species encountering and ingesting materials at the surface, leatherback sea turtles are more likely to be exposed.

In comparison to the No Action Alternative, the increase in training activities under Alternative 2 would increase the risk of sea turtles being exposed to parachutes, target materials, and flares; however, the expected impact on any exposed sea turtle would remain the same. For the same reasons stated in Section 3.5.3.5.2.1 (No Action Alternative), sub-lethal effects from ingestion of military expended materials other than munitions used in training activities may cause short-term or long-term disturbance to an individual turtle.

Pursuant to the ESA, the ingestion of military expended materials other than munitions during training activities under Alternative 2 may affect, but is not likely to adversely affect, leatherback, green, hawksbill, loggerhead, or olive ridley sea turtles.

Testing Activities

Tables 3.0-65, 3.0-82, 3.0-84, and 3.0-85 list the number and locations of activities that expend target materials, parachutes, chaff, and flares, respectively.

As indicated in Section 3.0.5.3.4.2 (Parachutes), the number of parachutes expended under Alternative 1 would be approximately 90 percent more than under the No Action Alternative. The activities using parachutes under Alternative 2 would occur in the same geographic locations as the No Action Alternative, with the exception of introducing flares into SOCAL training areas as part of Alternative 2 testing activities. As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), under Alternative 2, the number of testing activities that expend target materials would be about 10-times that of the No Action Alternative.

As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), approximately 660 chaff cartridges and flares would be expended under Alternative 2.

Any sea turtle species could be exposed to parachutes, target materials, chaff, or flares in the areas listed above, but given the very low probability of nearshore, bottom-feeding species encountering and ingesting materials at the surface, leatherback sea turtles are more likely to be exposed.

In comparison to the No Action Alternative, the increase in testing activities under Alternative 1 would increase the risk of sea turtles being exposed to parachutes, target materials, chaff, and flares; however, the expected impact on any exposed sea turtle remains the same. For the same reasons stated in Section 3.5.3.5.2.1 (No Action Alternative), sub-lethal effects from ingestion of military expended materials other than munitions used in testing activities may cause short-term or long-term disturbance to an individual turtle. Exposure to munitions is not expected to result in population-level impacts.

Pursuant to the ESA, the ingestion of military expended materials other than munitions during testing activities under Alternative 2 may affect, but is not likely to adversely affect, leatherback, green, hawksbill, loggerhead, or olive ridley sea turtles.

3.5.3.6 Secondary Stressors

This section analyzes potential impacts on sea turtles exposed to stressors indirectly through effects on habitat, sediment, or water quality. Secondary effects on sea turtles via sediment or water (not by

trophic transfer, e.g., bioaccumulation) are considered here. The terms "indirect" and "secondary" do not imply reduced severity of environmental consequences, but instead describe *how* the impact may occur to an organism. Bioaccumulation is considered in the Ecosystem Report.

Stressors from Navy training and testing activities could have secondary or indirect impacts on turtles via changes in habitat, sediment, or water quality. These stressors include: (1) explosives, (2) explosive byproducts and unexploded ordnance, (3) metals, and (4) chemicals. Activities associated with these stressors are detailed in Tables 2.8-1 to 2.8-5, and their potential impacts are discussed in Section 3.1 (Sediments and Water Quality) and Section 3.3 (Marine Habitats).

3.5.3.6.1 Explosives

In addition to directly affecting turtle and turtle habitat, underwater explosions could affect other species in the food web, including prey species upon which sea turtles feed. The impacts of underwater explosions would differ, depending on the type of prey species in the area of the blast.

In addition to the physical effects of an underwater blast, prey might have behavioral reactions to underwater sound. For instance, prey species might exhibit a strong startle reaction to detonations that might include swimming to the surface or scattering away from the source. This startle and flight response is the most common secondary defense among animals (Mather 2004). The abundance of prey species near the detonation point could be diminished for a short period before being repopulated by animals from adjacent waters. Many sea turtle prey items, such as jellyfish and sponges, have limited mobility and ability to react to pressure waves. Any of these scenarios would be temporary, only occurring during activities involving explosives, and no lasting effect on prey availability or the pelagic food web would be expected. The Navy avoids conducting training and testing activities in ESA-listed coral habitats, which would minimize secondary effects on sea turtle species that rely on these habitats. Furthermore, most explosions occur in depths exceeding that which normally support seagrass beds, again protecting these habitats.

3.5.3.6.2 Explosion By-Products and Unexploded Ordnance

Any explosive material not completely consumed during ordnance disposal and mine clearance detonations is collected after training is complete; therefore, potential impacts are assumed to be inconsequential and not detectable for these training and testing activities. Sea turtles may be exposed by contact with the explosive material, contact with contaminants in the sediment or water, and ingestion of contaminated sediments.

High-order explosions consume most of the explosive material, creating typical combustion products. In the case of Royal Demolition Explosive, 98 percent of the products are common seawater constituents and the remainder is rapidly diluted below threshold effect level (Table 3.1-9). Explosive byproducts from high-order detonations present no secondary stressors to turtles through sediment or water. However, low-order detonations and unexploded ordnance could have an impact on sea turtles.

Secondary effects of explosives and unexploded ordnance on turtles via sediment are possible near the ordnance. Degradation of explosives proceeds via several pathways discussed in Section 3.1.3.1.5 (Fates of Military Munitons in the Marine Environment). Degradation products of Royal Demolition Explosive are not toxic to marine organisms at realistic exposure levels (Rosen and Lotufo 2010). Relatively low solubility of most explosives and their degradation products means that concentrations of these contaminants in the marine environment are relatively low and readily diluted. Furthermore, while explosives and their degradation products were detectable in marine sediment approximately 6 to 12 in.

(15.2 to 30.5 cm) away from degrading ordnance, concentrations of these compounds were not statistically distinguishable from background beyond 3 to 6 ft. (0.9 to 1.8 m) from the degrading ordnance (Section 3.1.3.1.5, Fates of Military Munitons in the Marine Environment). Various lifestages of turtles could be impacted by the indirect effects of degrading explosives within a small radius of the explosive (1 to 6 ft. [0.3 to 1.8 m]).

3.5.3.6.3 Metals

Metals are introduced into seawater and sediments by training and testing activities involving vessel hulks, targets, ordnance, munitions, and other military expended materials (Section 3.1.3.2, Metals). Some metals bioaccumulate, and physiological impacts begin to occur only after several trophic transfers concentrate the toxic metals (see Section 3.3, Marine Habitats, and Section 4.0, Cumulative Impacts). Indirect impacts of metals on sea turtles via sediment and water involve concentrations several orders of magnitude lower than concentrations achieved via bioaccumulation. Sea turtles may be exposed by contact with the metal, contact with contaminants in the sediment or water, or ingestion of contaminated sediments. Concentrations of metals in seawater are orders of magnitude lower than concentrations in marine sediments. It is extremely unlikely that sea turtles would be indirectly impacted by toxic metals via water.

3.5.3.6.4 Chemicals

Several Navy training and testing activities introduce potentially harmful chemicals into the marine environment; principally, flares and propellants for rockets, missiles, and torpedoes. Polychlorinated biphenyls (PCBs) are discussed in Section 3.1.3.3 (Chemicals Other Than Explosives). PCBs have a variety of effects on aquatic organisms. The chemicals persist in the tissues of animals at the bottom of the food chain. Thereafter, consumers of those species tend to accumulate PCBs at levels that may be many times higher than in water. In the past, PCBs have been raised as an issue because they have been found in certain solid materials on vessels used as targets during vessel-sinking exercises (e.g., insulation, wires, felts, and rubber gaskets). Currently, vessels used for sinking exercises are selected from a list of U.S. Navy-approved vessels that have been cleaned in accordance with USEPA guidelines. Properly functioning flares, missiles, rockets, and torpedoes combust most of their propellants, leaving benign or readily diluted soluble combustion byproducts (e.g., hydrogen cyanide). Operational failures allow propellants and their degradation products to be released into the marine environment. Sea turtles may be exposed by contact with contaminated water or ingestion of contaminated sediments.

Missile and rocket fuel pose no risk of secondary impacts on sea turtles via sediment. In contrast, the principal toxic components of torpedo fuel, propylene glycol dinitrate, and nitrodiphenylamine adsorb to sediments, have relatively low toxicity, and are readily degraded by biological processes. Various lifestages of sea turtles could be indirectly impacted by propellants via sediment near the object (e.g., within a few inches), but these potential effects would diminish rapidly as the propellant degrades.

Pursuant to the ESA, secondary stressors associated with testing activities under the No Action Alternative, Alternative 1, or Alternative 2 may affect, but are not likely to adversely affect, green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.4 Summary of Potential Impacts (Combined Impacts of All Stressors) on Sea Turtles

As described in Section 3.0.5.5 (Resource-Specific Impacts Analysis for Multiple Stressors), this section evaluates the combined potential impacts of all the stressors from the Proposed Action. The analysis of

and conclusions for the potential impacts of each of the individual stressors are discussed in the analyses of each stressor in the sections above and summarized in Section 3.5.5 (Endangered Species Act Determinations).

There are generally two ways that a sea turtle could be exposed to multiple stressors. The first would be if the animal were exposed to multiple sources of stress from a single activity (e.g., a mine warfare activity may involve explosives and vessels that could introduce potential acoustic and physical strike stressors). The potential for a combination of these impacts from a single activity would depend on the range of effects on each of the stressors and the response or lack of response to that stressor. Most of the activities included in the Proposed Action involve multiple stressors; therefore, it is likely that if a sea turtle were within the potential impact range of those activities, they may be impacted by multiple stressors simultaneously. This would be more likely to occur during large-scale exercises or activities that span a period of days or weeks (such as a sinking exercise or composite training unit exercise).

Secondly, an individual sea turtle could be exposed to a combination of stressors from multiple activities over the course of its life. This is most likely to occur in areas where training and testing activities are more concentrated (e.g., near naval ports, testing ranges, and routine activity locations outlined in Table 3.0-2) and in areas that individual sea turtles frequently visit because it is within the animal's home range, migratory route, breeding area, or foraging area. Except for in the few concentrated areas mentioned above, combinations are unlikely to occur because training and testing activities are generally separated in space and time in such a way that it would be very unlikely that any individual sea turtles would be exposed to stressors from multiple activities. However, animals with a small home range intersecting an area of concentrated Navy activity have elevated exposure risks relative to animals that simply transit the area through a migratory route. Also, the majority of the proposed training and testing activities occur over a small spatial scale relative to the entire Study Area, have few participants, and are of a short duration (on the order of a few hours or less).

Multiple stressors may also have synergistic effects. For example, sea turtles that experience temporary hearing loss or injury from acoustic stressors could be more susceptible to physical strike and disturbance stressors via a decreased ability to detect and avoid threats. Sea turtles that experience behavioral and physiological consequences of ingestion stressors could be more susceptible to physical strike stressors via malnourishment and disorientation. These interactions are speculative, and without data on the combination of multiple Navy stressors, the synergistic impacts from the combination of Navy stressors on sea turtles are difficult to predict.

Although potential impacts on certain sea turtle species from the Proposed Action could include injury or mortality, impacts are not expected to decrease the overall fitness or result in long-term population-level impacts on any given population. In cases where potential impacts rise to a level that warrants mitigation, mitigation measures designed to reduce the potential impacts are discussed in Chapter 5. The potential impacts of the Proposed Action are summarized in Section 3.5.5 (Endangered Species Act Determinations) with respect to the ESA.

3.5.5 Endangered Species Act Determinations

Administration of ESA obligations associated with sea turtles are shared between NMFS and U. S. Fish and Wildlife Service, depending on life stage and specific location of the sea turtle. NMFS has jurisdiction over sea turtles in the marine environment, and U. S. Fish and Wildlife Service has jurisdiction over sea turtles on land. The Navy is consulting with NMFS on its determination of effect on the potential impacts of the Proposed Action. Because no activities analyzed in this EIS/OEIS occur on land, consultation with

U.S. Fish and Wildlife Service is not required for sea turtles. Table 3.5-14 summarizes the Navy's determination of effect on ESA listed sea turtles for the Proposed Action.

Table 3.5-14: Summary of Effects and Impact Conclusions: Sea Turtles

Stressor		Sea Turtle Species				
		Green	Hawksbill	Olive Ridley	Loggerhead	Leatherback
Acoustic Stressors						
Sonar and Other Active Acoustic Sources	Training Activities	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect
	Testing Activities	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect
Explosives	Training Activities	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect
	Testing Activities	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect
Pile Driving	Training Activities	May affect, not likely to adversely affect	No Effect	No Effect	No Effect	No Effect
	Testing Activities	No Effect	No Effect	No Effect	No Effect	No Effect
Swimmer Defense Airguns	Training Activities	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Testing Activities	May affect, likely to adversely affect	No Effect	No Effect	No Effect	No Effect
Weapons Firing, Launch, and Impact Noise	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Vessel and Aircraft Noise	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Energy Stressors						
Electro-magnetic Devices	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Testing	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect

Table 3.5-14: Summary of Effects and Impact Conclusions: Sea Turtles (continued)

Stressor		Sea Turtle Species				
		Green	Hawksbill	Olive Ridley	Loggerhead	Leatherback
Physical Disturbance and Strike						
Vessels	Training Activities	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect
	Testing Activities	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect
In-Water Devices	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Military Expended Materials	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Seafloor Devices	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Entanglement Stressors						
Fiber Optic Cables and Guidance Wires	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Parachutes	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Ingestion						
Munitions	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	No effect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	No effect
Military Expended Materials other than Munitions	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect

Table 3.5-14: Summary of Effects and Impact Conclusions: Sea Turtles (continued)

Stressor		Sea Turtle Species				
		Green	Hawksbill	Olive Ridley	Loggerhead	Leatherback
Secondary Stressors						
Explosives	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Explosive ByProducts and Unexploded Ordnance	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Metals	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Chemicals	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect

REFERENCES

Aki, K., Brock, R., Miller, J., Mobley, J. R., Jr., Rappa, P. J., Tarnas, D. & Yuen, M. (1994). A Site Characterization Study for the Hawaiian Islands Humpback Whale National Marine Sanctuary. (pp. 119). Prepared by University of Hawaii Sea Grant College Program School of Ocean and Earth Science and Technology. Prepared for National Oceanic and Atmospheric Administration.

Alfaro-Shigueto, J., Dutton, P. H., Mangel, J. C. & Vega, D. (2004). First occurrence of loggerhead turtles in Peru. Marine Turtle Newsletter, 103, 7-11. Retrieved from http://www.seaturtle.org/mtn/archives/mtn103/mtn103p7.shtml

Arenas, P. & Hall, M. (1992). The association of sea turtles and other pelagic fauna with floating objects in the eastern tropical Pacific Ocean. In M. Salmon and J. Wyneken (Eds.), Proceedings of the Eleventh Annual Workshop on Sea Turtle Biology and Conservation. (NOAA Technical Memorandum NMFS-SEFSC-302, pp. 7-10) U.S. Department of Commerce, National Oceanic and Atmospheric Administration and Nationa Marine Fisheries Service.

Avens, L. & Lohmann, K.J. (2003). Use of multiple orientation cues by juvenile loggerhead sea turtles Caretta caretta. Journal of Experimental Biology. 206: 4317-4325.

Balazs, G. & Chaloupka, M. (2006). Recovery trend over 32 years at the Hawaiian Green sea turtle Rookery of French Frigate Shoals. Atoll Research Bulletin(543), 147-158.

Balazs, G. H. (1980). Synopsis of Biological Data on the Green sea turtle in the Hawaiian Islands. (NOAA-TM-NMFS-SWFC-7, pp. 141) U.S. Department of Commerce, Naitonal Oceanic and Atmospheric Administration and National Marine Fisheries Service.

Balazs, G. H. (1995). Status of sea turtles in the central Pacific Ocean. In K. A. Bjorndal (Ed.), Biology and Conservation of Sea Turtles (Revised ed., pp. 243-252). Washington, DC: Smithsonian Institution Press.

Balazs, G. H., Craig, P., Winton, B. R. & Miya, R. K. (1994). Satellite telemetry of green sea turtles nesting at French Frigate Shoals, Hawaii, and Rose Atoll, American Samoa. In K. A. Bjorndal, A. B. Bolten, D. A. Johnson and P. J. Eliazar (Eds.), Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. (NOAA Technical Memorandum NMFS-SEFSC-351, pp. 184-187) U.S. Department of Commerce, National Oceanic and Atmospheric Administration and National Marine Fisheries Service.

Bartol S.M., Musick J.A., Lenhardt M.L. (1999). Auditory evoked potentials of the loggerhead sea turtule (Caretta caretta). Copeia:836-840.

Bartol S.M., & Musick J.A. (2003). Sensory Biology of Sea Turtles, in: P. L. Lutz, et al. (Eds.), The Biology of Sea Turtles. pp. 16.

Bartol, S. M. & Ketten, D. R. (2006). Turtle and tuna hearing. In Y. Swimmer and R. W. Brill (Eds.), Sea Turtle and Pelagic Fish Sensory Biology: Developing Techniques to Reduce Sea Turtle Bycatch in Longline Fisheries (NOAA Technical Memorandum NMFS-PIFSC-7, pp. 98-103) U.S. Department of Commerce, NOAA.

Benoit-Bird, K. J., Au, W. W. L., Brainard, R. E. & Lammers, M. O. (2001). Diel horizontal migration of the Hawaiian mesopelagic boundary community observed acoustically. Marine Ecology-Progress Series, 217, 1-14.

Benson, S. R., Forney, K. A., Harvey, J. T., Carretta, J. V. & Dutton, P. H. (2007). Abundance, distribution, and habitat of leatherback turtles (Dermochelys coriacea) off California, 1990-2003. Fishery Bulletin, 105(3), 337-347.

Beavers, S. C., & E. R. Cassano (1996). Movement and dive behavior of a male sea turtle (Lepidochelys olivacea) in the eastern tropical Pacific. J. Herpetol. 30(1):97-104.

Bjorndal, K. A. (1995). The consequences of herbivory for the life history pattern of the green sea turtle, Chelonia mydas. In K. A. Bjorndal (Ed.), Biology and Conservation of Sea Turtles (Revised ed., pp. 111-116). Washington, DC: Smithsonian Institution Press.

Bjorndal, K. A. (1997). Foraging ecology and nutrition of sea turtles. In P. L. Lutz and J. A. Musick (Eds.), The Biology of Sea Turtles (pp. 199-231). Boca Raton, FL: CRC Press.

Bjorndal, K. A. (2003). Roles of loggerhead sea turtles in marine ecosystems. In A. B. Bolten and B. E. Witherington (Eds.), Loggerhead Sea Turtles (pp. 235-254). Washington, DC: Smithsonian Institution Press.

Bjorndal, K. A. & Bolten, A. B. (1988). Growth rates of immature green sea turtles, Chelonia mydas, on feeding grounds in the southern Bahamas. Copeia, 1988(3), 555-564.

Bjorndal, K. A., Bolten, A. B. & Lagueux, C. J. (1994). Ingestion of marine debris by juvenile sea turtles in coastal Florida habitats. Marine Pollution Bulletin, 28(3), 154-158.

Blumenthal, J. M., Austin, T. J., Bothwell, J. B., Broderick, A. C., Ebanks-Petrie, G., Olynik, J. R., Godley, B. J. (2009). Diving behavior and movements of juvenile hawksbill turtles Eretmochelys imbricata on a Caribbean coral reef. Coral Reefs, 28(1), 55-65. doi: 10.1007/s00338-008-0416-1.

Bolten, A. B. (2003). Variation in sea turtle life history patterns: Neritic vs. oceanic developmental stages. In P. L. Lutz, J. A. Musick and J. Wyneken (Eds.), The Biology of Sea Turtles (Vol. II, pp. 243-258). Boca Raton, FL: CRC Press.

Bowen, B. W., Abreu-Grobois, F. A., Balazs, G. H., Kamezaki, N., Limpus, C. J. & Ferl, R. J. (1995). Trans-Pacific migrations of the loggerhead turtle (Caretta caretta) demonstrated with mitochondrial DNA markers. Proceedings of the National Academy of Sciences of the United States of America, 92, 3731-3734.

Bowen, B. W., Clark, A. M., Abreu-Grobois, A. F., Chaves, A., Reichart, H. A. & Ferl, R. J. (1998). Global phylogeography of the ridley sea turtles (Lepidochelys spp.) As inferred from mitochondrial DNA sequences. Genetica, 101, 179-189.

Bowen, B. W. & Karl, S. A. (1997). Population genetics, phylogeography, and molecular evolution. In P. L. Lutz and J. A. Musick (Eds.), The Biology of Sea Turtles (pp. 29-50). Boca Raton, FL: CRC Press.

Bradshaw, C. J. A., McMahon, C. R. & Hays, G. C. (2007). Behavioral inference of diving metabolic rate in free-ranging leatherback turtles. Physiological and Biochemical Zoology 80(2), 209-219.

Bresette, M., Gorham, J. C. & Peery, B. D. (1998). Site fidelity and size frequencies of juvenile green turtles (Chelonia mydas) utilizing near shore reefs in St. Lucie County, Florida. Marine Turtle Newsletter, 82, 5-7. Retrieved from http://www.seaturtle.org/mtn/archives/mtn82/mtn82p5.shtml

Bresette, M., Singewald, D. & De Maye, E. (2006). Recruitment of post-pelagic green sea turtles (Chelonia mydas) to nearshore reefs on Florida's east coast. In M. Frick, A. Panagopoulou, A. F. Rees and K. Williams (Eds.), Book of Abstracts: Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation (Abstract, pp. 288). Athens, Greece: International Sea Turtle Society.

Brill, R. W., Balazs, G. H., Holland, K. N., Chang, R. K. C., Sullivan, S. & George, J. C. (1995). Daily movements, habitat use, and submergence intervals of normal and tumor-bearing juvenile green sea turtles (Chelonia mydas L.) within a foraging area in the Hawaiian islands. Journal of Experimental Marine Biology and Ecology, 185(2), 203-218. doi: 10.1016/0022-0981(94)00146-5

Brown, C. H. & Brown, W. M. (1995). Status of sea turtles in the Southeastern Pacific: Emphasis on Peru. In K. A. Bjorndal (Ed.), Biology and Conservation of Sea Turtles (Revised ed., pp. 235-240). Washington DC: Smithsonian Institution Press.

Byles, R. A. (1988). Behavior and ecology of sea turtles from Chesapeake Bay, Virginia. (Ph.D. dissertation). College of William and Mary, Williamsburg, Virginia. Retrieved from http://www.sefsc.noaa.gov/PDFdocs/Byles_dissertation_1988.pdf

Caillouet, C. W., Fontaine, C.T., Manzella-Tirpak, S. A. & Shaver, D. J. (1995). Survival of head-started Kemp's ridley sea turtles (*Lepidochelys kempii*) released into the Gulf of Mexico or adjacent bays. *Chelonian Conservation and Biology 1*(4):285-292.

California Department of Transportation. (2009). Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. Prepared by ICF Jones and Stokes and Illingworth and Rodkin, Inc.

Carr, A. (1986). Rips, FADS, and little loggerheads. BioScience, 36(2), 92-100.

Carr, A. (1987). New perspectives on the pelagic stage of sea turtle development. Conservation Biology, 1(2), 103-121.

Carr, A., Carr, M. & Meylan, A. B. (1978). The ecology and migrations of sea turtles, 7. The west carribean green sea turtle colony. Bulletin of the American Museum of Natural History, 162(1), 1-46.

Carr, A. & Meylan, A. B. (1980). Evidence of passive migration of green sea turtle hatchlings in Sargassum. Copeia, 1980(2), 366-368.

Chaloupka, M., Dutton, P. & Nakano, H. (2004). Status of sea turtle stocks in the Pacific. In Papers Presented at the Expert Consultation on Interactions between Sea Turtles and Fisheries Within an Ecosystem Context. (FAO Fisheries Report No. 738, Supplement, pp. 135-164). Rome, Italy: Food and Agriculture Organization of the United Nations.

Chaloupka, M., Work, T. M., Balazs, G., Murakawa, S. K. & Morris, R. (2008a). Cause-specific temporal and spatial trends in green sea turtle strandings in the Hawaiian Archipelago (1982-2003). Marine Biology, 154, 887-898.

Chaloupka, M., Kamezaki, N. & Limpus, C. (2008b). Is climate change affecting the population dynamics of the endangered Pacific loggerhead sea turtle? Journal of Experimental Marine Biology and Ecology, 356(1-2), 136-143. doi: 10.1016/j.jembe.2007.12.009

Chaloupka, M. Y. & Musick, J. A. (1997). Age, growth, and population dynamics. In P. L. Lutz and J. A. Musick (Eds.), The Biology of Sea Turtles (pp. 233-276). Boca Raton, FL: CRC Press.

Chua, T. H. (1988). Nesting population and frequency of visits in Dermochelys coriacea in Malaysia. Journal of Herpetology, 22(2), 192-207.

Clark S.L., Ward J.W. (1943) The Effects of Rapid Compression Waves on Animals Submerged In Water. Surgery, Gynecology & Obstetrics 77:403-412.

Cliffton, K., Cornejo, D. O. & Felger, R. S. (1995). Sea turtles of the Pacific coast of Mexico. In K. A. Bjorndal (Ed.), Biology and Conservation of Sea Turtles (Revised ed., pp. 199-209). Washington, DC: Smithsonian Institution Press. Retrieved from Copyright protected.

Conant, T. A., Dutton, P. H., Eguchi, T., Epperly, S. P., Fahy, C. C., Godfrey, M. H., Witherington, B. E. (2009). Loggerhead Sea Turtle (*Caretta caretta*) 2009 Status Review under the U.S. Endangered Species Act. (pp. 222) Loggerhead Biological Review Team and National Marine Fisheries Service.

Craig J.C., Jr., Hearn C.W. (1998). Appendix D. Physical impacts of explosions on marine mammals and turtles, Final Environmental Impact Statement on Shock Testing of the Seawolf Submarine, U.S. Department of the Navy, North Charleston, South Carolina. pp. D1-D41.

Craig J.C., Jr., Rye K.W. (2008). Appendix D: Criteria and thresholds for injury, Shock Trial of the Mesa Verde (LPD 19), Chief of Naval Operations, U.S. Navy, Arlington, Virginia.

Davenport, J. (1988). Do diving leatherbacks pursue glowing jelly? British Herpetological Society Bulletin, 24, 20-21.

Davenport, J. & Balazs, G. H. (1991). 'Fiery bodies' Are pyrosomas an important component of the diet of leatherback turtles? British Herpetological Society Bulletin, 37, 33-38.

Dobbs, K. A., Miller, J. D., Limpus, C. J. & Landry, A. M., Jr. (1999). Hawksbill turtle, Eretmochelys imbricate, nesting at Milman Island, northern Great Barrier Reef, Australia. Chelonian Conservation and Biology, 3(2), 344-361.

Dodd, C. K., Jr. (1988). Synopsis of the Biological Data on the Loggerhead Sea Turtle Caretta caretta (Linnaeus 1758). (Biological Report 88(14), pp. 110). Washington, D.C.: U.S. Fish and Wildlife Service.

Dutton, D., Dutton, P., Leroux, R. & Seminoff, J. (2002). Ultrasonic Tracking of Green sea turtles (Chelonia mydas) in south San Diego Bay: 2001-2002 Report [Draft Report]. (pp. 13). San Diego, CA. Prepared for San Diego Bay Port Authority.

Dutton, P. (2006). Building our knowledge of the leatherback stock structure. SWoT Report-State of the World's Sea Turtles, I, 10-11. Retrieved from http://seaturtlestatus.org/report/swot-volume-1

Dutton, P. & McDonald, D. (1990). Status of Sea Turtles in San Diego Bay: 1989-1990. [Final Report]. (SWRI Technical Report 90-225). San Diego, CA: Sea World Research Institute.

Dutton, P. H. (unpublished data, 5 February). Sea turtle satellite data inquiry. K. Kelly, Tetra Tech, Inc, Honolulu, HI.

Dutton, P. H., Balazs, G. H. & Dizon, A. E. (1998). Genetic stock identification of sea turtles caught in the Hawaii-based pelagic longline fishery. In S. P. Epperly and J. Braun (Eds.), Proceedings of the Seventeenth Annual Sea Turtle Symposium [Abstract]. (NOAA Technical Memorandum NMFS-SEFSC-415, pp. 45-46). U. S. Department of Commerce, National Oceanic and Atmospheric Administration and National Marine Fisheries Service. Available from http://www.nmfs.noaa.gov/pr/species/turtles/symposia.htm

Dutton, P. H., Balazs, G. H., LeRoux, R. A., Murakawa, S. K. K., Zarate, P. & Sarti Martinez, L. (2008). Composition of Hawaiian green sea turtle foraging aggregations: mtDNA evidence for a distinct regional population. Endangered Species Research, 5, 37-44. doi: 10.3354/esr00101

Dutton, P. H., Bowen, B. W., Owens, D. W., Barragan, A. & Davis, S. K. (1999). Global phylogeography of the leatherback turtle (Dermochelys coriacea). Journal of Zoology, London, 248, 397-409.

Eckert, K. L. (1987). Environmental unpredictability and leatherback sea turtle (Dermochelys coriacea) nest loss. Herpetologica, 43(3), 315-323.

Eckert, K. L. (1993). The Biology and Population Status of Marine Turtles in the North Pacific Ocean. (NOAA-TM-NMFS-SWFSC-186, pp. 166) U.S. Department of Commerce, National Oceanic and Atmospheric Administration and National Marine Fisheries Service.

Eckert, K. L. (1995). Anthropogenic threats to sea turtles. In K. A. Bjorndal (Ed.), Biology and Conservation of Sea Turtles (Revised ed., pp. 611-612). Washington, DC: Smithsonian Institution Press.

Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. & Donnelly, M. (Eds.) (1999). Research and Management Techniques for the Conservation of Sea Turtles. (IUCN/SSC Marine Turtle Specialist Group Publication No. 4, pp. 24).

Eckert, K. L. & Eckert, S. A. (1988). Pre-reproductive movements of leatherback sea turtles (Dermochelys coriacea) nesting in the Caribbean. Copeia, 1988(2), 400-406.

Eckert, K. L., Eckert, S. A., Adams, T. W. & Tucker, A. D. (1989). Inter-nesting migrations by leatherback sea turtles (Dermochelys coriacea) in the West Indies. Herpetologica, 45(2), 190-194.

Eckert, S. A. (2002). Distribution of juvenile leatherback sea turtle Dermochelys coriacea sightings. Marine Ecology Progress Series, 230, 289-293.

Eckert, S. A., Eckert, K. L., Ponganis, P. & Kooyman, G. L. (1989). Diving and foraging behavior of leatherback sea turtles (Dermochelys coriacea). Canadian Journal of Zoology, 67, 2834-2840.

Eckert, S. A., Liew, H. C., Eckert, K. L. & Chan, E. H. (1996). Shallow water diving by leatherback turtles in the South China Sea. Chelonian Conservation and Biology, 2(2), 237-243.

Eckert, S. A., Nellis, D. W., Eckert, K. L. & Kooyman, G. L. (1986). Diving patterns of two leatherback sea turtles (Dermochelys coriacea) during internesting intervals at Sandy Point, St. Croix, U.S. Virgin Islands. Herpetologica, 42(3), 381-388.

Eckert, S. A. & Sarti-Martinez, L. (1997). Distant fisheries implicated in the loss of the world's largest leatherback nesting population. Marine Turtle Newsletter, 78, 2-7. Retrieved from http://www.seaturtle.org/mtn/archives/mtn78/mtn78p2.shtml

Eguchi, T., Gerrodette, T., Pitman, R. L., Seminoff, J. A. & Dutton, P. H. (2007). At-sea density and abundance estimates of the olive ridley turtle Lepidochelys olivacea in the eastern tropical Pacific. Endangered Species Research, 3(2), 191-203. doi: 10.3354/esr003191

Eguchi, T., Seminoff, J., Leroux, R., Dutton, P. & Dutton, D. (2010). Abundance and survival rates of green sea turtles in an urban environment coexistence of humans and an endangered species. Marine Biology, 157, 1869-1877. doi: 10.1007/s00227-010-1458-9

Eisenberg, J. F. & Frazier, J. (1983). A leatherback turtle (Dermochelys coriacea) feeding in the wild. Journal of Herpetology, 17(1), 81-82.

Finneran J.J., Carder D.A., Schlundt C.E., Ridgway S.H. (2005). Temporary Threshold Shift in Bottlenose Dolphins (Tursiops truncatus) Exposed to Mid-frequency Tones. Journal of the Acoustical Society of America 118:2696-2705.

Finneran J.J., Schlundt C.E., Dear R., Carder D.A., Ridgway S.H. (2002). Temporary Shift in Masked Hearing Thresholds in Odontocetes After Exposure to Single Underwater Impulses from a Seismic Watergun. Journal of the Acoustical Society of America 111:2929-2940.

Finneran J.J., Schlundt C.E., Carder D.A., Clark J.A., Young J.A., Gaspin J.B., Ridgway S.H. (2000). Auditory and Behavioral Responses of Bottlenose Dolphins (Tursiops truncatus) and a Beluga Whale (Delphinapterus leucas) to Impulsive Sounds Resembling Distant Signatures of Underwater Explosions. Journal of the Acoustical Society of America 108:417-431.

Fossette, S., Ferraroli, S., Tanaka, H., Ropert-Coudert, Y., Arai, N., Sato, K., Georges, J. (2007). Dispersal and dive patterns in gravid leatherback turtles during the nesting season in French Guiana. Marine Ecology Progress Series 338, 233-247.

Frair, W., Ackman, R. G. & Mrosovsky, N. (1972). Body temperature of Dermochelys coriacea: Warm turtle from cold water. Science, 177, 791-793.

Frazier, J. G. (2001). General natural history of marine turtles. In K. L. Eckert and F. A. Abreu-Grobois (Eds.), Proceedings of the Marine Turtle Conservation in the Wider Caribbean Region: A Dialogue for Effective Regional Management. (pp. 3-17) WIDECAST, IUCN-MTSG, WWF and UNEP-CEP.

Fretey, J. (2001). Biogeography and Conservation of Marine Turtles of the Atlantic Coast of Africa. (CMS Technical Series Publication, no. 6, pp. 429). Bonn, Germany: UNEP/CMS Secretariat.

Frick, M. G., Williams, K. L., Bolten, A. B., Bjorndal, K. A. & Martins, H. R. (2009). Foraging ecology of oceanic-stage loggerhead turtles Caretta caretta. Endangered Species Research, 9, 91-97.

Fritts, T. H. (1981). Pelagic feeding habits of turtles in the eastern pacific. Marine Turtle Newsletter, 17(1), 4-5. Retrieved from http://www.seaturtle.org/mtn/archives/mtn17/mtn17p4.shtml

Fritts, T. H., Stinson, M. L. & Márquez, R. M. (1982). Status of sea turtle nesting in southern Baja California, México. Bulletin of the Southern California Academy of Sciences, 81(2), 51-60.

Gaos, A. R. & Yañez, I. L. (2008). Where have the Eastern Pacific Hawksbills Gone?! SWoT Report-State of the World's Sea Turtles, III, 18-19. Retrieved from http://seaturtlestatus.org/report/swot-volume-3

Gerstein, E.R, L.A. Gerstein, & S.E. Forsythe. (2009). Parametric projectors protecting marine mammals from vessel collisions. J. Acoust. Soc. Am. Volume 125, Issue 4, pp. 2689-2689.

Gilman, E. (2008). Pacific Leatherback Conservation and Research Activities, Financing and Priorities. (pp. 31). Honolulu, HI: The World Conservation Union and Western Pacific Fishery Management Council and IUCN.

Gilman, E., Clarke, S., Brothers, N., Alfaro-Shigueto, J., Mandelman, J., Mangel, J., Werner, T. (2007). Shark Depredation and Unwanted Bycatch in Pelagic Longline Fisheries: Industry Practices and Attitudes, and Shark Avoidance Strategies. (pp. 164). Honolulu, HI: Western Pacific Regional Fishery Management Council.

Godley, B. J., Broderick, A. C., Glen, F. & Hays, G. C. (2003). Post-nesting movements and submergence patterns of loggerhead marine turtles in the Mediterranean assessed by satellite tracking. Journal of Experimental Marine Biology and Ecology, 287, 119-134.

Godley, B. J., Thompson, D. R., Waldron, S. & Furness, R. W. (1998). The trophic status of marine turtles as determined by stable isotope analysis. Marine Ecology Progress Series, 166, 277-284.

Goertner J.F. (1982). Prediction of underwater explosion safe ranges for sea mammals, Naval Surface Weapons Center, Dahlgren Division, White Oak Detachment, Silver Spring, Maryland. pp. 38 pp.

Goertner, J. F., Wiley, M. L., Young, G. A. & McDonald, W. W. (1994). Effects of underwater explosions on fish without swimbladders. (NSWC TR 88-114). Silver Spring, Maryland: Naval Surface Warfare Center.

Goff, G. P. & Stenson, G. B. (1988). Brown adipose tissue in leatherback sea turtles: A thermogenic organ in an endothermic reptile? Copeia, 1988(4), 1071-1075.

Grant, G. S. & Ferrell, D. (1993). Leatherback turtle, Dermochelys coriacea (Reptilia: Dermochelidae): Notes on near-shore feeding behavior and association with cobia. Brimleyana, 19, 77-81.

Greaves F.C., Draeger R.H., Brines O.A., Shaver J.S., Corey E.L. (1943). An Experimental Study of Concussion. United States Naval Medical Bulletin 41:339-352.

Greer, A. E., Jr., Lazell, J. D., Jr. & Wright, R. M. (1973). Anatomical evidence for a counter-current heat exchanger in the leatherback turtle (Dermochelys coriacea). Nature, 244, 181.

Gregory, L. F. & Schmid, J. R. (2001). Stress response and sexing of wild Kemp's ridley sea turtles (Lepidochelys kempii) in the Northeastern Gulf of Mexico. General and Comparative Endocrinology, 124, 66-74 doi:10.1006/gcen.2001.7683

Guenther, G.C., T. J. Eisler, J.L. Riley, & S.W. Perez. (1996). Obstruction Detection and Data Decimation for Airborne Laser Hydrography. National Oceanic and Atmospheric Administration,National Ocean Service, Office of Coast Survey. Proceedings, 1996 Canadian Hydrographic Conference, Halifax, Canada.

Hailman, J. P. & Elowson, A. M. (1992). Ethogram of the nesting female loggerhead (Caretta caretta). Herpetologica, 48(1), 1-30.

Hatase, H., Matsuzawa, Y., Sakamoto, W., Baba, N. & Miyawaki, I. (2002). Pelagic habitat use of an adult Japanese male loggerhead turtle Caretta caretta examined by the Argos satellite system. Fisheries Science, 68, 945-947.

Hatase, H., Omuta, K. & Tsukamoto, K. (2007). Bottom or midwater: alternative foraging behaviours in adult female loggerhead sea turtles. Journal of Zoology, 273(1), 46-55. doi: 10.1111/j.1469-7998.2007.00298.x

Hatase, H., Sato, K., Yamaguchi, M., Takahashi, K. & Tsukamoto, K. (2006). Individual variation in feeding habitat use by adult female green sea turtles (Chelonia mydas): are they obligately neritic herbivores? Oecologia, 149(1), 52-64. doi: 10.1007/s00442-006-0431-2

Hawaii Department of Land and Natural Resources. (2002). Application for an Individual Incidental Take Permit Pursuant to the Endangered Species Act of 1973 for Listed Sea Turtles in Inshore Marine Fisheries in the Main Hawaiian Islands Managed by the State of Hawaii. (pp. 54). Honolulu, HI: State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources.

Hawkes, L. A., Broderick, A. C., Coyne, M. S., Godfrey, M. H., Lopez-Jurado, L.-F., Lopez-Suarez, P., Godley, B. J. (2006). Phenotypically linked dichotomy in sea turtle foraging requires multiple conservation approaches. Current Biology, 16, 990-995.

Hays, G. C., Houghton, J. D. R., Isaacs, C., King, R. S., Lloyd, C. & Lovell, P. (2004). First records of oceanic dive profiles for leatherback turtles, Dermochelys coriacea, indicate behavioural plasticity associated with long-distance migration. Animal Behaviour, 67, 733-743.

Hays, G. C., Metcalfe, J. D. & Walne, A. W. (2004). The implications of lung-regulated buoyancy control for dive depth and duration. Ecology, 85(4), 1137-1145.

Hazel, J., Lawler, I. R., Marsh, H. & Robson, S. (2007). Vessel speed increases collision risk for the green sea turtle Chelonia mydas. Endangered Species Research, 3(2), 105-113. doi: 10.3354/esr003105

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

Hirth, H., Kasu, J. & Mala, T. (1993). Observations on a Leatherback Turtle Dermochelys coriacea Nesting Population near Piguwa, Papua New Guinea. Biological Conservation, 65, 77-82.

Hirth, H. F. (1997). Synopsis of the Biological Data on the Green sea turtle Chelonia mydas (Linnaeus 1758). (Biological Report 97(1)). Washington, DC: U.S. Fish and Wildlife Service.

Hirth, H. F. & Ogren, L. H. (1987). Some Aspects of the Ecology of the Leatherback Turtle Dermochelys coriacea at Laguna Jalova, Costa Rica. (NOAA Technical Report NMFS 56, pp. 14) U.S. Department of Commerce, National Oceanic and Atmospheric Administration and National Marine Fisheries Service.

Hodge, R. P. & Wing, B. L. (2000). Occurrences of marine turtles in Alaska waters: 1960-1998. Herpetological Review, 31(3), 148-151.

Hughes, G. R., Luschi, P., Mencacci, R. & Papi, F. (1998). The 7000-km oceanic journey of a leatherback turtle tracked by satellite. Journal of Experimental Marine Biology and Ecology, 229, 209-217.

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

James, M. C. & Mrosovsky, N. (2004). Body temperatures of leatherback turtles (Dermochelys coriacea) in temperate waters off Nova Scotia, Canada. Canadian Journal of Zoology, 82, 1302-1306. doi: 10.1139/Z04-110

James, M. C., Myers, R. A. & Ottensmeyer, C. A. (2005a). Behaviour of leatherback sea turtles, Dermochelys coriacea, during the migratory cycle. Proceedings of the Royal Society B: Biological Sciences, 272, 1547-1555. doi: 10.1098/rspb.2005.3110

James, M. C., Ottensmeyer, C. A. & Myers, R. A. (2005b). Identification of high-use habitat and threats to leatherback sea turtles in northern waters: New directions for conservation. Ecology Letters, 2005(8), 195-201. doi: 10.1111/j.1461-0248.2004.00710.x

James, M. C., Sherrill-Mix, S. A., Martin, K. & Myers, R. A. (2006). Canadian waters provide critical foraging habitat for leatherback sea turtles. Biological Conservation, 133(3), 347-357.

Jones, T.T. (2009). Energetics of the leatherback turtle (Dermochelys coriacea). Thesis.

Jonsen, I. D., Myers, R. A. & James, M. C. (2007). Identifying leatherback turtle foraging behaviour from satellite telemetry using a switching state-space model. Marine Ecology Progress Series 337, 255-264.

Kalb, H. & Owens, D. (1994). Differences between solitary and arribada nesting olive ridley females during the internesting period. In K. A. Bjorndal, A. B. Bolten, D. A. Johnson and P. J. Eliazar (Eds.), Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. (NOAA Technical Memorandum NMFS-SEFSC-351, pp. 68) U.S. Department of Commerce, National Oceanic and Atmospheric Administration and National Marine Fisheries Service.

Kamezaki, N., Matsuzawa, Y., Abe, O., Asakawa, H., Fujii, T., Goto, K., Wakabayashi, I. (2003). Loggerhead turtles nesting in Japan. In A. B. Bolten and B. E. Witherington (Eds.), Loggerhead Sea Turtles (pp. 210-217). Washington DC: Smithsonian Books.

Keinath, J. A. & Musick, J. A. (1993). Movements and diving behavior of a leatherback turtle, Dermochelys coriacea. Copeia, 1993(4), 1010-1017.

Ketten, D. R. (1995). Estimates of blast injury and acoustic trauma zones for marine mammals from underwater explosions R. A. Kastelein, J. A. Thomas and P. E. Nachtigall (Eds.), Sensory Systems of Aquatic Mammals (pp. 391-407). Woerden, The Netherlands: De Spil Publishers.

Ketten, D. R. (1998). Marine Mammal Auditory Systems: A Summary of Audiometric and Anatomical Data and Its Implications for Underwater Acoustic Impacts. Dolphin-Safe Research Program, Southwest Fisheries Science Center, La Jolla, California.

Ketten D.R., Lien J., Todd S. (1993). Blast injury in humpback whale ears: Evidence and implications (A). Journal of the Acoustical Society of America 94:1849-1850.

Klima, E. F., Gitschlag, G. R. & Renaud, M. L. (1988). Impacts of the explosive removal of offshore petroleum platforms on sea turtles and dolphins. Marine Fisheries Review, 50, 33-42.

Lazell, J. D., Jr. (1980). New England waters: Critical habitat for marine turtles. Copeia, 1980(2), 290-295.

Lenhardt M.L., Klinger R.C., Musick J.A. (1985). Marine Turtle Middle-Ear Anatomy. The Journal of Auditory Research 25:66-72.

Lenhardt, M. L., S. Bellmund, R. A. Byles, S. W. Harkins and J. A. Musick. (1983). Marine turtle reception of bone-conducted sound. *Journal of Auditory Research 23*: 119-125.

Lenhardt M.L. (1994). Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (Caretta caretta), in: K. A. Bjorndal, et al. (Eds.), Fourteenth Annual Symposium on Sea Turtle Biology and Conservation, Hilton Head, South Carolina.

Lenhardt, M. L. (2002). "Sea turtle auditory behavior." *Journal of the Acoustical Society of America 112*(5, Part 2): 2314.

Levenson, D. H., S. A. Eckert, M. A. Crognale, J. I. Deegan and G. H. Jocobs. (2004). "Photopic spectral sensitivity of green and loggerhead sea turtles." *Copeia(4)*: 908–914.

Limpus, C., Bell, I. & Miller, J. (2009). Mixed stocks of green sea turtles foraging on Clack Reef, northern Great Barrier Reef identified from long term tagging studies. Marine Turtle Newsletter, 123, 3-5.

Limpus, C. J. (1992). The hawksbill turtle, Eretmochelys imbricata, in Queensland: population structure within a southern Great Barrier Reef ground. Wildlife Research 19, 489-506.

Lohmann, K. J. & Lohmann, C. M. F. (1992). Orientation to oceanic waves by green sea turtle hatchlings. Journal of Experimental Biology, 171, 1-13.

Lohmann, K. J. & Lohmann, C. M. F. (1996a). Detection of magnetic field intensity by sea turtles. Nature, 380, 59-61. doi:10.1038/380059a0

Lohmann, K. J. & Lohmann, C. M. F. (1996b). Orientation and open-sea navigation in sea turtles. Journal of Experimental Biology, 199(1), 73-81.

Lohmann, K. J., Witherington, B. E., Lohmann, C. M. F. & Salmon, M. (1997). Orientation, navigation, and natal beach homing in sea turtles. In P. L. Lutz and J. A. Musick (Eds.), The Biology of Sea Turtles (pp. 107-136). Boca Raton, FL: CRC Press.

Lopez-Castro, M. C. & Rocha-Olivares, A. (2005). The panmixia paradigm of eastern Pacific olive ridley turtles revised: consequences for their conservation and evolutionary biology. Molecular Ecology, 14(11), 3325-3334. doi: 10.1111/j.1365-294X.2005.02652.x

Lutcavage, M., Plotkin, P., Witherington, B. & Lutz, P. (1997). Human impacts on sea turtle survival. In P. Lutz and J. A. Musick (Eds.), The biology of sea turtles (Vol. 1, pp. 387-409). Boca Raton, FL: CRC Press.

Lutcavage, M. E. & Lutz, P. L. (1997). Diving Physiology. In P. L. Lutz and J. A. Musick (Eds.), The Biology of Sea Turtles (pp. 277-296). Boca Raton, FL: CRC Press.

MacDonald, B.D., R.L. Lewison, S.V. Madrak, J.A. Seminoff, T. Eguchi. (2012). Home ranges of East Pacific green turtles Chelonia mydas in a highly urbanized temperate foraging ground. *Marine Ecology Progress Series 461:*211-221.

Maison, K. A., Kelly, I. K. & Frutchey, K. P. (2010). Green sea turtle Nesting Sites and Sea Turtle Legislation throughout Oceania. (NOAA Technical Memorandum NMFS-F/SPO- 110, pp. 56) U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Marine Fisheries Service.

Makowski, C., Seminoff, J. A. & Salmon, M. (2006). Home range and habitat use of juvenile Atlantic green sea turtles (Chelonia mydas L.) on shallow reef habitats in Palm Beach, Florida, USA. Marine Biology, 148, 1167-1179. doi: 10.1007/s00227-005-0150-y

Márquez M., R. (1990). FAO Species Catalogue: SeaTurtles of the World. An Annotated and Illustrated Catalogue of Sea Turtle Species known to date. (Vol. 11, FAO Fisheries Synopsis. No. 125, pp. 81). Rome, Italy: Food and Agriculture Organization of the United Nations.

Mather, J. (2004). Cephalopod Skin Displays: From Concealment to Communication. Chapter 11, Part IV, in: The Evolution of Communication Systems: A Comparitive Approach. Edited by: D. Kimbrough Oller and Ulrike Griebel. The Vienna Series in Theoretical Biology and the Massachusettes Institute of Technology. Cambridge, MA.

McCauley, S. J. & Bjorndal, K. A. (1999). Conservation implications of dietary dilution from debris ingestion: Sublethal effects in post-hatchling loggerhead sea turtles. Conservation Biology, 13(4), 925-929.

McCauley R.D., Fewtrell J., Duncan A.J., Jenner C., Jenner M.-N., Penrose J.D., Prince R.I.T., Adhitya A., Murdoch J., McCabe K.A. (2000). Marine Seismic Surveys: Analysis and Propagation of Air-gun Signals; and Effects of Air-gun Exposure on Humpback Whales, Sea Turtles, Fishes and Squid, Centre for Marine Science and Technology, Western Australia. pp. 198.

McClellan, C. M. & Read, A. J. (2007). Complexity and variation in loggerhead sea turtle life history. Biology Letters 3, 592-594. doi: 10.1098/rsbl.2007.0355

McCracken, M. L. (2000). Estimation of Sea Turtle Take and Mortality in the Hawaiian Longline Fisheries. (SWFSC Administrative Report H-00-06, pp. 29). Honolulu, HI: Southwest Fisheries Science Center.

McVey, J.P. & Wibbels, T. (1984). The growth and movements of captive-reared Kemp's ridley sea turtles, Lepidochelys kempi, following their release in the Gulf of Mexico. NOAA Technical Memorandum NMFS-SEFC-145, 25p.

Meylan, A. (1995). Sea turtle migration evidence from tag returns. In K. A. Bjorndal (Ed.), Biology and Conservation of Sea Turtles (Revised ed., pp. 91-100). Washington, DC: Smithsonian Institution Press.

Meylan, A. B. (1988). Spongivory in hawksbill turtles: A diet of glass. Science, 239, 393-395.

Meylan, A. B. (1999). International movements of immature and adult hawksbill turtles (Eretmochelys imbricata) in the Caribbean region. Chelonian Conservation and Biology, 3(2), 189-194.

Meylan, A. B. & Donnelly, M. (1999). Status justification for listing the hawksbill turtle (Eretmochelys imbricata) as critically endangered on the 1996 IUCN Red List of Threatened Animals. Chelonian Conservation and Biology, 3(2), 200-224.

Miller, J. D., Limpus, C. J. & Godfrey, M. H. (2003). Nest site selection, oviposition, eggs, development, hatching, and emergence of loggerhead turtles. In A. B. Bolten and B. E. Witherington (Eds.), Loggerhead Sea Turtles (pp. 125-143). Washington, DC: Smithsonion Institution Press.

Moein Bartol S.E., Musick J.A., Keinath J.A., Barnard D.E., Lenhardt M.L., George R. (1995). Evaluation of Seismic Sources for Repelling Sea Turtles from Hopper Dredges, in: L. Z. Hales (Ed.), Sea Turtle Research Program: Summary Report, U.S. Army Engineer Division, South Atlantic, Atlanta, Georgia and U.S. Naval Submarine Base, Kings Bay, Georgia. pp. 90-93.

Morreale, S. J., Standora, E. A., Spotila, J. R. & Paladino, F. V. (1996). Migration corridor for sea turtles. Nature, 384, 319-320.

Mortimer, J. A. (1995). Feeding ecology of sea turtles. In K. A. Bjorndal (Ed.), Biology and Conservation of Sea Turtles (Revised ed., pp. 103-109). Washington, DC: Smithsonian Institution Press.

Mortimer, J. A. & Bresson, R. (1999). Temporal distribution and periodicity in hawksbill turtles (Eretmochelys imbricata) nesting at Cousin Island, Republic of Seychelles, 1971-1997. Chelonian Conservation and Biology, 3(2), 318-325.

Mortimer, J. A. & Donnelly, M. (2008). Hawksbill Turtle (Eretmochelys imbricate): Marine Turtle Specialist Group 2008 IUCN Red List status assessment. [Web Page]. Retrieved from www.iucnredlist.org, 03 September 2009.

Mrosovsky, N. (1980). Thermal biology of sea turtles. American Zoologist, 20(3), 531-547.

Mrosovsky, N. & Pritchard, P. C. H. (1971). Body temperatures of Dermochelys coriacea and other sea turtles. Copeia, 1971(4), 624-631.

Mrosovsky, N., Ryan, G. D. & James, M. C. (2009). Leatherback turtles: The menace of plastic. Marine Pollution Bulletin, 58, 287-289.

Musick, J. A. & Limpus, C. J. (1997). Habitat utilization and migration of juvenile sea turtles. In P. L. Lutz and J. A. Musick (Eds.), The Biology of Sea Turtles (pp. 137-163). Boca Raton, FL: CRC Press.

Myers, A. E. & Hays, G. C. (2006). Do leatherback turtles Dermochelys coriacea forage during the breeding season? A combination of data-logging devices provide new insights. Marine Ecology Progress Series, 322, 259-267.

Nachtigall P.E., Pawloski J.L., Au W.W.L. (2003). Temporary Threshold Shifts and Recovery Following Noise Exposure in the Atlantic Bottlenosed Dolphin (Tursiops truncatus). Journal of the Acoustical Society of America 113:3425-3429.

Nachtigall P.E., Supin A.Y., Pawloski J., Au W.W.L. (2004) Temporary Threshold Shifts after Noise Exposure in the Bottlenose Dolphin (Tursiops truncatus) Measured Using Evoked Auditory Potentials. Marine Mammal Science 20:673–687.

National Marine Fisheries Service. (2003). Taking of threatened or endangered species incidental to commercial fishing operations. Final rule and technical correction. [Final Rule]. Federal Register, 68(241), 69962-69967.

National Marine Fisheries Service. (2005). Endangered Fish and Wildlife; Notice of intent to prepare an environmental impact statement. 70 FR 1871.

National Marine Fisheries Service. (2010a). Endangered and threatened species; proposed listing of nine distinct population segments of loggerhead sea turtles as endangered or threatened. [Proposed Rule]. Federal Register, 75(50), 12598-12656.

National Marine Fisheries Service. (2010b). Marine Turtles. [Web Page] NOAA Fisheries Office of Protected Resources. Retrieved from http://www.nmfs.noaa.gov/pr/species/turtles/, 25 May 2010.

National Marine Fisheries Service, Pacific Islands Fisheries Science Center. (2004). Cause of Stranding Database for Marine Turtle Strandings in the Hawaiian Islands, 1982-2003. (Vol. 154). Honolulu, HI: National Marine Fisheries Service Pacific Islands Fisheries Science Center.

National Marine Fisheries Service, Southeast Fisheries Science Center. (2001). Stock Assessments of Loggerhead and Leatherback Sea Turtles and an Assessment of the Impact of the Pelagic Longline Fishery on the Loggerhead and Leatherback Sea Turtles of the Western North Atlantic. (NOAA Technical Memorandum NMFS-SEFSC-455, pp. 343) U.S. Department of Commerce.

National Marine Fisheries Service. (2008). Programmatic biological opinion on the U.S. Navy's proposal to conduct training exercises in the Hawai'i Range Complex from December 2008 to December 2013. Office of Protected Resources. National Oceanic and Atmospheric Administration, Silver Spring, MD.

National Marine Fisheries Service. (2011). Hawaii Longline Deep Set Quarterly and Annual Status Reports, 2004 2011. Retreived from: http://www.fpir.noaa.gov/OBS/obs_hi_ll_ds_rprts.html.

National Marine Fisheries Service. (2012). Endangered and Threatened Species: Final Rule To Revise the Critical Habitat Designation for the Endangered Leatherback Sea Turtle. 50 CFR Part 226 Docket No. 0808061067–1664–03.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. (1991). Recovery Plan for U.S. Populations of Atlantic Green sea turtle Chelonia mydas. (pp. 52). Washington, DC: National Marine Fisheries Service.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. (1992). Recovery Plan for Leatherback Turtles Dermochelys coriacea in the U.S. Carribean, Atlantic and Gulf of Mexico (pp. 65). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. (1998a). Recovery Plan for U.S. Pacific Populations of the East Pacific Green sea turtle (Chelonia mydas). (pp. 61). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. (1998b). Recovery Plan for U.S. Pacific Populations of the Green sea turtle (Chelonia mydas). (pp. 84). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. (1998c). Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle (Eretmochelys imbricata). (pp. 83). Silver Spring, MD: National Marine Fisheires Service.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. (1998d). Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle (Dermochelys coriacea). (pp. 65). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. (1998e). Recovery Plan for U.S. Pacific Populations of the Loggerhead Turtle (Caretta caretta). (pp. 59). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. (1998f). Recovery Plan for U.S. Pacific Populations of the Olive Ridley Turtle (Lepidochelys olivacea). (pp. 52). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. (2007a). Green Sea Turtle (Chelonia mydas) 5-year Review: Summary and Evaluation. (pp. 102). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. (2007b). Hawksbill Sea Turtle (Eretmochelys imbricata) 5-year Review: Summary and Evaluation. (pp. 90). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. (2007c). Leatherback Sea Turtle (Dermochelys coriacea) 5-year Review: Summary and Evaluation. (pp. 79). Silver Spring, MD: National Marine Fisheries.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. (2007d). Loggerhead Sea Turtle (Caretta caretta) 5-year Review: Summary and Evaluation. (pp. 65). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. (2007e). Olive Ridley Sea Turtle (Lepidochelys olivacea) 5-year Review: Summary and Evaluation. (pp. 64). Silver Spring, MD: National Marine Fisheries Service.

National Research Council. (2010). Assessment of Sea-Turtle Status and Trends: Integrating Demography and Abundance. Committee on the Review of Sea-Turtle Population Assessment Methods Ocean Studies Board Division on Earth and Life Studies. The National Academies Press. Washington, D.C.

Neill, W. H. & Stevens, E. D. (1974). Thermal inertia versus thermoregulation in "warm" turtles and tunas. Science, 184, 1008-1010.

Normandeau, Exponent, T., T. & Gill, A. (2011). Effects of Electromagnetic Fields from Undersea Power Cables on Elasmobranchs and Other Marine Species. Camarillo, California: U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific Outer Continental Shelf Region. Available from http://www.gomr.boemre.gov/PI/PDFImages/ESPIS/4/5115.pdf

Office of the Surgeon General. (1991). USA Textbook of Military Medicine; Part 1, Volume 5. Conventional Warfare; Ballistic, Blast and Burn Injuries.

O'Hara J., & Wilcox J.R. (1990). Avoidance responses of loggerhead turtles, Caretta caretta, to low frequency sound. Copeia 2:564-567.

Okuyama, J., S. Tomohito, O. Abe, K. Yoseda, & N. Arai. (2010). Wild versus head-started hawksbill turtles Eretmochelys imbricata: post-release behavior and feeding adaptions. Endangered Species Research, January 2010.

O'Malley, A. E. (2010). The Navy's Nature Guy. Midweek Kaua'i. Retrieved from http://www.midweekkauai.com/2010/09/the-navys-nature-guy

Paladino, F. V., O'Connor, M. P. & Spotila, J. R. (1990). Metabolism of leatherback turtles, gigantothermy and thermoregulation of dinosaurs. Nature, 344, 858-860.

Parker, D. M. & Balazs, G. H. (2005). Diet of the oceanic green sea turtle, Chelonia mydas, in the north Pacific. In H. Kalb, A. S. Rohde, K. Gayheart and K. Shanker (Eds.), Proceedings of the Twenty-fifth Annual Symposioum on Sea Turtle Biology and Conservation [Abstract]. (NOAA Technical Memorandum NMFS-SEFSC-582, pp. 94) U.S. Department of Commerce, National Oceanic and Atmospheric Administration and National Marine Fisheries Service.

Parker, D. M., Balazs, G. H., King, C. S., Katahira, L. & Gilmartin, W. (2009). Short-range movements of Hawksbill turtles (Eretmochelys imbricata) from nesting to foraging areas within the Hawaiian Islands. Pacific Science, 63(3), 371-382.

Parker, D. M., Dutton, P. H., Kopitsky, K. & Pitman, R. L. (2003). Movement and dive behavior determined by satellite telemetry for male and female olive ridley turtles in the Eastern Tropical Pacific. In J. A. Seminoff (Ed.), Proceedings of the Twenty-Second Annual Symposium on Sea Turtle

Biology and Conservation [Abstract]. (NOAA Technical Memorandum NMFS-SEFSC-503, pp. 48-49) U.S. Department of Commerce, National Oceanic and Atmospheric Administration and National Marine Fisheries Service. Available from http://www.nmfs.noaa.gov/pr/species/turtles/symposia.htm

Parker, L. G. (1995). Encounter with a juvenile hawksbill turtle offshore Sapelo Island, Georgia. Marine Turtle Newsletter, 71, 19-22. Retrieved from http://www.seaturtle.org/mtn/archives/mtn71/mtn71p19.shtml

Pelletier, D., Roos, D. & Ciccione, S. (2003). Oceanic survival and movements of wild and captive-reared immature green sea turtles (Chelonia mydas) in the Indian Ocean. Aquatic Living Resources, 16, 35-41. doi: 10.1016/S0990-7440(03)00005-6

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

Pitman, R. L. (1990). Pelagic distribution and biology of sea turtles in the eastern tropical Pacific. In T. H. Richardson, J. I. Richardson and M. Donnelly (Eds.), Proceedings of the Tenth Annual Workshop on Sea Turtle Biology and Conservation. (NOAA Technical Memorandum NMFS-SEFC-278, pp. 143-150) U.S. Department of Commerce, National Oceanic and Atmospheric Administration and National Marine Fisheries Service.

Pitman, R. L. (1992). Sea turtle associations with flotsam in the eastern tropical Pacific Ocean. In M. Salmon and J. Wyneken (Eds.), Proceedings of the Eleventh Annual Workshop on Sea Turtle Biology and Conservation [Abstract]. (NOAA Technical Memorandum NMFS-SEFSC-302, pp. 94) U.S. Department of Commerce, National Oceanic and Atmospheric Administration and National Marine Fisheries Service.

Plotkin, P. T., Byles, R. A. & Owens, D. W. (1994). Post-breeding movements of male olive ridley sea turtles Lepidochelys olivacea from a nearshore breeding area. In K. A. Bjorndal, A. B. Bolton, D. A. Johnson and P. J. Eliazar (Eds.), Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation [Abstract]. (NOAA Technical Memorandum NMFC-SEFSC-351) U.S. Department of Commerce, National Oceanic and Atmospheric Administration and National Marine Fisheries Service.

Polovina, J. J., Balazs, G. H., Howell, E. A., Parker, D. M., Seki, M. P. & Dutton, P. H. (2004). Forage and migration habitat of loggerhead (Caretta caretta) and olive ridley (Lepidochelys olivacea) sea turtles in the central North Pacific Ocean. Fisheries Oceanography, 13(1), 36-51.

Polovina, J. J., Howell, E., Kobayashi, D. R. & Seki, M. P. (2001). The transition zone chlorophyll front, a dynamic global feature defining migration and forage habitat for marine resources. Progress in Oceanography, 49, 469-483.

Polovina, J. J., Howell, E., Parker, D. M. & Balazs, G. H. (2002). Dive-depth distribution of loggerhead (Caretta caretta) and olive ridley (Lepidochelys olivacea) sea turtles in the central North Pacific:Might deep longline sets catch fewer turtles? Fishery Bulletin, 101(1), 189-193.

Polovina, J. J., Kobayashi, D. R., Parker, D. M., Seki, M. P. & Balazs, G. H. (2000). Turtles on the edge: movement of loggerhead turtles (Caretta caretta) along oceanic fronts, spanning longline fishing grounds in the central North Pacific, 1997-1998. Fisheries Oceanography, 9(1), 71-82.

Polovina, J. J., Uchida, I., Balazs, G. H., Howell, E., Parker, D. M. & Dutton, P. (2006). The Kuroshio Extension Bifurcation Region: A pelagic hotspot for juvenile loggerhead sea turtles. Deep-Sea Research II, 53, 326-339. doi: 10.1016/j.dsr2.2006.01.006

Pritchard, P. C. H. (1982). Nesting of the leatherback turtle, Dermochelys coriacea in Pacific Mexico, with a new estimate of the world population status. Copeia, 1982(4), 741-747.

Pritchard, P. C. H. (1997). Evolution, phylogeny, and current status. In P. L. Lutz and J. A. Musick (Eds.), The Biology of Sea Turtles (pp. 1-28). Boca Raton, FL: CRC Press.

Pritchard, P. C. H. & Plotkin, P. T. (1995). Olive ridley sea turtle, Lepidochelys olivacea. In P. T. Plotkin (Ed.), National Marine Fisheries Service and U.S. Fish and Wildlife Service Status Reviews of Sea Turtles Listed under the Endangered Species Act of 1973. (pp. 123-139). Silver Spring, MD: National Marine Fisheries Service.

Rees, A. F., Frick, M., Panagopoulou, A. & Williams, K. (2008). Proceedings of the twenty-seventh annual symposium on sea turtle biology and conservation National Oceanic and Atmospheric Administration Technical Memorandum. (pp. 262).

Reich, K. J., Bjorndal, K. A., Bolten, A. B. & Witherington, B. (2007). Do some loggerheads nesting in Florida have an oceanic foraging strategy? An assessment based on stable isotopes. In R. B. Mast, B. J. Hutchinson and A. H. Hutchinson (Eds.), Proceedings of the Twenty-fourth Annual Symposium on Sea Turtle Biology and Conservation [Abstract]. (NOAA Technical Memorandum NMFS-SEFSC-567, pp. 32) U.S. Department of Commerce, National Oceanic and Atmospheric Administration and National Marine Fisheries Service.

Reinhall, P.G. and P.H. Dahl. (2011). Acoustic radiation during marine pile driving. J. Acoust. Soc. Am., 129, 2460, doi:10.1121/1.3588091, 2011

Renaud, M. L. & Carpenter, J. A. (1994). Movements and submergence patterns of loggerhead turtles (Caretta caretta) in the Gulf of Mexico determined through satellite telemetry. Bulletin of Marine Science, 55(1), 1-15.

Resendiz, A., Resendiz, B., Nichols, W. J., Seminoff, J. A. & Kamezaki, N. (1998). First confirmed east-west transpacific movement of a loggerhead sea turtle, Caretta caretta, released in Baja California, Mexico. Pacific Science, 52(2), 151-153.

Rice, M. R. & Balazs, G. H. (2008). Diving behavior of the Hawaiian green sea turtle (Chelonia mydas) during oceanic migrations. Journal of Experimental Marine Biology and Ecology, 356(1-2), 121-127. doi: 10.1016/j.jembe.2007.12.010

Richmond D.R., Yelverton J.T., Fletcher E.R. (1973). Far-field underwater-blast injuries produced by small charges, Lovelace Foundation for Medical Education and Research, Defense Nuclear Agency, Washington, DC. pp. 108.

Ridgway S.H., Wever E.G., McCormick J.G., Palin J., Anderson J.H. (1969). Hearing in the giant sea turtle, Chelonia mydas. Proceedings of the National Academy of Sciences USA 64:884-890.

Richardson, J. I., R. Bell and T. H. Richardson. (1999). Population ecology and demographic implications drawn from an 11-year study of nesting hawksbill turtles, Eretmochelys imbricata, at Jumby Bay, Long Island, Antigua, West Indies. *Chelonian Conservation and Biology 3*(2): 244-250.

Rivers, J. (2011). Sea turtles nesting and in-water sightings in the Hawaiian Islands. Personal communication with Julie Rivers, Pacific Fleet Marine Biologist via comments on the HSTT DEIS v1.

Rosen, G. & Lutufo, G.R. (2010). Fate and effects of Composition B in multispecies marine exposures. *Environmental Toxicology and Chemistry 29*(6):1330-1337.

Sale, A., Luschi, P., Mencacci, R., Lambardi, P., Hughes, G. R., Hays, G. C., Papi, F. (2006). Long-term monitoring of leatherback turtle diving behaviour during oceanic movements. Journal of Experimental Marine Biology and Ecology, 328, 197-210. doi: 10.1016/j.jembe.2005.07.006

Salmon, M., Jones, T. T. & Horch, K. W. (2004). Ontogeny of diving and feeding behavior in juvenile seaturtles: Leatherback seaturtles (Dermochelys coriacea L) and green seaturtles (Chelonia mydas L) in the Florida current. Journal of Herpetology, 38(1), 36-43.

Sakamoto, W., K. Sato, H. Tanaka, and Y. Naito. (1993). Diving patterns and swimming environment of two loggerhead turtles during internesting. Nippon Suisan Gakkaishi 59(7):1129-1137.

Sarti-Martinez, A. L. (2000). Dermochelys coriacea. In IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2 Retrieved from www.iucnredlist.org, 19 November 2009.

Sarti-Martinez, L., Eckert, S. A., Garcia T., N. & Barragan, A. R. (1996). Decline of the world's largest nesting assemblage of leatherback turtles. Marine Turtle Newsletter, 74, 2-5. Retrieved from http://www.seaturtle.org/mtn/archives/mtn74/mtn74p2.shtml

Sasso, C. R. & Witzell, W. N. (2006). Diving behaviour of an immature Kemp's ridley turtle (Lepidochelys kempii) from Gullivan Bay, Ten Thousand Islands, south-west Florida. Journal of the Marine Biological Association of the United Kingdom, 86, 919-925.

Schecklman, S., Houser, D., Cross, M., Hernandez, D., and M. Siderius. (2011). Comparison of methods used for computing the impact of sound on the marine environment. Marine Environmental Research, vol. 71 (5): 342-350.

Schlundt, C.E., Finneran, J.J., Carder, D.A., and Ridgway, S.H. (2000). Temporary shift in masked hearing thresholds of bottlenose dolphins, Tursiops truncatus, and white whales, Delphinapterus leucas, after exposure to intense tones. J. Acoust. Soc. Am. 107: 3496–3508.

Schofield, G., Hobson, V. J., Lilley, M. K. S., Katselidis, K. A., Bishop, C. M., Brown, P. & Hays, G. C. (2010). Inter-annual variability in the home range of breeding turtles: Implications for current and future conservation management. Biological Conservation, 143(3), 722-730. doi: 10.1016/j.biocon.2009.12.011

Schroeder, B. A., Foley, A. M. & Bagley, D. A. (2003). Nesting patterns, reproductive migrations, and adult foraging areas of loggerhead turtles. In A. B. Bolten and B. E. Witherington (Eds.), Loggerhead Sea Turtles (pp. 114-124). Washington, DC: Smithsonian Institution Press.

Seminoff, J. A., Jones, T. T., Resendiz, A., Nichols, W. J. & Chaloupka, M. Y. (2003). Monitoring green sea turtles (Chelonia mydas) at a coastal foraging area in Baja California, Mexico: multiple indices describe population status. Journal of the Marine Biological Association of the United Kingdom, 83, 1355-1362.

Seminoff, J. A. & Marine Turtle Specialist Group Green sea turtle Task Force (2004). Marine Turtle Specialist Group Review: 2004 Global Status Assessment, Green sea turtle (Chelonia mydas). (pp. 71) The World Conservation Union (IUCN) Species Survival Commission, Red List Programme.

Seminoff, J. A., Nichols, W. J., Resendiz, A. & Brooks, L. (2003). Occurrence of hawksbill turtles, Eretmochelys imbricata (Reptilia: Cheloniidae), near the Baja California peninsula, Mexico. Pacific Science, 57(1), 9-16.

Shankar, K., Ramadevi, J., Choudhary, B. C., Singh, L. & Aggarwal, R. K. (2004). Phylogeography of olive ridley turtles (Lepidochelys olivacea) on the east coast of India: implications for conservation theory. Molecular Ecology, 13 1899-1909. doi: 10.1111/j.1365-294X.2004.02195.x

Skillman, R. A. & Balazs, G. H. (1992). Leatherback turtle captured by ingestion of squid bait on swordfish longline. Fishery Bulletin, 90, 807-808.

Skillman, R. A. & Kleiber, P. (1998). Estimation of Sea Turtle Take and Mortality in the Hawai'i-based Longline Fishery, 1994-96. (NOAA Technical Memorandum NMFS-SWFSC-257, pp. 52) U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service and Southwest Fisheries Science Center.

Smith, S. (2010), NAVFAC PAC. Sea turtles in Pearl Harbor. Telephone call K. Kelly, Tetra Tech, Inc., Honolulu, HI.

Smith, S. H., Deslarzes, K. J. P. & Brock, R. (2006). Characterization of Fish and Benthic Communities of Pearl Harbor and Pearl Harbor Entrance Channel, Hawai'i. (Project Number 03-183, pp. 83). Prepared for NAVFAC Pacific.

Soma, M. (1985). Radio biotelemetry system applied to migratory study of turtle. Journal of the Faculty of Marine Science and Technology, 21, 47-56.

Southall B.L., Bowles A.E., Ellison W.T., Finneran J.J., Gentry R.L., Greene Jr. C.R., Kastak D., Ketten D.R., Miller J.H., Nachtigall P.E., Richardson W.J., Thomas J.A., Tyack P.L. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals 33:411-521.

Southwood, A. L., Andrews, R. D., Lutcavage, M. E., Paladino, F. V., West, N. H., George, R. H. & Jones, D. R. (1999). Heart rates and diving behavior of leatherback sea turtles in the eastern Pacific Ocean. Journal of Experimental Biology, 202, 1115-1125.

Spotila, J. R., Dunham, A. E., Leslie, A. J., Steyermark, A. C., Plotkin, P. T. & Paladino, F. V. (1996). Worldwide population decline of Dermochelys coriacea: Are leatherback turtles going extinct? Chelonian Conservation and Biology, 2(2), 209-222.

Spotila, J. R., Reina, R. D., Steyermark, A. C., Plotkin, P. T. & Paladino, F. V. (2000). Pacific leatherback turtles face extinction. Nature, 405, 529-530.

Stancyk, S. E. (1982). Non-human predators of sea turtles and their control. In K. A. Bjorndal (Ed.), Biology and Conservation of Sea Turtles (pp. 139-152). Washington, DC: Smithsonian Institution Press.

Stanley, K. M., Stabenau, E. K. & Landry, A. M. (1988). Debris ingestion by sea turtles along the Texas coast. In Proceedings of the Eighth Annual Workshop on Sea Turtle Conservation and Biology, 24-26 February 1988, Fort Fisher, North Carolina. (NOAA Technical Memorandum NMFS-SEFC-214, pp. 119-121) U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Starbird, C. H., Baldridge, A. & Harvey, J. T. (1993). Seasonal occurrence of leatherback sea turtles (Dermochelys coriacea) in the Monterey Bay region, with notes on other sea turtles, 1986-1991. California Fish and Game, 79(2), 54-62.

Steiner, T. & Walder, R. (2005). Two records of live olive ridleys from central California, USA. Marine Turtle Newsletter, 107, 9-10. Retrieved from http://www.seaturtle.org/mtn/archives/mtn107/mtn107p9.shtml

Stinson, M. L. (1984). Biology of Sea Turtles in San Diego Bay, California, and in the Northeastern Pacific Ocean. San Diego State University, San Diego, CA.

Storch, S., Wilson, R. P., Hillis-Starr, Z. M. & Adelung, D. (2005). Cold-blooded divers: temperature-dependent dive performance in the wild hawksbill turtle Eretmochelys imbricata. Marine Ecology Progress Series, 293, 263-271.

Suarez, A., Dutton, P. H. & Bakarbessy, J. (2000). Leatherback (Dermochelys coriacea) nesting on the north Vogelkop coast of Irian Jaya, Indonesia. In H. Kalb and T. Wibbels (Eds.), Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation [Abstract]. (NOAA Technical Memorandum NMFS-SEFSC-443, pp. 260) U.S. Department of Commerce, National Oceanic and Atmospheric Administration and National Marine Fisheries Service.

Tomás, J., Guitart, R., Mateo, R. & Raga, J. A. (2002). Marine debris ingestion in loggerhead sea turtles, Caretta caretta, from the Western Mediterranean. Marine Pollution Bulletin, 44, 211-216.

Turtle Expert Working Group. (2007). An Assessment of the Leatherback Turtle Population in the Atlantic Ocean. (NOAA Technical Memorandum NMFS-SEFSC-555, pp. 116) U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service and Southeast Fisheries Science Center.

U.S. Department of the Navy. (1996). Environmental Assessment of the Use of Selected Navy Test Sites for Development Tests and Fleet Training Exercises of the MK 48 Torpedoes. Program Executive Office Undersea Warfare: Program Manager for Undersea Weapons.

U.S. Department of the Navy. (2001a). Integrated Natural Resources Management Plan: Pacific Missile Range Facility Hawaii [Final Report]. (pp. 376). Honolulu, Hawaii. Prepared by Belt Collins Hawaii Ltd. Prepared for Commander, Navy Region Hawaii.

U.S. Department of the Navy. (2001b). Pearl Harbor Naval Complex Integrated Natural Resources Management Plan. [Final Report]. (pp. 434). Honolulu, Hawai'i. Prepared by Helber Hastert & Fee Planners. Prepared for Commander Navy Region Hawaii.

U.S. Department of the Navy. (2002). Environmental Assessment for the Hawaiian Islands Shallow Water Training Range [Final Report]. Pearl Harbor, Hawaii. Prepared by Commander in Chief U.S. Pacific Fleet.

U.S. Department of the Navy. (2011). Silver Strand Training Complex Final EIS.

U.S. Department of the Navy & San Diego Unified Port District. (2011). San Diego Bay Integrated Natural Resources Management Plan, September 2011. (pp. 674). San Diego, CA. Prepared by T. D. Systems. Prepared for the U.S. Department of the Navy, Southwest Division and San Diego Unified Port District, San Diego, California by Tierra Data Systems, Escondido, California.

Van Dam, R. P. & Diez, C. E. (1996). Diving behavior of immature hawksbills (Eretmochelys imbricata) in a Caribbean cliff-wall habitat. Marine Biology, 127, 171-178.

Viada S.T., Hammer R.M., Racca R., Hannay D., Thompson M.J., Balcom B.J., Phillips N.W. (2008). Review of Potential Impacts to Sea Turtles from Underwater Explosive Removal of offshore Structures. Environmental Impact Assessment Review 28:267-285.

Wallace, B. P., Lewison, R. L., McDonald, S. L., McDonald, R. K., Kot, C. Y., Kelez, S., & Crowder, L. B. (2010). Global patterns of marine turtle bycatch. Conservation Letters, 3(3), 131-142. doi: 10.1111/j.1755-263X.2010.00105.x

Ward, W. D., Glorig, A., & Sklar, D. L. (1958). Dependence of temporary threshold shift at 4 kc on intensity and time. Journal of the Acoustical Society of America, 30, 944-954.

Ward, W. D., Glorig, A., & Sklar, D. L. (1959). Temporary threshold shift from octave-band noise: Applications to damage-risk criteria. Journal of the Acoustical Society of America, 31, 522-528.

Wartzok D., Ketten D.R. (1999). Marine Mammal Sensory Systems, in: J. E. Reynolds III and S. A. Rommel (Eds.), Biology of Marine Mammals, Smithsonian Institution Press, Washington, D.C. pp. 117-175.

Weir, C. (2007). Observations of Marine Turtles in Relation to Seismic Airgun Sound off Angola. *Marine Turtle Newsletter 116*: 17-20.

Wever E.G. (1978). The Reptile Ear: Its Structure and Function Princeton University Press, Princeton, New Jersey.

Witherington, B. & Hirama, S. (2006). Sea turtles of the epi-pelagic sargassum drift community. In M. Frick, A. Panagopoulou, A. F. Rees and K. Williams (Eds.), Book of Abstracts. Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation (Abstract, pp. 209). Athens, Greece: International Sea Turtle Society.

Witt, M. J., Hawkes, L. A., Godfrey, M. H., Godley, B. J. & Broderick, A. C. (2010). Predicting the impacts of climate change on a globally distributed species: the case of the loggerhead turtle. Journal of Experimental Biology, 213(6), 901-911. doi: 10.1242/jeb.038133

Witzell, W. N. (1983). Synopsis of Biological Data on the Hawksbill Turtle Eretmochelys imbricate (Linnaeus, 1766). (FAO Fisheries Synopsis 137, pp. 78). Rome, Italy: Food and Agriculture Organization of the United Nations.

Wood, F., & J. Wood. (1993). Release and recapture of captive-reared green sea turtles, Chelonia mydas, in the waters surrounding the Cayman Islands. Herpetological Journal 3:84-89.

Wyneken J. (2001). The Anatomy of Sea Turtles, The Anatomy of Sea Turtles [Technical Memorandum]. (National Oceanic and Atmospheric Administration Technical Memorandum NMFS-SEFSC-470, pp. 172) U.S. Department of Commerce. pp. 172.

Yelverton J.T., Richmond D.R., Fletcher E.R., Jones R.K. (1973). Safe distances from underwater explosions for mammals and birds, Lovelace Foundation for Medical Education and Research, Albuquerque, New Mexico. pp. 66.

Yelverton J.T., Richmond D.R., Hicks W., Saunders K., Fletcher E.R. (1975). The Relationship Between Fish Size and Their Response to Underwater Blast, in: Defense Nuclear Agency (Ed.), Lovelace Foundation for Medical Education and Research, Washington, D.C. pp. 40.

Yelverton, J.T. & Richmond D.R. (1981). Underwater Explosion Damage Risk Criteria for Fish, Birds, and Mammals, 102nd Meeting of the Acoustical Society of America Journal of the Acoustical Society of America, Miami Beach, Florida. pp. S84.

Yudhana, A., Din, J., Sundari, A.S., & Hassan, R.B.R. (2010). Green turtle hearing identification based on frequency spectral analysis. *Applied Physics Research 2,* 125-134.

Zenteno, M., Herrera, M., Barragan, A. & Sarti, L. (2008). Impact of Different Kinds and Times of Retention in Olive Ridley's (Lepidochelys olivacea) Hatchlings in Blood Glucose Levels. Presented at the Twnety-Seventh Annual Symposium on Sea Turtles, Myrtle Beach, South Carolina.

Zug, G. R., Chaloupka, M. & Balazs, G. H. (2006). Age and growth in olive ridley sea turtles *(Lepidochelys olivacea*) from the North-central Pacific: a skeletochronological analysis. *Marine Ecology, 27*, 263-270. doi: 10.1111/j.1439-0485.2006.00109.x

Zug, G. R. & Parham, J. F. (1996). Age and growth in leatherback turtles *Dermochelys coriacea* (Testudines: Dermochelyidae): a skeletochronological analysis. *Chelonian Conservation and Biology*, 2(2), 244-249.

3.6 Seabirds

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3.6 SEABIRDS

SEABIRDS SYNOPSIS

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

- Acoustic (sonar and other active acoustic sources, underwater explosives, pile driving, swimmer defense airguns, vessel noise, and aircraft noise)
- Energy (electromagnetic devices)
- Physical disturbance and strike (aircraft, vessels and in-water devices, and military expended materials)
- Ingestion (munitions, military expended materials other than munitions)
- Secondary

Preferred Alternative (Alternative 2)

- Acoustics: Pursuant to the Endangered Species Act (ESA), the use of sonar and other active acoustic sources, explosives, swimmer defense airguns, and aircraft noise may affect but is not likely to adversely affect ESA-listed seabirds. Pile driving may affect but is not likely to adversely affect California least terns and would have no effect on other ESA-listed seabirds. Vessels would have no effect on ESA-listed seabirds. Acoustic sources would have no effect on critical habitat.
- Energy: Pursuant to the ESA, the use of electromagnetic devices may affect but is not likely to adversely affect ESA-listed seabirds. Energy sources would have no effect on critical habitat.
- Physical Disturbance and Strike: Pursuant to the ESA, the use of aircraft, vessels and in-water devices, and military expended materials may affect but is not likely to adversely affect ESA-listed seabirds. Physical disturbance and strike sources would have no effect on critical habitat.
- Ingestion: Pursuant to the ESA, the potential for ingestion of military expended materials may affect but is not likely to adversely affect ESA-listed seabirds.
- Secondary: Pursuant to the ESA, secondary stressors may affect but are not likely to adversely affect ESA-listed seabirds. Secondary stressors would not affect critical habitat.

3.6.1 INTRODUCTION

This chapter provides the analysis of potential impacts on seabirds that are found in the Hawaii-Southern California Training and Testing (HSTT) Study Area (Study Area). This section provides an introduction to the species and taxonomic groups that occur in the Study Area. Section 3.6.2 provides detailed information on the baseline affected environment. The complete analysis and summary of potential impacts of the proposed action on seabirds are found in Sections 3.6.3 and 3.6.4 through 3.6.6, respectively.

Seabirds are found throughout the Study Area. This section introduces the Endangered Species Act (ESA)-listed species, the major taxonomic groups of seabirds that occur in the Study Area, species protected under the Migratory Bird Treaty Act, and United States (U.S.) Fish and Wildlife Service Birds of Conservation Concern, and a general description of major species groups of seabirds in the Study Area.

3.6.1.1 Endangered Species Act Species

Five seabird species that occur in the Study Area are listed under the ESA as endangered or threatened species. Additionally, three seabird species are listed under the ESA as candidates for listing. The status, presence, and nesting occurrence of ESA-listed and candidate seabirds in the Study Area are listed in Table 3.6-1. These species will be further discussed in detailed species profiles (Section 3.6.1.4, United States Fish and Wildlife Service Birds of Conservation Concern).

Table 3.6-1: Endangered Species Act Listed Seabird Species Found in the Study Area

Species Name and Regulatory Status[1]			Presence in Study Area[2]		
Common Name	**Scientific Name**	**Endangered Species Act-Listing**	**Open Ocean Area**	**Large Marine Ecosystem**	**Bays, Estuaries, and Rivers**
California least tern	*Sterna antillarum browni*	Endangered	None	California Current (nesting)	San Diego Bay
Hawaiian petrel	*Pterodroma sandwichensis*	Endangered	North Pacific Subtropical Gyre	Insular Pacific-Hawaiian (nesting)	None
Short-tailed albatross	*Phoebastria albatrus*	Endangered	North Pacific Subtropical Gyre	California Current, Insular Pacific-Hawaiian	None
Marbled murrelet	*Brachyramphus marmoratus*	Threatened	None	California Current	None
Newell's shearwater	*Puffinus auricularis newelli*	Threatened	North Pacific Subtropical Gyre	Insular Pacific-Hawaiian (nesting)	None
Band-rumped Storm Petrel	*Oceanodroma castro*	Candidate	North Pacific Subtropical Gyre	Insular Pacific-Hawaiian (nesting)	None
Guadalupe Murrulet	*Synthliboramphus hypoleucus*	Candidate	None	California Current (nesting)	None
Scripps's Murrelet	*Synthliboramphus scrippsi*	Candidate	None	California Current (nesting)	None

[1] Endangered Species Act listing status
[2] Presence in the Study Area indicates open ocean areas (North Pacific Subtropical Gyre) and coastal waters of large marine ecosystems (California Current, Insular Pacific-Hawaiian) in which the species are found. Nesting in the Study Area is indicated in parentheses.

3.6.1.2 Major Bird Groups

There are three major taxonomic groups of seabirds represented in the Study Area (Table 3.6-2). These seabirds may be found in air, at the water's surface, or in the water column of the Study Area. The vertical distribution descriptions provided in Table 3.6-2 are meant to provide a representative description of the taxonomic group; however, due to variations in species behavior, may not apply to all species within each group. Distribution in the water column is indicative of a species that is known to dive under the surface of the water (for example, during foraging). More detailed species descriptions, including diving behavior, are provided in Sections 3.6.2.13 (Order Procellariiformes), 3.6.2.14 (Order Pelecaniformes), and 3.6.2.15 (Order Charadriiformes).

All three major groups of seabirds in the Study Area occur either in open-ocean areas (North Pacific Subtropical Gyre and North Pacific Transition Zone) or coastal waters of large marine ecosystems (California Current and Insular Pacific-Hawaiian) or coastal bays or estuaries (San Diego Bay) (see map of the Study Area in Figure 3.0-1).

3.6.1.3 Migratory Bird Treaty Act Species

A variety of seabird species would be encountered in the Study Area including those listed under the Migratory Bird Treaty Act (U.S. Fish and Wildlife Service 2010b). The Migratory Bird Treaty Act

established federal responsibilities for protecting nearly all migratory species of seabirds, eggs, and nests. Migratory bird means any bird, whatever its origin and whether or not raised in captivity, which belongs to a species listed in Section 10.13 of the Migratory Bird Treaty Act, or which is a mutation or a hybrid of any such species, including any part, nest, or egg of any such bird, or any product, whether or not manufactured, which consists, or is composed in whole or part, of any such bird or any part, nest, or egg thereof. Bird migration is defined as the periodic seasonal movement of birds from one geographic region to another, typically coinciding with available food supplies or breeding seasons. Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 Code of Federal Regulations [C.F.R.] Part 21), the U.S. Fish and Wildlife Service has promulgated a rule that authorizes the incidental take of migratory seabirds under certain circumstances (see Section 3.0.1, Regulatory Framework). Of the 1,007 species protected under the Migratory Bird Treaty Act, 105 species occur in the Study Area. These species are not analyzed individually, but rather are grouped based on taxonomic or behavioral similarities based on the stressor that is being analyzed. Conclusions of potential impacts on species protected under the Migratory Bird Treaty Act are presented at the conclusion of each stressor subsection as well as in Section 3.6.4 (Summary of Potential Impacts [Combined Impacts of All Stressors] on Seabirds).

Table 3.6-2: Descriptions and Examples of Major Taxonomic Groups within the Study Area

Major Bird Groups[1]		Vertical Distribution in the Study Area		
Common Name (Taxonomic Group)	**Description**	**Open Ocean Areas[2]**	**Large Marine Ecosystem[2]**	**Bays, Estuaries, and Rivers**
Albatrosses, petrels, shearwaters, and storm-petrels (Order Procellariiformes)	Group of largely pelagic seabirds, fly nearly continuously when at sea, soar low over the water surface to find prey, some species dive below the surface.	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column
Tropicbirds, boobies, pelicans, cormorants, and frigatebirds (Order Pelecaniformes)	Diverse group of large, fish-eating seabirds with four toes joined by webbing, often occur in large flocks near high concentrations of bait fish.	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column
Phalaropes, gulls, noddies, terns, skua, jaegers, and alcids (Order Charadriiformes)	Diverse group of small to medium sized shorebirds, seabirds and allies inhabiting coastal, nearshore, and open-ocean waters	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column

[1] Major taxonomic groups based on American Ornithologists' Union (American Ornithologists' Union 1998), Sibley (Sibley 2000).
[2] Presence in the Study Area includes open ocean areas (North Pacific Subtropical Gyre and North Pacific Transition Zone) and coastal waters of two Large Marine Ecosystems (California Current and Insular Pacific-Hawaiian).

3.6.1.4 United States Fish and Wildlife Service Birds of Conservation Concern

Birds of Conservation Concern are species, subspecies, and populations of migratory and nonmigratory birds that the U.S. Fish and Wildlife Service has determined to be the highest priority for conservation actions (U.S. Fish and Wildlife Service 2008a). The purpose of the Birds of Conservation Concern list is to prevent or remove the need for additional ESA bird listings by implementing proactive management and conservation actions needed to conserve these species. Of the 105 species that occur within the Study Area, 13 are considered Birds of Conservation Concern (Table 3.6-3). These species are not analyzed individually, but rather are grouped by taxonomic or behavioral similarities based on the stressor that is being analyzed.

Table 3.6-3: Migratory Bird Treaty Act Species and Birds of Conservation Concern within the Study Area

Family/Subfamily	Common Name	Scientific Name	Birds of Conservation Concern
Order PROCELLARIIFORMES			
Family DIOMEDEIDAE			
	Laysan albatross	*Phoebastria immutabilis*	X
	Black-footed albatross	*Phoebastria nigripes*	X
	Short-tailed albatross	*Phoebastria albatrus*	
Family PROCELLARIIDAE			
	Northern fulmar	*Fulmarus glacialis*	
	Kermadec petrel	*Pterodroma neglecta*	
	Murphy's petrel	*Pterodroma ultima*	
	Mottled petrel	*Pterodroma inexpectata*	
	Juan Fernandez petrel	*Pterodroma externa*	
	Hawaiian petrel	*Pterodroma sandwichensis*	
	White-necked petrel	*Pterodroma cervicalis*	
	Bonin petrel	*Pterodroma hypoleuca*	
	Black-winged petrel	*Pterodroma nigripennis*	
	Cook's petrel	*Pterodroma cookii*	
	Stejneger's petrel	*Pterodroma longirostris*	
	Phoenix petrel	*Pterodroma alba*	
	Tahiti petrel	*Pseudobulweria rostrata*	
	Bulwer's petrel	*Bulweria bulwerii*	
	Streaked shearwater	*Calonectris leucomelas*	
	Pink-footed shearwater	*Puffinus creatopus*	X
	Flesh-footed shearwater	*Puffinus carneipes*	
	Wedge-tailed shearwater	*Puffinus pacificus*	
	Buller's shearwater	*Puffinus bulleri*	
	Sooty shearwater	*Puffinus griseus*	
	Short-tailed shearwater	*Puffinus tenuirostris*	
	Christmas shearwater	*Puffinus nativitatis*	X
	Townsend's shearwater	*Puffinus auricularis*	
	Black-vented shearwater	*Puffinus opisthomelas*	X
Family HYDROBATIDAE			
	Wilson's storm-petrel	*Oceanites oceanicus*	
	Fork-tailed storm-petrel	*Oceanodroma furcata*	
	Leach's storm-petrel	*Oceanodroma leucorhoa*	
	Ashy storm-petrel	*Oceanodroma homochroa*	X
	Band-rumped storm-petrel	*Oceanodroma castro*	X
	Wedge-rumped storm-petrel	*Oceanodroma tethys*	
	Matsudaira's storm-petrel	*Oceanodroma matsudairae*	
	Black storm-petrel	*Oceanodroma melania*	
	Tristram's storm-petrel	*Oceanodroma tristrami*	X
	Least storm-petrel	*Oceanodroma microsoma*	

Table 3.6-3: Migratory Bird Treaty Act Species and Birds of Conservation Concern within the Study Area (continued)

Family/Subfamily	Common Name	Scientific Name	Birds of Conservation Concern
Order PELECANIFORMES			
Family PHAETHONTIDAE			
	Red-billed tropicbird	*Phaethon aethereus*	
	Red-tailed tropicbird	*Phaethon rubricauda*	
	White-tailed tropicbird	*Phaethon lepturus*	
Family SULIDAE			
	Masked booby	*Sula dactylatra*	
	Blue-footed booby	*Sula nebouxii*	
	Brown booby	*Sula leucogaster*	
	Red-footed booby	*Sula sula*	
Family PELECANIDAE			
	American white pelican	*Pelecanus erythrorhynchos*	
	California brown pelican	*Pelecanus occidentalis californicus*	
Family PHALACROCORACIDAE			
	Brandt's cormorant	*Phalacrocorax penicillatus*	
	Double-crested cormorant	*Phalacrocorax auritus*	
	Pelagic cormorant	*Phalacrocorax pelagicus*	
Family FREGATIDAE			
	Magnificent frigatebird	*Fregata magnificens*	
	Great frigatebird	*Fregata minor*	
Order CHARADRIIFORMES			
Family LARIDAE			
Subfamily LARINAE	Laughing gull	*Larus atricilla*	
	Franklin's gull	*Larus pipixcan*	
	Little gull	*Larus minutes*	
	Black-headed gull	*Larus ridibundus*	
	Bonaparte's gull	*Larus philadelphia*	
	Heermann's gull	*Larus heermanni*	
	Mew gull	*Larus canus*	
	Ring-billed gull	*Larus delawarensis*	
	California gull	*Larus californicus*	
	Herring gull	*Larus argentatus*	
Subfamily LARINAE	Thayer's gull	*Larus thayeri*	
	Slaty-backed gull	*Larus schistisagus*	
	Yellow-footed gull	*Larus livens*	
	Western gull	*Larus occidentalis*	
	Glaucous-winged gull	*Larus glaucescens*	
	Glaucous gull	*Larus hyperboreus*	
	Sabine's gull	*Xema sabini*	
	Black-legged kittiwake	*Rissa tridactyla*	

Table 3.6-3: Migratory Bird Treaty Act Species and Birds of Conservation Concern within the Study Area (continued)

Family/Subfamily	Common Name	Scientific Name	Birds of Conservation Concern
Subfamily STERNINAE	Blue noddy	*Procelsterna cerulea*	X
	Black noddy	*Anous minutus*	
	Brown noddy	*Anous stolidus*	
	White tern	*Gygis alba*	
	Sooty tern	*Onychoprion fuscatus*	
	Gray-backed tern	*Onychoprion lunatus*	
	Little tern	*Sternula albifrons*	
	California Least tern	*Sternula antillarum browni*	
	Caspian tern	*Hydroprogne caspia*	
	Black tern	*Chlidonias niger*	
	Common tern	*Sterna hirundo*	
	Arctic tern	*Sterna paradisaea*	
	Forster's tern	*Sterna forsteri*	
	Black-naped tern	*Sterna sumatrana*	
	Royal tern	*Thalasseus maximus*	
	Great Crested tern	*Thalasseus bergii*	
	Elegant tern	*Thalasseus elegans*	
	Gull-billed tern	*Sterna nilotica*	X
Subfamily RYNCHOPINAE	Black skimmer	*Rynchops niger*	X
Family STERCORARIIDAE			
	South polar skua	*Stercorarius maccormicki*	
	Pomarine jaeger	*Stercorarius pomarinus*	
	Parasitic jaeger	*Stercorarius parasiticus*	
	Long-tailed jaeger	*Stercorarius longicaudus*	
Family ALCIDAE			
	Common murre	*Uria aalge*	
	Thick-billed murre	*Uria lomvia*	
	Pigeon guillemot	*Cepphus columba*	
	Long-billed murrelet	*Brachyramphus perdix*	
	Marbled murrelet	*Brachyramphus marmoratus*	
	Guadalupe murrelet	*Synthliboramphus hypoleucus*	X
	Scripps's murrelet	*Synthliboramphus scrippsi*	X
	Craveri's murrelet	*Synthliboramphus craveri*	
	Ancient murrelet	*Synthliboramphus antiquus*	
	Cassin's auklet	*Ptychoramphus aleuticus*	X
	Parakeet auklet	*Aethia psittacula*	
	Rhinoceros auklet	*Cerorhinca monocerata*	
	Horned puffin	*Fratercula corniculata*	
	Tufted puffin	*Fratercula cirrhata*	

3.6.2 AFFECTED ENVIRONMENT

Seabirds are a diverse group that are adapted to living in marine environments (Enticott and Tipling 1997) and use coastal (nearshore) waters, offshore waters (continental shelf), or open ocean areas (Harrison 1983). There are many biological, physical, and behavioral adaptations that are different for seabirds than for terrestrial birds. Seabirds typically live longer, breed later in life, and produce fewer young than other bird species (Onley and Scofield 2007). The feeding habits of seabirds are related to their individual physical characteristics, such as body mass, bill shape, and wing area (Hertel and Ballance 1999; Spear and Ainley 1998). Some seabirds look for food (forage) on the sea surface, whereas others dive to variable depths to obtain prey (Burger 2001). Many seabirds spend most of their lives at sea and come to land only to breed, nest, and occasionally rest (Schreiber and Chovan 1986). Most species nest in groups (colonies) on the ground of coastal areas or oceanic islands, where breeding colonies number from a few individuals to thousands.

The Hawaiian Islands are important habitat for seabirds in the North Pacific Subtropical Gyre. The shoreline, estuarine, and open ocean environments support a variety and large population of seabird species by providing important nesting and feeding habitats. The Hawaiian Islands are in the warm North Pacific water mass (U.S. Fish and Wildlife Service 2005b). Despite low levels of localized production, recent research estimates that 15 million seabirds inhabit the Hawaiian Islands; 22 species of seabirds regularly nest in the Hawaiian Islands, and many more pass through during migration to and from their breeding grounds elsewhere in the Pacific (Birding Hawaii 2004).

The entire world populations of Hawaiian petrels and Newell's shearwaters and more than 95 percent of the world's Laysan and black-footed albatrosses nest in the northwest Hawaiian Islands. Most of the world's ashy storm-petrels, western gulls, and Brandt's cormorants nest along the west coast of the United States (U.S. Fish and Wildlife Service 2005b). In addition to breeding seabirds, millions of seabirds from more than 100 different species migrate to or through the Study Area. For example, an estimated abundance of 5.5 to 6 million seabirds off California are thought to occur based on at-sea surveys (U.S. Fish and Wildlife Service 2005b). Surveys around the Hawaiian Islands found 40 different species of seabirds, half of which were local breeders and the remainder were migrant species.

The Southern California Bight, within the California Current Large Marine Ecosystem, is important for both breeding and migratory bird species. More than 195 species of birds use coastal or offshore aquatic habitats in the Southern California Bight—the area of the Pacific Ocean lying between Point Conception on the Santa Barbara County coast to a point south of the U.S.-Mexico border (Anderson et al. 2007; Bearzi et al. 2009; Hunt and Butler 1980).

The following sections contain profiles for ESA-listed and ESA-candidate species and species groups that occur in the Study Area. The emphasis on species-specific information is placed on the ESA-protected species list because any threats or potential impacts on those species are subject to consultation with regulatory agencies. Additional information on the biology, life history, and conservation of seabird species, including species-specific profiles, can be found on the following organizations' websites: U.S. Fish and Wildlife Service Endangered Species Program (2010a), Birdlife International (2010), and the International Union for Conservation of Nature and Natural Resources (2010). Sections 3.6.2.5 to 3.6.2.12 describe the taxonomic groups of ESA-listed and candidate seabird species in the Study Area.

3.6.2.1 Group Size

A variety of group sizes and diversity may be encountered throughout the Study Area, ranging from solitary migration of an individual seabird to large concentrations of mixed-species flocks. Depending on

season, location, and time of day, the number of seabirds observed (group size) will vary and will likely fluctuate from year to year. During spring and fall periods, diurnal and nocturnal migrants would likely occur in large groups as they migrate over open water. Most seabird species nest in groups (colonies) on the ground of coastal areas or oceanic islands, where breeding colonies number from a few individuals to thousands. This breeding strategy is believed to have evolved in response to the limited availability of relatively predator-free nesting habitats and distance to foraging sites from breeding grounds. (Siegel-Causey and Kharitonov 1990). Outside of the breeding season, most Proceliid (birds within the Order Procelliiformes) seabirds are solitary, though they may join mixed-species flocks while foraging and can be associated with whales and dolphins (Onley and Scofield 2007) or areas where prey density is high (U.S. Fish and Wildlife Service 2005c). During the breeding season, these seabirds usually form large nesting colonies. Similarly, Pelecaniform (birds within the Order Pelecaniformes) breeding, whether on the ground or in trees, is typically colonial. Foraging occurs either singly or in small groups. Foraging seabirds of the order Charadriiformes can range from singles or pairs (murrelets) (International Union for the Conservation of Nature 2010f; U.S. Fish and Wildlife Service 2005b) and can extend upward into larger groups (terns) where juveniles accompany adults to post-breeding foraging areas, where the water is calm and the food supply is good. There are post-season dispersal sites, where adults and fledglings congregate (U.S. Fish and Wildlife Service 2006). Large groups are occasionally observed foraging at great distances from colonies, including at inland water sources (Atwood and Minsky 1983).

3.6.2.2 Diving Information

Most of the seabird species found with the Study Area will dive, skim, or grasp prey at the water's surface or within the upper portion (1 to 2 meters [m] [3.3 to 6.6 feet {ft.}]) of the water column (Sibley 2007). Foraging strategies are species specific such as plunge-diving or pursuit diving. Plunge-diving, as utilized by terns and pelicans, is a foraging strategy in which the bird hovers over the water and dives into the water to pursue fish. Diving behavior in terns is limited to plunge-diving during foraging (U.S. Fish and Wildlife Service 1985) and in general, tern species do not usually dive deeper than 3 ft. (0.9 m). Pursuit divers, a common foraging strategy of seabirds of the Family Alcidae, usually float on the water and dive under to pursue fish and other prey. They most commonly eat fish, squid, and crustaceans (Burger 2004).

Petrels forage both night and day; they capture prey by resting on the water surface and dipping their bill and by aerial pursuit of flying fish (International Union for the Conservation of Nature 2010d). Hawaiian petrels eat mostly squid (50–75 percent of their diet), fish, and crustaceans (International Union for the Conservation of Nature 2010d).

More specific diving information in regard to taxonomic groups is provided in Sections 3.6.2.13 (Order Procellariiformes), 3.6.2.14 (Order Pelecaniformes) and 3.6.2.15 (Order Charadriiformes).

3.6.2.3 Bird Hearing

The majority of the published literature on bird hearing focuses on terrestrial birds and their ability to hear in air as there is a paucity of data regarding underwater hearing abilities (Melvin and Parrish 1999). A review of 32 terrestrial and marine species indicates that birds generally have greatest hearing sensitivity between 1 and 4 kilohertz (kHz) (see Beason 2004). Very few can hear below 20 hertz (Hz), most have an upper frequency hearing limit of 10 kHz, and none exhibit hearing at frequencies higher than 20 kHz (Dooling et al. 2000). Thiessen (1958) reported the lower hearing threshold for the ring-billed gull (*Larus delawarensis*) of 2 kHz. Starlings (*Sturnus vulgais*) and house sparrows (*Passer domesticus*) have reported hearing ranges of 0.2–18 kHz (Brand and Kellogg 1939) while the hearing range of pigeons (*Columba livia*) is 0.1 to 10 kHz (Necker 1983). Hearing capabilities have been studied

for only a few seabirds (Beason 2004, Beuter et al. 1986, Thiessen 1958, Wever et al. 1969); these studies show that seabird hearing ranges and sensitivity are consistent with what is known about bird hearing in general.

There is little published literature on the hearing abilities of birds underwater. In fact, there are no measurements of the underwater hearing of any diving birds (Therrien et al. 2011). There are some studies of bird behavior underwater when exposed to sounds, from which some hearing abilities of birds underwater could be inferred. Common murres (*Uria aalge*) were deterred from gillnets by acoustic pingers emitting 1.5 kHz pings at 120 decibels (dB) referenced (re) to 1 microPascal (µPa); however, there was no significant reduction in rhinoceros auklet (*Cerorhinca monocerata*) bycatch in the same nets (Melvin et al. 1999).

3.6.2.4 General Threats

Threats to seabird populations in the Study Area include human-caused stressors such as incidental mortality from interactions with commercial and recreational fishing gear, predation by introduced species, disturbance and degradation of nesting areas by humans and domesticated animals, noise pollution from construction and other human activities, nocturnal collisions with power lines and artificial lights, collisions with aircraft, and pollution, such as that from oil spills and plastic debris (Anderson et al. 2007; Burkett et al. 2003; California Department of Fish and Game 2010; Carter and Kuletz 1995; Carter et al. 2005; Clavero et al. 2009; International Union for Conservation of Nature and Natural Resources 2010; North American Bird Conservation Initiative 2010; Piatt and Naslund 1995; U.S. Fish and Wildlife Service 2005b, 2008a, 2010a). Disease, volcanic eruptions, storms, and harmful algal blooms are also threats to seabirds (Anderson et al. 2007; Jessup et al. 2009; North American Bird Conservation Initiative 2010; U.S. Fish and Wildlife Service 2005b). In addition, seabird distribution, abundance, breeding, and other behaviors are affected by cyclical environmental events, such as the El Niño Southern Oscillation and Pacific Decadal Oscillation in the Pacific Ocean (Vandenbosch 2000).

In the long term, climate change could be the largest threat to seabirds (North American Bird Conservation Initiative 2010). Climate change effects include changes in air and sea temperatures, precipitation, the frequency and intensity of storms, pH level of sea water, and sea level. These changes could affect overall marine productivity, which could affect the food resources, distribution, and reproductive success of seabirds (Aebischer et al. 1990; Congdon et al. 2007). The projection for global sea levels rise from 2090 to 2099 is up to 1 ft. (0.3 m) relative to 1980–1999 levels (Church and White 2006; Solomon et al. 2007). As a result, seabird nesting colonies that occur along sections of coastlines undergoing sea level rise may experience a loss of nesting habitat (Congdon et al. 2007; Gilman and Ellison 2009; Gilman et al. 2008; Hitipeuw et al. 2007; Mullane and Suzuki 1997).

3.6.2.5 California Least Tern (*Sternula antillarum browni*)

3.6.2.5.1 Status and Management

The California least tern (*Sternula antillarum browni*) was federally listed as endangered in 1970 and is listed as endangered by the state of California (California Department of Fish and Game 2010). In 2006, the U.S. Fish and Wildlife Service completed the most recent 5-year status review for the species and recommended that the California least tern be downlisted to threatened under the ESA. The population increased from 600 pairs in 1973 to approximately 7,100 pairs in 2005, and least tern nesting sites have nearly doubled since the species was first listed (U.S. Fish and Wildlife Service 2006). In 2007, an estimated 6,744 to 6,989 California least tern breeding pairs established nests at 48 locations in

California (Marschalek 2008); however, the species' population increase does not meet the requirements in the 1985 recovery plan to warrant delisting.

No critical habitat has been designated for the California least tern. Conservation for the California least tern is addressed in multiple memoranda of understanding and integrated natural resource management plans for military lands in the Southern California region, including Marine Corps Base Camp Pendleton, Naval Amphibious Base Coronado (U.S. Department of the Navy 2002), and Naval Base Ventura County Point Mugu.

3.6.2.5.2 Habitat and Geographic Range

The preferred nesting habitat consists of beaches, dunes, and sand bars on the ocean shore (U.S. Fish and Wildlife Service 1985). The California least tern nests in areas generally free of vegetation above the high tide mark. Colony sites are often near estuaries, lagoons, rivers, or the seacoast (U.S. Fish and Wildlife Service 1985). Atwood and Minsky (1983) noted that before the decline of the species, at least 82 percent of known nesting sites in California were within 1 mile (mi.) (1.6 kilometers [km]) of a river mouth or estuarine habitat.

California least terns spend the breeding season (April through August) in coastal waters along the central and Southern California coast, as well as along the west and southwestern coast of Mexico. Their distribution is from San Francisco to Baja California on the Pacific Coast of North America (U.S. Fish and Wildlife Service 2010b). The California least tern historically nested on coastal beaches of Monterey, California, to Cabo San Lucas, Baja California.

Foraging habitats include nearshore ocean waters, bays, river mouths, salt marshes, marinas, river channels, lakes, and ponds (Thompson et al. 1997). California least terns feed within 2 mi. (3.2 km) of the shoreline in ocean waters less than 60 ft. (18.3 m) deep, with most foraging within 1 mi. (1.6 km) of shore (Atwood and Minsky 1983). Atwood and Minsky (1983) also observed a tendency for foraging birds to be concentrated in coastal waters near major river mouths. Foraging habitat use varies within and between years, depending on the stage of breeding and prey availability (Atwood and Minsky 1983, BirdLife International 2009). Atwood and Minsky (1983) noted in their coastal colony study that, before terns disperse after breeding, they typically forage within 2 mi. (3.2 km) of nesting sites, although large groups were occasionally observed foraging at greater distances from colonies, including inland water sources. The presence of eelgrass is important because it is habitat for several prey species of the least tern such as topsmelt, one of the California least terns' preferred prey (BirdLife International 2009).

3.6.2.5.2.1 California Current Large Marine Ecosystem

California least terns occur in coastal waters throughout the Southern California portion of the Study Area during the breeding, non-breeding, and migration seasons. The current nesting range is from San Francisco Bay and south along the California coast to San Diego County which includes the Southern California portion of the Study Area in the California Current Large Marine Ecosystem and parts north of the Study Area (Massey and Fancher 1989). During migration, California least terns remain near the coast, although they have been observed foraging in multispecies feeding flocks 1–20 mi. (1.6–32.2 km) off the western coast of Baja California in late April and early May (U.S. Fish and Wildlife Service 2005b). The California least tern can be found in more offshore waters during the breeding season (courtship and incubation stages) when they forage farther from the nest site over open and deep water. Adults tend to travel farther when food availability is low, foraging in open ocean waters (BirdLife International 2009).

3.6.2.5.3 Population and Abundance

The California least tern population in California averaged about 4,300 pairs between 2000 and 2002, making up about 10 percent of the North American population (U.S. Fish and Wildlife Service 2005b). The California population has increased almost 12-fold from a low of 600 pairs in the early 1970s to roughly 7,100 pairs in 2005 (U.S. Fish and Wildlife Service 2001, 2005b).

3.6.2.5.4 Predator and Prey Interactions

California least terns forage by plunge-diving to catch prey in upper surface waters, usually within the first meter of water depth. In general, other tern species do not usually dive deeper than 3 ft. (0.9 m) (Eriksson 1985). No information exists on specific dive depths for California least terns. Prey species include anchovies, topsmelt, silverside smelt, opaleye, and gobies (BirdLife International 2009). Prey species composition varies throughout the year, depending on availability. Length of foraging and peak foraging behavior typically occur from the end of May through mid-July after chicks hatch.

California least terns are preyed upon by various species; these include gulls, ravens, crows, rodents, raccoons, and coyotes, which prey upon tern eggs, chicks, and adults (U.S. Fish and Wildlife Service 2006).

3.6.2.5.5 Species-Specific Threats

Threats to breeding least terns include the alteration of river habitat, flooding and development of coastal areas, disruptive recreation, an increase in aggressive gulls that compete for nesting sites, and predation by native and feral species, such as rats, great horned owls, black-crowned night herons, dogs, and cats (Sidle et al. 1992; U.S. Fish and Wildlife Service 1990). Oil pollution is also a concern within coastal and inland habitats.

3.6.2.6 Hawaiian Petrel (*Pterodroma sandwichensis*)

The Hawaiian petrel (*Pterodroma sandwichensis*) was recently split from the Galapagos petrel (*Pterodroma phaeopygia*) based on genetic and morphological evidence; before the split they were collectively known as the dark-rumped petrel (U.S. Fish and Wildlife Service 2005a).

3.6.2.6.1 Status and Management

The Hawaiian petrel is found only in Hawaii and is listed as endangered throughout its range under the ESA (U.S. Fish and Wildlife Service 2005a); there is no designated critical habitat. The greatest threat to adult survival and breeding success is predation by introduced animals, such as mongooses, cats, and rats. In some cases, predation has caused more than 70 percent nesting failure (U.S. Fish and Wildlife Service 2005a).

3.6.2.6.1.1 Habitat and Geographic Range

Hawaiian petrels nest only in Hawaii, specifically in the main Hawaiian Islands, though there are specimen records from Japan, Philippines, and Mollucas at the western edge of the distribution (International Union for the Conservation of Nature 2010d). Under pressure of predation, most nesting habitat is at the highest elevations available in the main Hawaiian Islands. Most sites (Haleakala National Park in Maui and Mauna Kea, Mauna Loa, and Kilauea in Hawaii) are characterized by high elevation (6,560–9,840 ft. [1,999.5–2,999.2 m]), dry climate, and sparse vegetation (less than 10 percent plant cover). Nesting habitat is poorly known on other islands. The Hawaiian petrel is present throughout the offshore waters of the Hawaiian Islands (International Union for the Conservation of Nature 2010d).

The Hawaiian petrel typically feeds well offshore but tends to feed closer to shore (0–45 mi. [0–72.4 km]) during spring than in the fall (most abundant at 170–230 mi. [273.6–370.1 km]) (Spear et al. 1999). The Hawaiian petrel favors open ocean water conditions, with an average sea surface temperature of 80 degrees (°) Fahrenheit (F) (27° Celsius [C]), sea surface salinity of 34 parts per thousand, wind speed of 19 mi. per hour (30.6 km per hour), and a wave height of 5 ft. (1.5 m). It also prefers an average depth from the warmer surface water to the point where cold water begins (the thermocline) of 35 ft. (10.7 m) (Spear et al. 1995).

The Hawaiian petrel is an open ocean species of the central tropical Pacific (U.S. Fish and Wildlife Service 2005a). They occur in open ocean waters throughout most of the Hawaii portion of the Study Area and the western portion of the Transit Corridor in the Insular Pacific-Hawaiian Large Marine Ecosystem. The Hawaiian petrel occurs largely in equatorial waters of the eastern tropical Pacific, generally from 10° South (S) to 20° North (N). Because of the difficulty in identification, the precise southeastern extent of the Hawaiian petrel and the northwestern extent of the similar Galapagos petrel remains uncertain (Spear et al. 1995).

3.6.2.6.1.2 Insular Pacific-Hawaiian Large Marine Ecosystem

Hawaiian petrels have important resting sites in coastal waters throughout the Hawaii portion of the Study Area in portions of the Insular Pacific-Hawaiian Large Marine Ecosystem. An area of the north shore of Kauai is widely known as a resting location for Hawaiian petrels (Birding Hawaii 2004). Based on known or suspected colony sites, gathering areas likely occur near shore on Lehua Rock, Kauai, Molokai, Lanai, Maui, and Hawaii (Day and Cooper 1995; Day et al. 2003; International Union for the Conservation of Nature 2010d; U.S. Fish and Wildlife Service 2005a) and perhaps around Kahoolawe (U.S. Fish and Wildlife Service 2005a). These areas provide resting habitat before the birds fly to inland nesting colonies. Hawaiian petrels move to and from nesting colonies during dusk and dawn (International Union for the Conservation of Nature 2010d).

3.6.2.6.2 Population and Abundance

The total population of Hawaiian petrels was estimated at 20,000, with a breeding population of 4,500–5,000 pairs (Spear et al. 1995; U.S. Fish and Wildlife Service 2005a); overall population trends on the Hawaiian islands are not known (U.S. Fish and Wildlife Service 2005a). Numbers of breeding Hawaiian petrels on Maui appear stable and have increased in areas of the Haleakala National Park, where predators are being managed (U.S. Fish and Wildlife Service 2005a). On Hawaii, numbers may be declining because of predation by introduced species (U.S. Fish and Wildlife Service 2005a).

3.6.2.6.3 Predator and Prey Interactions

Hawaiian petrels eat mostly squid (50 to 75 percent of their diet), fish, and crustaceans (International Union for the Conservation of Nature 2010d). They forage both night and day; they capture prey by resting on the water surface and dipping their bill and by aerial pursuit of flying fish (International Union for the Conservation of Nature 2010d). The foraging member of a pair may fly up to 930 mi. (1,496.7 km) from the nesting island (U.S. Fish and Wildlife Service 2005a).

Adult and young Hawaiian petrels are preyed on by introduced animals such as mongooses, cats, and rats.

3.6.2.6.4 Species-Specific Threats

Threats to this endangered seabird include predation by introduced mammals, development, light attraction and collision, ocean pollution, and disturbance of its breeding grounds. The petrel does not have any natural defenses against predators such as rats, feral cats, and mongooses, and its burrows are very vulnerable. Collisions with artificial lights, utility poles, and fences kill Hawaiian petrels on some islands (International Union for the Conservation of Nature 2010d).

3.6.2.7 Short-tailed Albatross (*Phoebastria albatrus*)

The short-tailed albatross (*Phoebastria albatrus*) was formerly in the genus *Diomedea* and known as Steller's albatross; it is the largest of the North Pacific albatrosses.

3.6.2.7.1 Status and Management

The short-tailed albatross is widely regarded as one of the rarest species of albatrosses and one of the world's rarest birds (Harrison 1983; International Union for the Conservation of Nature 2010c). The short-tailed albatross is listed as endangered under the ESA throughout its range. Additionally, it is listed as endangered by the state of Hawaii (NatureServe 2004; U.S. Fish and Wildlife Service 2000, 2005b). No critical habitat has been designated for this species because little is known about its life in the open ocean (Piatt et al. 2006; U.S. Fish and Wildlife Service 2000).

3.6.2.7.2 Habitat and Geographic Range

Short-tailed albatrosses are typically found in the open ocean and tend to concentrate along the edge of the continental shelf (NatureServe 2004). Upwelling zones are not only nutrient rich, but they also bring prey (for example, squid and fish) typically found only in deeper water to the surface, where they become available to albatrosses. Upwelling occurs when the wind moves warm, nutrient poor water away from the area, which allows colder, nutrient rich water to rise to the surface of the ocean. Short-tailed albatross nest on isolated, windswept, offshore islands with restricted human access (U.S. Fish and Wildlife Service 2000). Current and historical nesting habitat can be described as flat to steep slopes that are sparsely or fully vegetated. Short-tailed albatrosses disperse throughout the temperate and subarctic North Pacific approximately from May to October when they are not breeding, from Japan through California (U.S. Fish and Wildlife Service 2005b; 2008b). Nonbreeders and failed breeders disperse from the colony months sooner. While many nonbreeders return to the colonies each year, the presence of immature birds far from the colony (such as the U.S. Pacific coast) during the breeding season suggests that some immature birds may spend years at sea before they return to the colony (U.S. Fish and Wildlife Service 2005c).

3.6.2.7.2.1 Open Ocean

The short-tailed albatross is an open ocean species that occurs throughout the Hawaii Range Complex (HRC), Transit Corridor, and Southern California (SOCAL) Range Complex portions of the Study Area. The range of the short-tailed albatross extends from Siberia south to the China coast, into the Bering Sea and Gulf of Alaska south to Baja California, Mexico, and throughout the North Pacific, including the Northwestern Hawaiian Islands (Committee on the Status of Endangered Wildlife in Canada 2003; Harrison 1983; Roberson 2000). Their at-sea distribution includes the entire North Pacific Ocean north of about 20° N latitude. Short-tailed albatrosses move seasonally around the North Pacific Ocean, with high densities observed during the breeding season (December through May) in Japan and throughout Alaska and along the west coast of North America during the non-breeding season (April through September) (International Union for the Conservation of Nature 2010c). Non-breeding subadults can be found in all

areas throughout the year. They are seen regularly in the North Pacific Subtropical Gyre (U.S. Fish and Wildlife Service 2005c).

3.6.2.7.2.2 California Current Large Marine Ecosystem

Short-tailed albatross occasionally occur in SOCAL Range Complex portion of the California Current Large Marine Ecosystem, which is part of the Study Area. As the population began a gradual recovery after 1950, sporadic sightings have been recorded off California (International Union for the Conservation of Nature 2010c). Based on the number of sightings in the SOCAL Range Complex, the short-tailed albatross is considered rare in that portion of the Study Area, as well as off the entire California coast. Breeding does not occur in the SOCAL Bight, but because of the unique circulation and upwelling characteristics of this area, potential foraging habitat exists. Two documented sightings of the short-tailed albatross have occurred in SOCAL. Roberson (2000) reported a sighting in 1977 of an all-dark immature bird approximately 90 mi. (144.8 km) west of the San Diego area. McCaskie and Garrett (2002) reported a sighting in the vicinity of Santa Barbara Island in late February of 2002.

3.6.2.7.2.3 Insular Pacific-Hawaiian Large Marine Ecosystem

Short-tailed albatross occur in coastal waters throughout the Hawaii portion of the Study Area in the Insular Pacific-Hawaiian Large Marine Ecosystem. The short-tailed albatross regularly occurs on Midway Atoll and has been observed at other Northwestern Hawaiian Islands. Since the 1930s, short-tailed albatrosses have been occasionally reported during the breeding season at Midway Atoll. Some of these short-tailed albatrosses were recorded for several successive years. Although unconfirmed successful nesting was reported in 1961 and 1962 (Tickell 2000), the first confirmed nest site that produced an egg did not occur until 1993 (International Union for the Conservation of Nature 2010c). Nesting on the Northwestern Hawaiian Islands has been attempted, but successful nesting has not been confirmed (U.S. Fish and Wildlife Service 2005c). In the Hawaiian Islands, there was an unconfirmed sighting at Barking Sands on Kauai during March 2000 (Birding Hawaii 2004). Other known occurrences in Hawaii are of single birds (in 1976 and 1981) at French Frigate Shoals in the Northwestern Hawaiian Islands (U.S. Fish and Wildlife Service 2008b).

3.6.2.7.3 Population and Abundance

In 2005, the total population was estimated at 1,712, with 513 pairs at Torishima and 340 birds and 85 breeding pairs at Minami-Kojima (located northeast of Taiwan) (U.S. Fish and Wildlife Service 2005c). The Japan and Taiwan population is growing extremely rapidly at about 7.3 percent annually (International Union for the Conservation of Nature 2010c; U.S. Fish and Wildlife Service 2005c). Average population survival rate is 96 percent, and the current annual population growth is greater than 6 percent (U.S. Fish and Wildlife Service 2005c). Short-tailed albatross regularly visit the Hawaiian islands; although breeding attempts on Midway Atoll have been unsuccessful historically (U.S. Fish and Wildlife Service 2005c), a pair successfully bred in late 2010, hatching a chick in early 2011 which successfully fledged.

3.6.2.7.4 Predator and Prey Interactions

Short-tailed albatrosses are surface feeders and scavengers, feeding more inshore than other North Pacific albatrosses. In Japan, their diet consists of shrimp, squid, and fish (including bonita, flying fish, and sardines); diet information is not available for birds in the Study Area (U.S. Fish and Wildlife Service 2005c). Unlike other North Pacific albatrosses, short-tailed albatrosses frequently feed in sight of land.

Short-tailed albatross chicks are predated by other birds and introduced mammals such as cats and rats on nesting colonies (U.S. Fish and Wildlife Service 2005c).

3.6.2.7.5 Species-Specific Threats

Short-tailed albatrosses have survived multiple threats to their existence. During the late 1800s and early 1900s, feather hunters clubbed to death an estimated five million of them, stopping only when the species was nearly extinct. In the 1930s, nesting habitat on the only active nesting island in Japan was damaged by volcanic eruptions, leaving fewer than 50 birds by the 1940s. Loss of nesting habitat to volcanic eruptions, severe storms, and competition with black-footed albatrosses for nesting habitat continue to be natural threats to short-tailed albatrosses today.

Current threats to this species include ingestion of plastics mistaken for food items, volcanic eruption (at Torishima, Japan), typhoons, sunken longline fishing in Alaska and Russia, jig/troll fishery in Japan, invasive species at colonies (cats, rats, and plants), and researcher disturbance (U.S. Fish and Wildlife Service 2005c). Additional human-induced threats include hooking and drowning on commercial longline gear, contamination from oil spills, and potential predation by introduced mammals on breeding islands.

3.6.2.8 Marbled Murrelet (*Brachyramphus marmoratus*)

3.6.2.8.1 Status and Management

The marbled murrelet (*Brachyramphus marmoratus*) is listed as a threatened species in California, Oregon, and Washington under the ESA (U.S. Fish and Wildlife Service 1992) and is considered endangered by the state of California (California Department of Fish and Game 2010). Marbled murrelet populations have suffered significant declines in the Pacific Northwest, caused primarily by the removal of essential habitat by logging and coastal development (International Union for the Conservation of Nature 2010a). To stem these declines, critical habitat was designated in 1996 in mature and old-growth forest nesting habitat within 30 mi. (48.3 km) off the coast in Washington, Oregon, and California (U.S. Fish and Wildlife Service 1997). The entire critical habitat, as well as Primary Constituent Elements, are outside of the Study Area.

3.6.2.8.2 Habitat and Geographic Range

Marbled murrelets do not build a nest but use natural features, such as moss, clumps of mistletoe, or piles of needles as a nest site on tree limbs (International Union for the Conservation of Nature 2010a). Nests are in large conifers, such as coast redwood and western hemlock, in old-growth stands typically within 35 mi. (56.3 km) of marine waters. Important features in nesting habitat are stands of 500 acres (ac.) (202.3 hectares [ha]) or larger, multistoried canopy layers, and less than average canopy closures (Grenier and Nelson 1995; Hamer and Nelson 1995; Miller and Ralph 1995). In addition, habitat along major drainages (e.g., rivers and streams) is a key component (International Union for the Conservation of Nature 2010a), as murrelets tend to use these drainages as flight corridors to and from inland nest sites.

Marbled murrelets generally remain near breeding sites year-round in most areas (U.S. Fish and Wildlife Service 2005b). Foraging habitat is generally found within 3 mi. (4.8 km) from shore and in water less than 195 ft. (59.4 m) deep (Day and Nigro 2000; International Union for the Conservation of Nature 2010a). Birds occur closer to shore in exposed coastal areas and farther offshore in protected coastal areas (International Union for the Conservation of Nature 2010a). The highest concentrations are found in protected inshore waters (U.S. Fish and Wildlife Service 2005b). Physical and biological oceanographic processes that concentrate prey (such as upwelling and rip currents) have an important influence on the foraging distribution of marbled murrelets (Ainley et al. 1995; Burger 1995, 2002; Day and Nigro 2000; International Union for the Conservation of Nature 2010a; Strong et al. 1995). They are more commonly

found inland during the summer breeding season but make daily trips to the ocean to gather food and have been detected in forests throughout the year. When not nesting, the birds live at sea, spending their days feeding close to shore and then moving several miles offshore at night.

3.6.2.8.2.1 California Current Large Marine Ecosystem

Marbled murrelets only occur in coastal waters of the California Current Large Marine Ecosystem within the northeast corner of the SOCAL Range Complex portion of the Study Area. Eight reported sightings of marbled murrelets have been documented within the Study Area off the California coast. Sightings have been reported at Marina del Rey, off Santa Barbara Island, at Mugu Lagoon in Ventura County, along the coast in San Diego County, and at the northern end of the Study Area near San Simeon Point (McCaskie and Garrett 2001). All of these documented sightings were recorded between November and March.

Foraging habitat in the Southern California Bight occurs usually within 3 mi. (4.8 km) of the coast in waters less than 195 ft. (59.4 m) deep (Day and Nigro 2000; International Union for the Conservation of Nature 2010a); however, because upwelling areas represent important foraging habitat for the marbled murrelet, the potential exists for individuals to be observed farther offshore in the Southern California Bight.

Winter distributions of marbled murrelets are poorly documented. In California, most birds appear to be year-round residents near breeding areas (Naslund 1993), although dispersal in the winter as far south as SOCAL and northern Mexico has been documented (Erickson et al. 1995). A single sighting has occurred at Enseñada Harbor (Erickson et al. 1995). The species is a rare fall/winter vagrant (occurring outside of its normal range) to SOCAL, and is “accidental” from the U.S.-Mexico border south along the Mexico coastline (International Union for the Conservation of Nature 2010a).

3.6.2.8.3 Population and Abundance

The largest number of marbled murrelets occurs in Alaska, where the population is estimated at 270,000, although the population has experienced a dramatic decline of approximately 70 percent over the last 25 years (Piatt et al. 2007). The population in British Columbia is estimated to be between 54,000 and 92,000 (Piatt et al. 2007). Current populations in Washington, Oregon, and California are small compared with the historical populations of British Columbia and Alaska, which at one time were believed to number in the hundreds of thousands (Piatt et al. 2007). A recent population estimate for Washington, Oregon, and California is a combined 20,200 (Raphael et al. 2007).

3.6.2.8.4 Predator and Prey Interactions

Marbled murrelets feed opportunistically on small fish, including sand lance, anchovy, herring, capelin, and smelt, and also on invertebrates (U.S. Fish and Wildlife Service 1997, 2005b). Feeding takes place in the nearshore marine environment, primarily in protected waters where both Pacific sand lance and surf smelt occur (Burger 2002; Whitworth et al. 2000). Individuals forage by diving, using their wings for underwater propulsion. The murrelet forages by pursuit diving in relatively shallow waters, usually between 20 and 80 m (6.1 and 24.4 ft.) in depth. The majority of birds are found as pairs or as singles in a band about 300 to 2,000 m (91.4 to 609.6 ft.) from shore. Foraging dive times averaged about 16 seconds. Murrelets generally forage during the day, and are most active in the morning and late afternoon hours. Some foraging occurs at night (Ralph et al. 1995).

While at sea, marbled murrelets are preyed on by birds and mammals including peregrine falcons, bald eagles, western gulls, and northern fur seals. Birds such as common ravens, Steller’s jays, and

sharp-shinned hawks are predators of marbled murrelet eggs, chicks, and adults during the nesting season (Nelson 1997).

3.6.2.8.5 Species-Specific Threats

The principal factor threatening the persistence of marbled murrelet over the southern portions of its range is harvesting of old-growth and mature forests. In addition to habitat loss, interactions with fisheries, especially gill-net fisheries, and oil spills have also contributed to population declines (Ralph et al. 1995). An estimated 3,500 murrelets are killed annually in Alaska by gill-net fisheries (Carter et al. 2005; Piatt and Naslund 1995). In addition, more than 1,000 oiled marbled murrelet carcasses were collected after the Exxon Valdez oil spill in Alaska (Carter and Kuletz 1995). Nest failure is caused by predation by raptors, ravens, and jays (Nelson 1997).

3.6.2.9 Newell's Shearwater (*Puffinus auricularis newelli*)

The classification of the Newell's shearwater (*Puffinus auricularis newelli*) is in flux. It was, until recently, regarded by some authorities as a distinct species, *Puffinus newelli* (International Union for the Conservation of Nature 2010a). Since 1982, most authorities have considered it a subspecies of Townsend's shearwater (*Puffinus auricularis*) (American Ornithologists' Union 1998). At least one author (Harrison 1983) regarded Newell's shearwater as a subspecies of Manx shearwater (*Puffinus puffinus newelli*). The U.S. Fish and Wildlife Service (2005b) identifies Newell's shearwater as a subspecies of Townsend's shearwater. Newell's shearwater is also known as Newell's dark-rumped shearwater.

3.6.2.9.1 Status and Management

Newell's shearwater is an ESA-listed threatened species, found only in the Hawaiian Islands. This species is also listed as threatened by the state of Hawaii (U.S. Fish and Wildlife Service 2005b). A federal recovery plan was finalized in 1983 (U.S. Fish and Wildlife Service 1983). Within the Hawaiian Islands Bird Conservation Region, Newell's shearwater is evaluated as highly imperiled, the most serious category, because of restricted breeding distribution and threats to breeding populations (U.S. Fish and Wildlife Service 2003). There is no critical habitat designation for the Newell's shearwater.

Newell's shearwater was thought to be extinct by 1908 as a consequence of subsistence hunting by Polynesians and predation by introduced rats, pigs, and dogs. However, they were rediscovered offshore in 1947. One was collected on Oahu in 1954 (Day et al. 2003) and Newell's shearwaters were confirmed as still breeding on Kauai in 1967 (U.S. Fish and Wildlife Service 2005b).

3.6.2.9.2 Habitat and Geographic Range

Newell's shearwater occurs in open ocean waters in the southern portion of the Hawaii portion of the Study Area and into the western portion of the Transit Corridor Study Area. They spend most of their time in the open ocean year-round (U.S. Fish and Wildlife Service 2005b) and come ashore only to nest. They avoid inshore waters except when gathering before they fly inland to breeding colonies at night (International Union for the Conservation of Nature 2010e).

Newell's shearwaters forage only over open ocean waters of depths reportedly much greater than 6,560 ft. (1,999.5 m) (Spear et al. 1995). Even when nesting, they feed over deep waters and are typically not within 15 mi. (24.1 km) of island shores (International Union for the Conservation of Nature 2010e). In particular, they find abundant food along oceanic fronts, such as the Equatorial Countercurrent (Spear et al. 1995). Preferred average ocean conditions are 80°F (26.7°C) sea surface temperature, 34.5 parts per thousand sea surface salinity, and 250 ft. (76.2 m) depth to cold water

(Spear et al. 1995). The meteorological conditions favored by Newell's shearwaters are frequent clouds and rain squalls typical of intertropical convergence zones (Spear et al. 1995).

3.6.2.9.2.1 Insular Pacific-Hawaiian Large Marine Ecosystem

Newell's shearwater occurs in coastal waters throughout the Hawaii portion of the Study Area during the breeding season. Newell's shearwater nesting is entirely confined to the main Hawaiian Islands, from Lehua Rock east to Hawaii. Nesting is known on Lehua Rock, Kauai, Molokai, and Hawaii. No population estimates exist for the small nesting colonies that exist on Lehua Rock and Molokai (Day and Cooper 1995; International Union for the Conservation of Nature 2010e; U.S. Fish and Wildlife Service 2005b). About 20 breeding colonies of Newell's shearwaters are known in the main Hawaiian Islands, but others probably exist (International Union for the Conservation of Nature 2010e). In 1992, 11 colonies were known on Kauai. There is evidence but no confirmation of nesting on Oahu, Maui, and Lanai (U.S. Fish and Wildlife Service 2005b).

Newell's shearwaters nest on Kauai at high elevations (525–3,935 ft.) (160.02–1,199.4 m) on steep, densely vegetated mountain slopes and in burrows or deep rock crevices, although a substantial number also nest on dry sparsely vegetated cliffs on the Na Pali coast of Kauai and on Lehua Island (Reynolds and Ritchotte 1997; U.S. Fish and Wildlife Service 2005b). The use of steep slopes (mostly greater than 65°) for nesting is probably a consequence of predation pressure from introduced pigs, mongooses, and cats; they select sites where there is either an open canopy of trees and ground cover of uluhe ferns or a dense ground cover of tussock grasses (International Union for the Conservation of Nature 2010e).

On the Island of Hawaii, Newell's shearwaters fly over the entire island except the southwestern coast. Shearwaters are most numerous flying to and from the Kohala Mountains on the north coast (Day et al. 2003). During adult presence in the breeding season (April to September), Newell's shearwaters gather on the water close to shore before they fly inland around sunset (International Union for the Conservation of Nature 2010e). Based on known or suspected colony locations, Newell's shearwaters are expected to be found gathering in early evening at Niihau (north end around Lehua Rock), Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii from April to September.

3.6.2.9.2.2 Open Ocean

During the breeding season, some birds forage west and north of the Hawaiian Islands so that the central part of their marine range moves northward in the Transit Corridor portion of the Study Area (International Union for the Conservation of Nature 2010e; U.S. Fish and Wildlife Service 2005b).

3.6.2.9.3 Population and Abundance

Population in the 1980s and early 1990s was estimated at about 84,000, but numbers in 2000 may have been only 21 percent of what they were in 1987 (U.S. Fish and Wildlife Service 2005b). The largest known population, found on Kauai, was devastated by two hurricanes in 1982 and 1992. Since that last storm, the species has been in steady decline on Kauai. The remaining adults and fledglings are suffering significant deaths from utility pole and line strikes (International Union for the Conservation of Nature 2010e). Continuing forest habitat destruction and predation from introduced mammals are also taking a toll on this species (International Union for the Conservation of Nature 2010e).

3.6.2.9.4 Predator and Prey Interactions

Although diet is not well known, evidence suggests that squid are a major dietary item. Newell's shearwaters capture food by pursuit-plunging (diving into water and swimming after prey, typically 10 to 30 m [32.8 to 98.4 ft.] deep), usually in company with multispecies feeding flocks associated with tuna

(International Union for the Conservation of Nature 2010e). This species is not attracted to discarded fish byproducts and does not follow ships (Onley and Scofield 2007).

Newell's shearwaters are preyed on by introduced animals at their breeding sites, such as cats and birds such as barn owls (Ainley et al. 1997). Nocturnal activity and cavity-nesting behaviors are their only defense against mammal predators.

3.6.2.9.5 Species-Specific Threats

Historical threats included subsistence hunting by Polynesians and predation by rats, dogs, and pigs. Current threats include artificial lights (e.g., street and resort lights) along the coast that blind and disorient fledglings. Once on the ground, these fledglings are unable to fly and thousands are killed each year by cars, cats, and dogs. In addition, adults can collide with power facilities and associated utility wires and associated lines are in the direct path of known Newell's flight corridors. Additional threats are the loss and degradation of forested habitat caused by introduced plants and herbivores.

3.6.2.10 Band-Rumped Storm-Petrel (*Oceanodroma castro*)

The band-rumped storm-petrel (*Oceanodroma castro*) is also known as Madeira or Madeiran storm-petrel, Harcourt's storm-petrel, or Hawaiian storm-petrel (American Ornithologists' Union 1998, Harrison 1983).

3.6.2.10.1 Status and Management

Storm-petrels are the smallest of all the oceanic seabirds (Onley and Scofield 2007). The Hawaii population has been a candidate for listing under the ESA since 1989 (U.S. Fish and Wildlife Service 2004). Their global population is not a conservation concern due to large populations in Japan and the Galapagos Islands (International Union for the Conservation of Nature 2010b, U.S. Fish and Wildlife Service 2005b). In the Hawaiian Islands, band-rumped storm-petrels are the rarest breeding seabirds (International Union for the Conservation of Nature 2010b, U.S. Fish and Wildlife Service 2005b). The State of Hawaii categorizes the local population as endangered (U.S. Fish and Wildlife Service 2005b) and regards it as highly imperiled within the Hawaiian Islands Bird Conservation Region, based on population size, breeding distribution, and threats to breeding distribution (U.S. Fish and Wildlife Service 2003).

3.6.2.10.2 Habitat and Geographic Range

Band-rumped storm-petrels prefer warm deep water of 3,280 ft. to more than 6,560 ft. (999.7 to 1,999.5 m) deep. This species occurs close to land where deep water is near an island; otherwise, they occur offshore or in upwelling regions (International Union for the Conservation of Nature 2010b). Preferred waters range from 80 to 84°F (26.7 to 28.9°C) (International Union for the Conservation of Nature 2010b). Nesting habitat in the main Hawaiian Islands consists of steep cliffs and barren lava flows at high elevations. Nests are in burrows or crevices in rock or lava (International Union for the Conservation of Nature 2010b; U.S. Fish and Wildlife Service 2004, 2005b). Also, they have been documented using artificial nest boxes (Mitchell et al. 2005). These sites may well be the last resort of predator avoidance for a species that formerly most likely nested closer to the coast (International Union for the Conservation of Nature 2010b).

Insular Pacific-Hawaiian Large Marine Ecosystem

Band-rumped storm-petrels occur in coastal waters of the Hawaii portion of the Study Area and into the western portion of the Transit Corridor portion of the Study Area. Colonies in the main Hawaiian Islands

are known or suspected on Lehua Rock, Kauai, Maui, Kahoolawe, and Hawaii. Other colonies are likely in Waimea Canyon and Hanapepe Valley on the western side of Kauai. On Hawaii, one small population is known to nest on the upper west slope of Mauna Loa. There are no confirmations of occurrence on the other islands (Lehua Rock, Maui, and Kahoolawe), where nesting is suspected, although Lehua Rock and Maui (Haleakala crater) are likely (International Union for the Conservation of Nature 2010b, U.S. Fish and Wildlife Service 2004). There is no known nesting in the Northwestern Hawaiian Islands (U.S. Fish and Wildlife Service 2004).

During the nesting season, deep water (more than 3,280 ft. [999.7 m]) close to shore can be used for foraging. Fishermen report them mostly at about 3 mi. (4.8 km) off the Na Pali coast of Kauai (International Union for the Conservation of Nature 2010b). Band-rumped storm-petrels are known to gather in nearshore waters before they fly inland to nesting colonies in the early evening.

Open Ocean

Band-rumped storm-petrels occur in the Hawaii portion of the Study Area and the western portion of the Transit Corridor Study Area. They are distributed in the Pacific from Japan east to Central America and northern South America (Harrison 1983). Pacific populations are divided into distinct Japanese, Hawaiian, and Galapagos breeding populations (U.S. Fish and Wildlife Service 2004). The Hawaiian population at sea is thought to remain in the central Pacific, ranging south to the Equatorial Countercurrent. Some individuals spend most of their time in open ocean, occurring far offshore from nesting islands; others seem to remain close to nesting colonies year-round (U.S. Fish and Wildlife Service 2005b).

3.6.2.10.3 Population and Abundance

The Hawaiian populations, a tiny remnant of historical numbers, are of unknown size and trends (U.S. Fish and Wildlife Service 2005b). In 2004, the population of band-rumped storm-petrels at sea was estimated at about 5,500 (U.S. Fish and Wildlife Service 2004). In 2002, the population on Kauai was estimated at 171 to 221 breeding pairs, mostly occurring along the Na Pali coast (Pohakuao Valley, Kalalau Valley, Awaawapuhi Valley, Nuololo Aina, and Nuololo Kay) on the west side of the island.

3.6.2.10.4 Predator and Prey Interactions

Band-rumped storm-petrels most likely feed on small fish, squid, and crustaceans, based on records from the Galapagos Islands; diet information is not available for Hawaiian birds (U.S. Fish and Wildlife Service 2005b). Foraging is confirmed diurnally and suspected nocturnally. Food is captured while sitting on the water or off the surface by bill snatching as the bird gently flaps just above the surface of the water (International Union for the Conservation of Nature 2010b). Foraging occurs mostly in deep water in all seasons. They are attracted to discarded fish by-product from fishing boats (Onley and Scofield 2007). Band-rumped storm-petrels are vulnerable to predation by introduced rats, mice, cats, mongooses, pigs, and barn owls (U.S. Fish and Wildlife Service 2005b).

3.6.2.10.5 Species-Specific Threats

This small seabird is highly vulnerable to predation by introduced rats, mice, cats, mongooses, pigs, and barn owls, as well as being vulnerable to striking power lines and street lights at night (U.S. Fish and Wildlife Service 2005b). Street and resort lights disorient fledglings, causing them to collide with structures or fall to the ground, where they are at risk from predators and cars. Additional threats are the loss and degradation of forested habitat caused by introduced plants and herbivores.

3.6.2.11 Guadalupe Murrelet (*Synthliboramphus hypoleucus*)

The Guadalupe murrelet (*Synthliboramphus hypoleucus*) was until recently a subspecies of the Xantus's murrelet, along with the Scripps's murrelet (*Synthliboramphus scrippsi*). These species can be distinguished by differences in breeding range, facial plumage, bill size, and vocalizations (International Union for the Conservation of Nature 2010b).

3.6.2.11.1 Status and Management

The (formerly known as) Xantus's murrelet population as a whole is designated as a candidate species under the ESA and as a threatened species by the State of California (California Department of Fish and Game 2010). In 2012, the two subspecies of Xantus's murrelet (*Synthliboramphus hypoleucus hypoleucus* and *Synthliboramphus hypoleucus scrippsi*) were elevated to species status (Chesser et al. 2012). As the Xantus's murrelet was considered a candidate species (and included both subspecies), the Guadalupe murrelet is considered a candidate species following the taxonomic split.

3.6.2.11.2 Habitat and Geographic Range

Guadalupe murrelets are found only on the Pacific coast of North America, ranging from Baja California, Mexico (23° N), to British Columbia (52° N), and offshore to a distance of approximately 310 mi. (499 km) (Carter et al. 2005). Guadalupe murrelets prefer to nest on offshore islands free from human disturbance and predators. Nest locations include natural cavities, under shrubs or in hollows beneath adequate vegetation, along or near steep cliffs, on offshore rocks, and in sea caves (Burkett et al. 2003).

The open water distributions of *Synthliboramphus hypoleucus* and *Synthliboramphus scrippsi* overlap extensively, after breeding and dispersing, and at-sea distributions are highest over the upper continental slope at depths of 655–3,280 ft. (200–1,000 m). Individuals of both subspecies disperse offshore, moving from the breeding colonies as far north as British Columbia (U.S. Fish and Wildlife Service 2005b). The Guadalupe murrelet breeds only off of Baja California, on the three San Benito Islands, and on two rocks offshore of Guadalupe Island. The breeding range overlaps with that of Scripps's murrelet only at the San Benito Islands off Baja California. (Carter et al. 2005, International Union for the Conservation of Nature 2010f, Karnovsky et al. 2005).

During the breeding season, Guadalupe murrelets forage in waters surrounding nesting islands within 60–95 mi. (96.6–153 km) of colonies (Whitworth et al. 2000). Non-breeding birds forage in surface waters, with the highest densities observed over the upper continental slope in water depths of 655–3,280 ft. (200–1,000 m) (Briggs et al. 1987, Karnovsky et al. 2005). Moderately high densities of Xantus's murrelets are found foraging over the outer continental slope at depths of 3,280–9,840 ft. (1,000–3,000 m), and the lowest densities are observed over the continental shelf (depth less than 655 ft. [200 m]) and in open ocean waters (depths greater than 9,840 ft. [3,000 m]).

California Current Large Marine Ecosystem

Guadalupe murrelets occur in coastal and open ocean areas of the Southern California portion of the Study Area and the eastern portion of the Transit Corridor Study Area. This species is present at nesting colonies in central Baja California from approximately February to May (Wolf et al. 2005). After breeding, they are more evenly distributed, extending from southern British Columbia to southern Baja California. The highest concentrations offshore occur from Point Conception to Cape Mendocino and off Baja California (Briggs et al. 1987, Karnovsky et al. 2005).

3.6.2.11.3 Population and Abundance

Historical accounts of the species from the 1940s indicate that all murrelets were once more abundant, although there are no reliable estimates of historical populations. The most recent worldwide population estimate based on at-sea surveys is 39,700, consisting of 17,900 breeding birds and 21,800 subadults and nonbreeders (Karnovsky et al. 2005), though this is an estimate of the two subspecies of Xantus murrelet. The Coronado Island (Mexico) breeding population is approximately 750, which makes up about 20 percent of the total population of the subspecies *Synthliboramphus hypoleucus scrippsi* (International Union for the Conservation of Nature 2010f). Current population estimates are not available for Guadalupe Island. In 1968, an estimated 2,400–3,500 Xantus's murrelet breeding pairs were on Guadalupe Island (U.S. Fish and Wildlife Service 2007).

Predator/Prey Interactions

Guadalupe murrelets capture prey underwater by using their wings for propulsion in a technique known as pursuit-diving (International Union for the Conservation of Nature 2010f). Few studies have been conducted on the food habits of the Guadalupe murrelet. They are known to feed on small schooling fish and zooplankton near the surface of the water. Predators of adult murrelets include peregrine falcons, barn owls, Western gulls, and feral cats. Deer mice and rats are significant egg predators (Drost and Lewis 1995).

3.6.2.11.4 Species-Specific Threats

Numerous threats have contributed to declines in the Guadalupe murrelet populations, including nonnative mammals (e.g., rats) that directly prey on murrelets or destroy or alter habitat. Other threats are from oil pollution, native predators feeding on eggs, chicks, or adults, artificial light pollution from seagoing vessels, human disturbance at nesting colonies, oceanographic changes that affect prey species abundance, military operations, and being caught in fishing nets (Burkett et al. 2003).

3.6.2.12 Scripps's Murrelet (*Synthliboramphus scrippsi*)

Scripps's murrelet (*Synthliboramphus scrippsi*) was until recently a subspecies of the Xantus's murrelet, along with the Guadalupe murrelet (*Synthliboramphus hypoleucus*). These species can be distinguished by differences in breeding range, facial plumage, bill size, and vocalizations (International Union for the Conservation of Nature 2010b).

3.6.2.12.1 Status and Management

The (formerly known as) Xantus's murrelet population as a whole is designated as a candidate species under the ESA and as a threatened species by the State of California (California Department of Fish and Game 2010). In 2012, the two subspecies of Xantus's murrelet (*Synthliboramphus hypoleucus hypoleucus* and *Synthliboramphus hypoleucus scrippsi*) were elevated to species status (Chesser et al. 2012). As the Xantus's murrelet was considered a candidate species (and included both subspecies), Scripps's murrelet is considered a candidate species following the taxonomic split.

3.6.2.12.2 Habitat and Geographic Range

Scripps's murrelets are found only on the Pacific coast of North America, ranging from Baja California, Mexico (23° N), to British Columbia (52° N), and offshore to a distance of approximately 310 mi. (499 km) (Carter et al. 2005). Scripps's murrelets prefer to nest on offshore islands free from human disturbance and predators. Nest locations include natural cavities, under shrubs or in hollows beneath adequate vegetation, along or near steep cliffs, on offshore rocks, and in sea caves (Burkett et al. 2003).

The open water distributions of *Synthliboramphus scrippsi and Synthliboramphus hypoleucus* overlap extensively, after breeding and dispersing, and at-sea distributions are highest over the upper continental slope at depths of 655–3,280 ft. (200–1,000 m). Individuals of both subspecies disperse offshore, moving from the breeding colonies as far north as British Columbia (U.S. Fish and Wildlife Service 2005b). *Synthliboramphus hypoleucus scrippsi* nests primarily on the Channel Islands and Coronado Islands in the Southern California Bight, but also south to the San Benito Islands where it overlaps with *Synthliboramphus hypoleucus hypoleucus* (Carter et al. 2005, International Union for the Conservation of Nature 2010f, Karnovsky et al. 2005).

During the breeding season, Scripps's murrelets forage in waters surrounding nesting islands within 60–95 mi. (96.6–153 km) of colonies (Whitworth et al. 2000). Non-breeding birds forage in surface waters, with the highest densities observed over the upper continental slope in water depths of 655–3,280 ft. (200–1,000 m) (Briggs et al. 1987, Karnovsky et al. 2005). Moderately high densities of Scripps's murrelets are found foraging over the outer continental slope at depths of 3,280–9,840 ft. (1,000–3,000 m), and the lowest densities are observed over the continental shelf (depth less than 655 ft. [200 m]) and in open ocean waters (depths greater than 9,840 ft. [3,000 m]).

California Current Large Marine Ecosystem

Scripps's murrelets occur in coastal and open ocean areas of the Southern California portion of the Study Area and the eastern portion of the Transit Corridor Study Area. This species is present at nesting colonies in the Southern California Bight from approximately March to June. During this period, Xantus's murrelets occur from northern Oregon to southern Baja California but tend to be concentrated in the Southern California Bight (Karnovsky et al. 2005). After breeding, they are more evenly distributed, extending from southern British Columbia to southern Baja California. The highest concentrations offshore occur from Point Conception to Cape Mendocino and off Baja California (Briggs et al. 1987, Karnovsky et al. 2005).

3.6.2.12.3 Population and Abundance

Historical accounts of the species from the 1940s indicate that all murrelets were once more abundant, although there are no reliable estimates of historical populations. The most recent worldwide population estimate based on at-sea surveys is 39,700, consisting of 17,900 breeding birds and 21,800 subadults and nonbreeders (Karnovsky et al. 2005), though this is an estimate of the two subspecies of Xantus murrelet. The California population is now considered "uncommon," with an estimated 3,460 breeding birds. The breeding distribution is restricted to about 12 offshore islands of Southern California and Baja California, Mexico (U.S. Fish and Wildlife Service 2005b). Santa Barbara Island hosts the largest breeding colony in California with 500–750 pairs (Whitworth et al. 2005). Santa Barbara Island is located just outside the northern border of the Study Area off the coast of California and is part of a series of islands, the Channel Islands, which are partially included in the Study Area. Although Santa Barbara Island is the smallest of the Channel Islands, with an area of just 1 square mile (2.6 square kilometers), it is the most important of these islands for Scripps's murrelets because 51 percent of the California population nests on this island (Burkett et al. 2003). Research in the Southern California Bight from the 1970s to 1991 indicated a decline of approximately 30 percent in Scripps's murrelets on Santa Barbara Island; however, multiple studies used different methods and are therefore difficult to compare and use to deduce accurate population estimates (Burkett et al. 2003). Difficulty in accurately censusing populations at breeding colonies is also compounded by Scripps's murrelet's crevice-nesting behavior.

The murrelet populations at Anacapa Island historically experienced significant declines primarily caused by predation following the introduction of the black rat in the mid-1800s and early 1900s (Burkett et al.

2003). The eradication of rats in 2002 has resulted in improved hatching success and colony expansion (Whitworth et al. 2005). Burkett et al. (2003) estimated approximately 200–600 breeding pairs of Xantus's murrelets on Anacapa Island. Scripps's murrelet breeding pairs on other Channel Islands in the Study Area include Santa Cruz (100–300), San Miguel (50–300), Santa Catalina (25–75) (U.S. Fish and Wildlife Service 2007), and San Clemente Island at Seal Cove and China Point (10–15) (U.S. Department of the Navy - Southwest Division 2001). Santa Catalina and San Clemente are the only islands that are within the Study Area. Individuals have also been known to use offshore rock outcrops near the island for roosting and as takeoff points for foraging (U.S. Department of the Navy - Southwest Division 2001).

Predator/Prey Interactions

Scripps's murrelets capture prey underwater by using their wings for propulsion in a technique known as pursuit-diving (International Union for the Conservation of Nature 2010f). Few studies have been conducted on the food habits of the Scripps's murrelet. They are known to feed on small schooling fish and zooplankton near the surface of the water. Larval fish, especially anchovies but also Pacific sauries and rockfish, are major food items during the nesting period at Santa Barbara Island (Hunt and Butler 1980). Predators of adult Scripps's murrelets include peregrine falcons, barn owls, Western gulls, and feral cats. Deer mice and rats are significant egg predators (Drost and Lewis 1995).

3.6.2.12.4 Species-Specific Threats

Numerous threats have contributed to declines in the Guadalupe murrelet populations, including nonnative mammals (e.g., rats) that directly prey on murrelets or destroy or alter habitat. Other threats are from oil pollution, native predators feeding on eggs, chicks, or adults, artificial light pollution from seagoing vessels, human disturbance at nesting colonies, oceanographic changes that affect prey species abundance, military operations, and being caught in fishing nets (Burkett et al. 2003).

3.6.2.13 Albatrosses, Petrels, Shearwaters, and Storm-Petrels (Order Procellariiformes)

The Procellariiformes is a large order of open ocean seabirds that are divided into four families: Diomedeidae (albatrosses), Procellariidae (petrels and shearwaters), Hydrobatidae (storm-petrels), and Pelecanoididae (diving-petrels) (Enticott and Tipling 1997; Onley and Scofield 2007). There are 39 species representing three families—albatrosses, petrels and shearwaters, and storm-petrels—that occur in the Study Area (Table 3.6-2 and Table 3.6-3). These species are generally long-lived, breed once a year, and lay only one egg. They have extremely broad distributions and include all marine birds that spend most of their lives at sea and exclusively feed in the open ocean, primarily on fish, crustaceans, and crabs. They can be found in high numbers resting on the water in flocks where prey is concentrated (Enticott and Tipling 1997). Some species feed around fishing boats or become injured from longline gear (Enticott and Tipling 1997; Onley and Scofield 2007). They nest in colonies on remote islands uninhabited by people. Some are ground nesters; others nest in cavities or burrows (Ramos et al. 1997). They return to their birth colonies. Most species of this order are monogamous and mate for life. Both parents participate in egg incubation and chick rearing (Elphick et al. 2001). Representative species include Laysan albatross, Northern fulmar, mottled petrel, pink-footed shearwater, and Wilson's storm-petrel.

3.6.2.14 Tropicbirds, Boobies, Pelicans, Cormorants, and Frigatebirds (Order Pelecaniformes)

The Pelecaniformes order includes anhingas, pelicans, gannets and boobies, tropicbirds, cormorants, and frigatebirds. There are 14 species representing 5 families that occur in the Study Area: tropicbirds, boobies, pelicans, cormorants, and frigatebirds (Table 3.6-2 and Table 3.6-3). They all have webbed feet and eight toes, and all have a throat sac, called a gular sac (Brown and Harshman 2008). This sac is highly

developed and visible in pelicans and frigatebirds but is also readily apparent in boobies and cormorants. Pelicans use the sac to trap fish, frigatebirds use it as a mating display and to feed on fish, squid, and similar marine life (Dearborn et al. 2001), and cormorants and boobies utilize the sac for heat regulation. These birds nest in colonies, but individual birds are monogamous (Brown and Harshman 2008). Representative species within the Study Area include white-tailed tropicbird, blue-footed booby, California brown pelican, pelagic cormorant, and magnificent frigatebird.

3.6.2.15 Phalaropes, Gulls, Noddies, Terns, Skua, Jaegers, and Alcids (Order Charadriiformes)

There are 54 species representing three families from this diverse group that occur within the Study Area (Table 3.6-2 and Table 3.6-3). Gulls, noddies, and terns in the family Laridae are a diverse group of small to medium sized seabirds that inhabit coastal, nearshore, and open sea waters. Skuas and jaegers in the family Stercorariidae are stocky powerful birds with long pointed wings, long tails, strong hooked bills, and sharp talons known for robbing the food of smaller seabirds, teasing and harassing them until they drop their prey. Murres, murrelets, and auklets in the family Alcidae are good swimmers and divers and have short wings, which require them to flap their wings rapidly to fly.

Species in the order Charadriiformes occupy diverse habitats. Some species in this order spend most of their time at sea (e.g., jaegers, skuas, alcids), whereas others are more coastal or near shore (e.g., gulls). Many charadriiforms inhabit marine and freshwater wetlands; others spend most of their lives in or near the ocean. Many species breed in colonies, and some species lay more than one egg (Ericson et al. 2003; Fain and Houde 2007; Harrison 1983; Onley and Scofield 2007). Representative species within the Study Area include Sabine's gull, black-legged kittiwake, black noddy, sooty tern, South polar skua, pomerine jaeger, common murre, long-billed murrelet, rhinoceros auklet, and horned puffin.

3.6.3 ENVIRONMENTAL CONSEQUENCES

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) affect seabirds and seabird communities known to occur within the Study Area. For this Environmental Impact Statement (EIS)/Overseas EIS (OEIS), seabirds are evaluated as groups of species characterized by distribution, body type, or behavior relevant to the stressor being evaluated. Activities are evaluated for their potential effect on all seabirds in general, on each taxonomic grouping, and on the five seabirds in the Study Area listed as endangered or threatened under the ESA. An impacts analysis for seabirds has been conducted for potential mortality, habitat destruction, or breeding and roosting disturbance. Migratory and breeding seabirds utilize portions of the Study Area to differing degrees depending on the foraging and breeding requirements of each species. As listed in the ESA-listed species descriptions, there is no critical habitat or primary constituent elements for listed species within the Study Area. Therefore, the analysis of stressors on critical habitat is not carried though this EIS document.

The alternatives for training and testing activities were examined to determine if the Proposed Action would produce one or more of the following impacts:

- A direct or indirect impact on seabirds or seabird populations from mortality attributed to military training and testing activities taking place within the Study Area.
- A direct or indirect impact on seabird populations from destruction or disturbance of foraging habitat attributed to military training and testing activities taking place within the Study Area.

- A direct or indirect impact on seabird populations from destruction or disturbance of seabird breeding colonies, foraging or roosting areas attributed to military training and testing activities taking place within the Study Area.

The consequences of the proposed military readiness activities on non-federally listed migratory seabirds or on modification of their habitat are evaluated based on the criteria described in the Final Rule authorizing DoD to incidentally take migratory seabirds during military readiness activities (50 C.F.R. Part 21, 28 February 2007) which states that military readiness activities are authorized to take migratory birds provided they do not result in a significant adverse effect on a population of a migratory seabird species. An activity has a significant adverse effect if, over a reasonable period of time, it diminishes the capacity of a population of migratory seabird species to maintain genetic diversity, to reproduce, and to function effectively in its native ecosystem. A population is defined as "a group of distinct, coexisting, same species, whose breeding site fidelity, migration routes, and wintering areas are temporally and spatially stable, sufficiently distinct geographically (at some point of the year), and adequately described so that the population can be effectively monitored to discern changes in its status." (U.S. Bureau of Land Management and U.S. Fish and Wildlife Service 2010).

Navy training and testing activities have the potential to contribute acoustic, energy, physical disturbance/strike, entanglement or ingestion stressors to seabird populations within the Study Area. These stressor types are induced by the training and testing activity types noted in Chapter 2 (Description of Proposed Action and Alternatives), which vary in intensity, frequency, duration, and location within the Study Area; therefore, seabird species may be impacted by different proposed activities. Certain activities take place in specific locations or depth zones within the Study Area outside of the range or foraging abilities of seabirds. Therefore, seafloor device strike, cable and wire entanglement, parachute entanglement, and ingestion of munitions were not carried forward in this analysis for seabirds. Tables 2.8-1 through 2.8-5 present the baseline and proposed training and testing activity locations for each alternative (including number of events and ordnance expended). Based on the general threats to seabirds and shorebirds discussed in Section 3.6.2 (Affected Environment) the stressors applicable to ESA-listed species in the Study Area and analyzed below include the following:

- Acoustic (sonar, other active acoustic sources, explosives, pile driving, swimmer defense airguns, vessel noise, aircraft noise)
- Energy (electromagnetic devices)
- Physical disturbance and strike (aircraft, vessels and in-water devices, military expended materials)
- Ingestion (munitions, military expended materials other than munitions)
- Secondary

3.6.3.1 Acoustic Stressors

This section evaluates the potential for acoustic and explosive stressors to affect seabirds during training and testing activities in the Study Area. These stressors are associated with sonar and other underwater active acoustic sources, explosives, pile driving, aircraft noise, and vessel noise. Following the Conceptual Framework for Assessing Effects from Sound-Producing Activities (Section 3.0.5.7.1), categories of potential impacts from exposure to explosions and noise are direct trauma, hearing loss, auditory masking, behavioral reactions, and physiological stress. Potential negative nonphysiological consequences to seabirds from acoustic and explosive stressors include disturbance of foraging, roosting, or breeding; degradation of foraging habitat; and degradation of known seabird breeding colonies.

The types of seabirds exposed to noise-producing activities or explosive detonations depend on where training and testing activities occur relative to the coast. Seabirds can be divided into three groups based on breeding and foraging habitat: (1) those species such as albatrosses, petrels, frigatebirds, tropicbirds, boobies, and some terns that forage over the ocean and nest on oceanic islands; (2) species such as pelicans, cormorants, gulls, and some terns that nest along the coast and forage in nearshore areas; and (3) those few species such as marbled murrelet that nest in inland habitats and come to the coastal areas to forage.

The area from the beach to about 10 nautical miles (nm) offshore provides foraging areas for breeding terns, gulls, skimmers, and pelicans; a migration corridor and winter habitat for terns, gulls, skimmers, pelicans, loons, cormorants, and gannets; and supports nonbreeding and transient pelagic seabirds. Offshore pelagic waters support nonbreeding and transient pelagic seabirds, loons, gannets, and several tern species (Davis et al. 2000; Hunter et al. 2006a). Pelagic seabirds are generally widely distributed, but they tend to congregate in areas of higher productivity and prey availability (Haney 1986). Such areas include the Pacific Current, particularly areas of eddies and upwelling; areas with productive live/hard bottom habitats; and large algal mats.

Seabirds and migrating birds could be exposed to noises from sources near the water surface or from airborne sources. While foraging seabirds will be present near the water surface, migrating birds may fly at various altitudes. Some species such as sea ducks and loons may be commonly seen flying just above the water's surface, but the same species can also be spotted flying so high that they are barely visible through binoculars (United States Geological Service 2006). While there is considerable variation, the favored altitude for most small birds appears to be between 500 ft. (152.4 m) and 1,000 ft. (304.8 m). Radar studies have demonstrated that 95 percent of the migratory movements occur at less than 10,000 ft. (3,048 m), the bulk of the movements occurring under 3,000 ft. (914.4 m) (United States Geological Service 2006).

Seabirds use a variety of foraging behaviors that could expose them to underwater noise. Most seabirds plunge-dive from the air into the water or perform aerial dipping (the act of taking food from the water surface in flight); others surface-dip (swimming and then dipping to pick up items below the surface) or jump-plunge (swimming, then jumping upward and diving under water). Birds that plunge-dive typically submerge for no more than a few seconds, and any exposure to underwater noise would be very brief. Other seabirds pursue prey under the surface, swimming deeper and staying underwater longer than other plunge-divers. Some of these seabirds may stay underwater for up to several minutes and reach depths between 50 ft. (15.2 m) and 550 ft. (167.6 m) (Jones 2001; Ronconi 2010). Noises generated under water during training and testing would be more likely to impact seabirds that pursue prey, although as previously stated, little is known about seabird hearing ability underwater. Birds that forage in the open ocean often forage more actively at night, when prey species are more likely to be near the surface and naval training and testing is more limited.

If a seabird is close to an explosive detonation, the exposure to high pressure levels and noise impulse can cause barotrauma, physical injury due to a difference in pressure between an air space inside the body and the surrounding air or water. Damage could occur to the structure of the ear, resulting in hearing loss, or to internal organs, causing hemorrhage and rupture.

If a seabird is close to an intense noise source, it could suffer auditory fatigue. Auditory fatigue manifests itself as hearing sensitivity loss over a portion of hearing range, called a noise-induced threshold shift. A threshold shift may be either permanent threshold shift (PTS) or temporary threshold

shift (TTS). Studies have examined hearing loss and recovery in only a few species of birds, and none studied hearing loss in seabirds (e.g., Hashino et al. 1988; Ryals et al. 1999; Ryals et al. 1995; Saunders and Dooling 1974). A bird may experience permanent threshold shift if exposed to a continuous over 110 A-weighted decibels (dBA) re 20 µPa sound pressure level in air or blast noise over 140 dB re 20 µPa sound pressure level in air (Dooling and Therrien 2012). Unlike other species, birds have the ability to regenerate hair cells in the ear, usually resulting in considerable anatomical, physiological, and behavioral recovery within several weeks. Still, intense exposures are not always fully recoverable, even over periods up to a year after exposure, and damage and subsequent recovery vary significantly by species (Ryals et al. 1999). Birds may be able to protect themselves against damage from sustained noise exposures by regulating inner ear pressure, an ability that may protect ears while in flight (Ryals et al. 1999). Diving birds have adaptations to protect the middle ear and tympanum from pressure changes during diving that may affect hearing (Dooling and Therrien 2012). Auditory fatigue can impair an animal's ability to hear biologically important sounds within the affected frequency range. Biologically important sounds come from social groups, potential mates, offspring, or parents; environmental sounds; or predators.

Numerous studies have documented that birds respond to anthropogenic noise, including aircraft overflights, weapons firing, and explosions (Larkin et al. 1996; National Park Service 1994; Plumpton 2006). Studies generally indicate that birds hear in-air sounds over a very limited range between 1 and 5 kHz but specific species hearing can extend to higher and lower frequencies (Beason 2004). The manner in which birds respond to noise depends on several factors, including life-history characteristics of the species, characteristics of the noise source, loudness, onset rate, distance from the noise source, presence or absence of associated visual stimuli, and previous exposure (Larkin et al. 1996; National Park Service 1994; Plumpton 2006). Researchers have documented a variety of behavioral responses of birds to noise, such as alert behavior, startle response, flying or swimming away, diving into the water, and increased vocalizations. While they are difficult to measure in the field, some of these behavioral responses may be accompanied by physiological responses, such as increased heart rate short-term changes in stress hormone levels (Partecke et al. 2006).

Chronic stress due to disturbance may compromise the general health and reproductive success of birds (Kight et al. 2012), but a physiological stress response is not necessarily indicative of negative consequences to individual birds or to populations (Larkin et al. 1996; National Parks Service 1994). The reported behavioral and physiological responses of birds to noise exposure can fall within the range of normal adaptive responses to external stimuli, such as predation, that birds face on a regular basis. These responses can include activation of the neural and endocrine systems, causing changes such as increased blood pressure, available glucose, and blood levels of corticosteroids (Manci et al. 1988). It is possible that individuals would return to normal almost immediately after exposure, and the individual's metabolism and energy budget would not be affected long-term. Studies also have shown that birds can become habituated to noise following frequent exposure and cease to respond behaviorally to the noise (Larkin et al. 1996; National Park Service 1994; Plumpton 2006). However, the likelihood of habituation is dependent upon a number of factors, including species of bird (Bowles et al. 1991), and frequency of and proximity to exposure. Raptors have been shown to shift their terrestrial home range when concentrated military training activity was introduced to the area (Andersen et al. 1990). On the other hand, cardinals nesting in areas with high levels of military training activity (including gunfire, artillery, and explosives)were observed to have similar reproductive success and stress hormone levels as cardinals in areas of low activity (Barron et al. 2012).

3.6.3.1.1 Impacts from Sonar and Other Active Acoustic Sources

Sonar and other underwater active acoustic sources could be used throughout the Study Area. Information regarding the impacts from sonar on seabirds and the ability for seabirds to hear underwater is virtually unknown. The exposure to these sounds by seabirds, other than pursuit diving species, is likely to be very limited due to spending a very short time under water (plunge-diving or surface-dipping) or foraging only at the water surface. Pursuit divers may remain under water for minutes, increasing the chance of underwater sound exposure.

A physiological impact, such as hearing loss, would likely occur if a seabird is close to an intense sound source. In general, birds are less susceptible to both temporary and permanent threshold shift than mammals (Saunders and Dooling 1974), so an underwater sound exposure would have to be intense and of a sufficient duration to cause temporary or permanent threshold shift. Avoiding the sound by returning to the surface would limit extended or multiple sound exposures underwater. There have been no studies documenting diving seabirds' reactions to sonar.

Seabirds that approach vessels while foraging would be most likely to be exposed to underwater active acoustic sources. If the presence of a ship attracts diving seabirds, the seabirds could be more likely to be exposed to an underwater sound if the ship is engaged in anti-submarine warfare or mine warfare with active acoustic sources. Some seabirds commonly follow vessels, including certain species of gulls, storm petrels, and albatrosses, for increased potential of foraging success as the prop wake brings prey to the surface (Hamilton III 1958; Hyrenbach 2001, 2006b; Melvin et al. 2001). However, most hull-mounted sonars do not project sound aft of ships (behind the ship, opposite the direction of travel), so most seabirds diving in ship wakes would not be exposed to sonar.

The possibility of an ESA-listed seabird species being exposed to sonar and other active acoustic sources depends on whether it submerges during foraging and whether it forages in areas where these sound sources may be used. Although petrels and albatrosses forage in open ocean areas where sonar training and testing occurs, they would not be exposed to underwater sound because they forage at the surface. Least terns forage in coastal shallow waters where they could be exposed to sonar and other active acoustic sources, notably near ports and shipyards where sonar maintenance and testing occur. However, their plunge dives are brief, so any chance of exposure would be minimal. Most other sonar use occurs farther offshore, however, so the chance for an exposure would be low.

3.6.3.1.1.1 No Action Alternative

Training Activities

Training activities under the No Action Alternative include activities that produce in-water sound from the use of sonar and other active non-impulsive acoustic sources include anti-submarine warfare, mine warfare, object detection and navigation, communication, and maintenance. These activities could occur throughout the Study Area, but would be concentrated in the SOCAL and HRC portions of the study area. The Pacific Current runs through the SOCAL Range Complex portion of the Study Area, and is an area of increased productivity that attracts foraging seabirds. Therefore, seabirds that forage in these open ocean areas would have a greater chance of underwater sound exposure than seabirds that forage in coastal areas.

Diving seabirds may not respond to an underwater sound, but if a diving seabird does react to an underwater sound source, it could result in a short-term behavioral response. Seabirds would avoid any additional exposures during a foraging dive when they surface. Due to the limited duration of training

events and widespread availability of open ocean foraging habitat, any sound exposures would be minimal and are unlikely to have a long-term impact on an individual or a population.

Least terns may briefly submerge while foraging, so there is a remote chance that a least tern could be briefly exposed to underwater sound sonar and other active acoustic sources. However, least terns forage in the nearshore waters, in areas where the acoustic sources used are minimal, further reducing the potential for exposure.

It is likely that few seabirds would be affected by sonar and other underwater active acoustic sources because:

- sources are used intermittently during a training event,
- training events are dispersed in space and time,
- most seabirds spend little time submerged, and
- exposures sufficiently intense (i.e., of a certain duration or within a close proximity) to cause physiological impacts are unlikely.

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of sonar and other active acoustic sources during training activities under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Testing activities under the No Action Alternative include activities that produce in-water sound from the use of sonar and other active non-impulsive acoustic sources could occur throughout the Study Area, but would be concentrated in the SOCAL and HRC portions of the study area. The Pacific Current runs through the SOCAL Range Complex portion of the Study Area, and is an area of increased productivity that attracts foraging seabirds. Therefore, seabirds that forage in these open ocean areas would have a greater chance of underwater sound exposure than seabirds that forage in coastal areas.

Diving seabirds may not respond to an underwater sound, but if a diving seabird does react to an underwater sound source, it could result in a short-term behavioral response. Seabirds would avoid any additional exposures during a foraging dive when they surface. Due to the limited duration of training events and widespread availability of open ocean foraging habitat, any sound exposures would be minimal and are unlikely to have a long-term impact on an individual or a population.

It is likely that few seabirds would be affected by sonar and other underwater active acoustic sources because:

- sources are used intermittently during a training event,
- training events are dispersed in space and time,
- most seabirds spend little time submerged, and
- exposures sufficiently intense (i.e., of a certain duration or within a close proximity) to cause physiological impacts are unlikely.

Hawaiian petrels and short-tailed albatrosses do not submerge while foraging; therefore, they would not be exposed to underwater sound from sonar and other active acoustic sources. Least terns, marbled murrelet, and Newell's shearwater may briefly submerge while foraging, either during plunge-diving (terns) or pursuit diving (murrelet and shearwater), so there is a remote chance that these species could be exposed to underwater sound sonar and other active acoustic sources.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of sonar and other underwater acoustic sources during testing activities under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.1.2 Alternative 1

Training Activities

The number of annual training activities that produce in-water sound from the use of sonar and other active acoustic sources under Alternative 1 would approximately double from the No Action Alternative. This includes overall increases to anti-submarine warfare; mine warfare; object detection and navigation; communication; and maintenance. Training activities would occur in similar areas as under the No Action Alternative for similar activities. Based on the increased operations under Alternative 1 versus the No Action Alternative, more seabirds could be exposed to sonar and other active acoustic sources. Although the quantity of underwater acoustic stressors would increase, any impacts on seabirds would likely be limited to short-term behavioral reactions by diving seabirds as described under the No Action Alternative. Due to the limited duration of training events and widespread availability of open ocean foraging habitat, any sound exposures would be minimal and are unlikely to have a long-term impact on an individual or a population.

Hawaiian petrels and short-tailed albatrosses do not submerge while foraging; therefore, they would not be exposed to underwater sound from sonar and other active acoustic sources. Least terns, marbled murrelet, and Newell's shearwater may briefly submerge while foraging, either during plunge-diving (terns) or pursuit diving (murrelet and shearwater), so there is a remote chance that these species could be exposed to underwater sound sonar and other active acoustic sources. However, any sound exposures would be minimal and are unlikely to have a long-term impact on an individual or a population.

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities under the Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of sonar and other active acoustic sources during training activities under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources) and Table 3.0-8 describe the use of sonar and other underwater active acoustic sources during testing activities under Alternative 1. Use of sonar and other active acoustic sources would approximately double under Alternative 1 versus the No Action Alternative. Sonar and other active acoustic sources would be used in waters throughout the range complexes and testing ranges, and smaller amounts would be used in waters beyond the range

complexes or in nearshore areas, including locations not used under the No Action Alternative. Although the quantity of underwater acoustic stressors would increase, any impacts on seabirds would likely be limited to short-term behavioral reactions by diving seabirds, as described under the No Action Alternative. Due to the limited duration of testing events and widespread availability of open ocean foraging habitat, any sound exposures would be minimal and are unlikely to have a long-term impact on an individual or a population.

Hawaiian petrels and short-tailed albatrosses do not submerge while foraging; therefore, they would not be exposed to underwater sound from sonar and other active acoustic sources. Least terns, marbled murrelet, and Newell's shearwater may briefly submerge while foraging, either during plunge-diving (terns) or pursuit diving (murrelet and shearwater), so there is a remote chance that these species could be exposed to underwater sound sonar and other active acoustic sources. However, any sound exposures would be minimal and are unlikely to have a long-term impact on an individual or a population.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of sonar and other active acoustic sources during testing activities under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.1.3 Alternative 2

Training Activities

The number of annual training activities that produce in-water noise from the use of sonar and other active acoustic sources under Alternative 2 would increase over the No Action Alternative. This includes overall increases to anti-submarine warfare; mine warfare; object detection and navigation; communication; and maintenance. Training activities would occur in similar areas as under the No Action Alternative for similar activities. Based on the increased operations under Alternative 2 versus the No Action Alternative, more seabirds could be exposed to sonar and other active acoustic sources. Although the quantity of underwater acoustic stressors would increase, any impacts on seabirds would likely be limited to short-term behavioral reactions by diving seabirds, as described under the No Action Alternative. Due to the limited duration of training events and widespread availability of open ocean foraging habitat, any sound exposures would be minimal and are unlikely to have a long-term impact on an individual or a population.

Hawaiian petrels and short-tailed albatrosses do not submerge while foraging; therefore, they would not be exposed to underwater sound from sonar and other active acoustic sources. Least terns, marbled murrelet, and Newell's shearwater may briefly submerge while foraging, either during plunge-diving (terns) or pursuit diving (murrelet and shearwater), so there is a remote chance that these species could be exposed to underwater sound sonar and other active acoustic sources.

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities under the Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of sonar and other active acoustic sources during training activities under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources) describes the use of sonar and other underwater active acoustic sources during testing activities under Alternative 2, including relative concentrations and locations within the Study Area. Use of sonar and other active acoustic sources would increase under Alternative 2 versus the No Action Alternative. The proposed testing activities would also increase over Alternative 1. Sonar and other active acoustic sources would be used in waters throughout the range complexes and testing ranges, and smaller amounts would be used in waters beyond the range complexes or in nearshore areas, including locations not used under the No Action Alternative. Although the quantity of underwater acoustic stressors would increase, any impacts on seabirds would likely be limited to short-term behavioral reactions by diving seabirds, as described under the No Action Alternative. Due to the limited duration of testing events and widespread availability of open ocean foraging habitat, any sound exposures would be minimal and are unlikely to have a long-term impact on an individual or a population.

Hawaiian petrels and short-tailed albatrosses do not submerge while foraging; therefore, they would not be exposed to underwater sound from sonar and other active acoustic sources. Least terns, marbled murrelet, and Newell's shearwater may briefly submerge while foraging, either during plunge-diving (terns) or pursuit diving (murrelet and shearwater), so there is a remote chance that these species could be exposed to underwater sound sonar and other active acoustic sources.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of sonar and other active acoustic sources during testing activities under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.2 Impacts from Explosives and Swimmer Defense Airguns

The potential for seabirds to be exposed to explosive detonations from training or testing activities depends on several factors, including the presence of seabirds at, beneath, or above the water surface near the detonation; location of the detonation at, below, or above the water surface; size of the explosive; and distance from the detonation. Explosions are associated with detonations of high-explosive missiles and projectiles in air; high-explosive grenades, bombs, missiles, rockets, and projectiles at or immediately below the sea surface; mine neutralization charges on the bottom and in the water column; high-explosive torpedoes near the surface and in the water column; explosive sonobuoys in the water column; and other small charges used at various depths during testing. Section 3.0 describes the shock waves and acoustic waves imparted to a surrounding medium by an explosive detonation and how these waves propagate. Because airguns are an impulsive source, with the potential for similar non-traumatic impacts as explosives, they are considered in this section.

A seabird close to an explosive detonation could be killed or injured. Blast injuries are usually most evident in the gas-containing organs, such as those of the respiratory and gastrointestinal systems. Blasts can also damage pressure-sensitive components of the auditory system. In general, the impacts of explosions would be reduced with increasing distance of the seabird from the explosion, and would range from lethal injury in the immediate vicinity of an explosion to short-term behavioral impacts on the outer edges of the zone of influence.

Underwater detonations could affect diving seabirds and seabirds on the water surface. Studies have shown that birds are more susceptible to underwater explosions when they are submerged versus on the surface (Yelverton et al. 1973). Underwater detonations could have lethal impacts on seabirds in water if impulse exceeds 36 pounds per square inch (in.) (psi)-milliseconds (msec) (psi-msec) (248 Pascal [Pa]-second [sec]) for birds underwater and 100 psi-msec (690 Pa-sec) just below the water surface for birds at the water surface (Yelverton et al. 1973). These impulse levels correspond to onset mortality, or the level at which one percent of animals would not be expected to survive. Exposures to higher impulse levels would have greater likelihoods of mortality. No injuries would be expected for seabirds underwater at blast pressures below 6 psi-msec (41 Pa-sec) and for seabirds on the surface at blast pressures below 30 psi-msec (207 Pa-sec). Table 3.6-4 shows estimated ranges to onset mortality and to the safety range (no injury expected) for several classes of charges proposed to be used in the Study Area, assuming a diving seabird is exposed at 15 ft. (4.6 m) below the water surface, using the Yelverton method. Ranges to impacts are based on several factors including charge size, depth of the detonation, and how far the seabird is beneath the water surface. It should be cautioned that these are estimates, and actual ranges to impacts would depend on conditions at each detonation site.

Detonations in air could also injure seabirds while either in flight or at the water surface. Experiments that exposed seabirds to blast waves in air provided a relationship between charge size, distance from detonation, and likelihood of seabird injury or mortality (Damon et al. 1974). Table 3.6-5 shows the safe distance from a detonation in air beyond which no injuries to seabirds would be expected.

Table 3.6-4: Estimated Ranges to Impacts for Diving Birds Exposed to Underwater Detonations

Source Class	Representative Munitions	Net Explosive Weight (lb.)	Depth of Charge	Distance to Onset Mortality	Safety Range
E6	Air-to-Surface missile	11–20	33 ft. (10 m)	220–330 ft. (70–100 m)	780–920 ft. (240–280 m)
E12	2,000 lb. bomb	601–1,000	10 ft. (3 m)	460–600 ft. (140–180 m)	1,000–1,200 ft. (330–370 m)
E17	40,000 lb. HBX charge	14,501–58,000	200 ft. (61 m)	2,700–3,900 ft. (800–1200 m)	7,300–9,700 ft. (2,200–3,000 m)

Notes: ft. = feet, HBX = high blast explosive, lb. = pounds, m = meters

Table 3.6-5: Safe Distance from Detonations in Air for Birds

Explosive Source Class	Sample Ordnance	Net Explosive Weight	Safe Distance (no Injury)[1]
E3	76 mm round	0.6–2 lb.	22 ft. (7 m)
E5	5 in. projectiles	6–10 lb.	22 ft. (10 m)
E7	Rolling Airframe Anti-Air Missile	21–60 lb.	70 ft. (21 m)

[1] Damon 1974

Notes: ft. = feet, in. = inches, lb.= pounds, m = meters, mm = millimeters

The airborne noise associated with underwater explosions and airgun use is minimal. Because of the differences in acoustic transmission in water and in air, an effect called the Lloyd mirror reflects underwater noise at the water surface. Therefore, noise generated in the water will not pass over to the air (refer to the acoustic and explosives primer in Section 3.0). Noises generated by most small underwater explosions, therefore, are unlikely to disturb seabirds above the water surface. If a

detonation is sufficiently large or is near the water surface, however, pressure will be released at the air-water interface. Birds above this pressure release could be injured or killed.

Most high-explosive ordnance used in anti-surface warfare training and testing detonates at the water surface or a short distance below the water surface. The blast waves and acoustic waves would propagate through both water and air, although near the surface most pressure release would be into the air. Birds close to the detonation point would be injured or killed. Detonations in air during anti-air warfare training and testing would typically occur at much higher altitudes (greater than 3,000 ft. [914.4 m] above sea level) where seabirds and migrating birds are less likely to be present (U.S. Geological Survey 2006). Foraging seabirds will typically be at lower elevations where they are likely to be unaffected by in-air explosions. Therefore, seabirds are unlikely to be injured or killed by high-altitude in-air detonations.

At distances beyond those to injury, responses to noise from an explosive detonation would be limited to short-term behavioral or physiological responses (e.g., alert response, startle response, and temporary increase in heart rate). Startle or alert reactions to muzzle blasts are not likely to disrupt major behavior patterns, such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any seabirds. Birds may be temporarily displaced and there may be temporary increases in stress levels; however, behavior and use of habitat would return shortly after the training is complete. Beason (2004) notes that birds exposed to up to 146 dBA within 325 ft. (99.1 m) of the noise source flushed but then returned within minutes of the disturbance. The range of impacts could depend on the charge size, distance from the charge, and the seabird's life activity at the time of the exposure.

Fleeing response to an initial explosion may reduce seabird exposure to any additional explosions that occur within a short timeframe. Seabirds could also be attracted to an area to forage if an explosion resulted in a fish kill. This would only be a concern for events that involved multiple explosions in the same area within a single event, such as firing exercises, which involves firing multiple high-explosive 5 in. rounds at a target area, and bombing exercises, which could involve multiple bomb drops separated by several minutes.

3.6.3.1.2.1 No Action Alternative

Training Activities

Explosive detonations are associated with training activities under the No Action Alternative that use high-explosive charges, including bombs, missiles, explosive munitions, explosive sonobuoys, grenades, munitions used in sinking exercises, and underwater detonations associated with mine neutralization training. The detonations would include explosive source classes up to E13 (1,000–1,740 lb. net explosive weight) (see Table 3.0-9). Training activities involving explosive detonations are spread throughout the Study Area, but would be concentrated in the SOCAL Range Complex portion of the Study Area, followed in descending order of numbers of activities by HRC, Silver Strand Training Complex (SSTC), and the Transit Corridor. Training activities using explosives generally do not occur within 1.6 nm of shore or within 3 nm of bays, rivers, or estuaries except those used in the San Diego Bay and boat training lanes of SSTC (E1–E6 [less than 20 lb. net explosive weight]). A more detailed description of these training activities and their proposed locations are presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives).

Nearshore waters are the primary foraging habitat for many seabird species. Any small detonations close to shore could have a short-term adverse impact on nesting and nearshore foraging species. Most larger detonations would occur near areas with the potential for relatively high concentrations of

seabirds (upwelling areas associated with the Pacific Current; productive live/hard bottom habitats; and large algal mats); therefore, any impacts on seabirds are likely to be greater in these areas. While the impacts of explosive detonations on seabirds under the No Action Alternative cannot be quantified due to limited data on seabird density, lethal injury to some seabirds could occur. Lethal injuries would likely be associated with detonations of bombs with larger net explosive weights, although any event employing static targets may attract seabirds to the detonation site. Because explosive detonations occur at varying locations over a short time period and seabird presence changes seasonally and on a short-term basis, individual seabirds would not be expected to be repeatedly exposed to explosive detonations. Any impacts on migratory or breeding seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent and would not impact seabird or migratory bird populations.

Airborne detonations would occur during gunnery and air-to-air missile activities, although these would occur at relatively high altitudes. Any impacts would likely be limited to short-term startle reactions, as the detonations would occur far above typical seabird flight altitudes.

ESA-listed seabirds are known to be present in areas where detonations would occur during training under the No Action Alternative. While the information known about seabird distribution limits the ability to quantify the impacts of explosions, the likelihood of an injurious exposure seems remote based on the very low density of seabirds. An exposure resulting in a short-term behavioral response would be more likely to occur than an exposure that causes injury. Least terns could startle in the vicinity of explosive detonations from training at SSTC as they forage areas where detonations occur. However, the detonations used in these foraging areas are restricted to less than 20 lb. net explosive weight. If a detonation occurred in the vicinity of least terns, impacts would likely be limited to short-term startle reactions as the zone of impact around these smaller detonations are minimal. Protective measures, such as restricting underwater explosions if flocks of seabirds are rafting on the water's surface inside a mitigation zone or if flocks of seabirds are migrating directly above the proposed training site minimize impacts on seabirds (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring). Mitigation measures include visual surveillance from surface vessels or aircraft beginning 30 minutes before, during, and 30 minutes after the completion of the exercise within the mitigation zones around the detonation site. If a seabird is visually detected within the mitigation zone, then the exercise will cease until the mitigation zone has been clear from any additional sightings for 30 minutes. These mitigation measures further reduce the potential impact upon seabirds.

Pursuant to the ESA, the use of explosives during training activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of explosives during training activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Explosive detonations are associated with testing activities under the No Action Alternative that use high-explosive charges, including bombs, missiles, explosive munitions, explosive sonobuoys, grenades, munitions used in sinking exercises, and underwater detonations associated with mine neutralization training. The detonations would include explosive source classes up to E11 (500–650 lb. net explosive weight) (see Table 3.0-9). Testing activities involving explosive detonations are spread throughout the Study Area, but would be concentrated in the SOCAL Range Complex portion of the Study Area, followed

in descending order of numbers of activities by the HRC. Further, under the No Action Alternative, the vast majority (4,546) of explosive detonations are explosive source class E1–E4 (less than 5 lb. net explosive weight). A more detailed description of these testing activities and their proposed locations are presented in Tables 2.8-2 through 2.8-5 of Chapter 2 (Description of Proposed Action and Alternatives).

Nearshore waters are the primary foraging habitat for many seabird species. Any small detonations close to shore could have a short-term adverse impact on nesting and nearshore foraging species. Most larger detonations would occur near areas with the potential for relatively high concentrations of seabirds (upwelling areas associated with the Pacific Current; productive live/hard bottom habitats; and large algal mats); therefore, any impacts on seabirds are likely to be greater in these areas. However, under the No Action Alternative, only 15 explosive detonations of explosive class source E5 or greater (greater than 5 lb. net explosive weight) (Table 3.0-9) would occur. While the impacts of explosive detonations on seabirds under the No Action Alternative cannot be quantified due to limited data on seabird density, lethal injury to some seabirds could occur. Lethal injuries would likely be associated with detonations of bombs with larger net explosive weights, although any event employing static targets may attract seabirds to the detonation site. While some seabird mortality could occur, the mortality potential is very low, given the low number of large net explosive weight detonations and the dispersed nature of seabirds in the study area. Because explosive detonations occur at varying locations over a short time period and seabird presence changes seasonally and on a short-term basis, individual seabirds would not be expected to be repeatedly exposed to explosive detonations. Airgun detonations may startle diving birds foraging in port areas where underwater airgun detonations would occur. Any impacts on migratory or breeding seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent and would not impact seabird or migratory bird populations.

ESA-listed seabirds are known to be present in areas where detonations would occur during training under the No Action Alternative. While the information known about seabird distribution limits the ability to quantify the impacts of explosions, the likelihood of an injurious exposure seems remote based on the very low density of seabirds and low net explosive weight used. An exposure resulting in a short-term behavioral response would be more likely to occur than an exposure that causes injury.

Pursuant to the ESA, the use of explosives during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of explosives during testing activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.2.2 Alternative 1

Training Activities

The total number of explosive detonations throughout the Study Area would decrease by 15 percent under Alternative 1 (Table 3.0-9) as compared to the No Action Alternative. The detonations would include explosive source classes up to E13 (1,000–1,740 lb. net explosive weight). Training activities involving explosive detonations occur throughout the Study Area, but would be concentrated in the SOCAL Range Complex portion of the Study Area, followed in descending order of numbers of activities by HRC, SSTC, and the Transit Corridor. Training activities using explosives generally do not occur within 1.6 nm of shore or within 3 nm of bays, rivers, or estuaries except those used in the San Diego Bay and

boat training lanes of SSTC (E1–E7 [less than 60 lb. net explosive weight]). Alternative 1 would introduce the use of high explosive rockets. The majority of these rockets would be used in the SOCAL Range Complex portions of the Study Area, with the remainder being used in the HRC portion of the Study Area, and none would be used in the SSTC portion of the Study Area. A more detailed description of these training activities and their proposed locations are presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives).

Potential impacts on seabirds by explosive detonations are expected to be similar to those under the No Action Alternative, but the potential for exposure would decrease with lower number of explosive detonations. While some seabird mortalities could occur, only a small number of seabirds would be affected. Any impacts on seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term (behavioral) and infrequent and would not impact seabird or migratory bird populations. Repeated exposure of individual seabirds or groups of seabirds would be unlikely, based on the large operational area of the Study Area and the dispersed nature of the activities.

ESA-listed seabirds are known to be present in areas where detonations would occur during training under Alternative 1. While the information known about seabird distribution limits the ability to quantify the impacts of explosions, the likelihood of an injurious exposure seems remote based on the very low density of seabirds and smaller number of explosive detonations. An exposure resulting in a short-term behavioral response would be more likely to occur than an exposure that causes injury.

Pursuant to the ESA, the use of explosives during training activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of explosives during training activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Explosive detonations associated with testing activities under Alternative 1 would nearly triple as compared to the No Action Alternative. The detonations would include explosive source classes up to E11 (500–650 lb. net explosive weight) (see Table 3.0-9). However, the vast majority (16,136 of 16,424) of explosive detonations are explosive source class E1–E4 (less than 5 lb. net explosive weight).Testing activities involving explosive detonations are spread throughout the Study Area, but would be concentrated in the SOCAL Range Complex portion of the Study Area, followed in descending order of numbers of activities by the HRC. A more detailed description of these testing activities and their proposed locations are presented in Tables 2.8-2 through 2.8-5 of Chapter 2 (Description of Proposed Action and Alternatives).

Small detonations close to shore could have a short-term adverse impact on nesting and nearshore foraging species. Most larger detonations would occur near areas with the potential for relatively high concentrations of seabirds (upwelling areas associated with the Pacific Current; productive live/hard bottom habitats; and large algal mats); therefore, any impacts on seabirds are likely to be greater in these areas. However, under Alternative 1, only 288 explosive detonations are of explosive class source E5 or greater (greater than 5 lb. net explosive weight) (Table 3.0-9). While the impacts of explosive detonations on seabirds under Alternative 1 cannot be quantified due to limited data on seabird density, lethal injury to some seabirds could occur. Lethal injuries would likely be associated with explosive

detonations with larger net explosive weights, although any event employing static targets may attract seabirds to the detonation site. While some seabird mortality could occur, the mortality potential is low, given the number of large net explosive weight detonations and the dispersed nature of seabirds in the study area. Because explosive detonations occur at varying locations over a short time period and seabird presence changes seasonally and on a short-term basis, individual seabirds would not be expected to be repeatedly exposed to explosive detonations. Similar to the No Action Alternative, any impacts on migratory or breeding seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent and would not impact seabird or migratory bird populations.

ESA-listed seabirds are known to be present in areas where detonations would occur during training under Alternative 1. While the information known about seabird distribution limits the ability to quantify the impacts of explosions, the likelihood of an injurious exposure seems remote based on the very low density of seabirds and net explosive weight used. An exposure resulting in a short-term behavioral response would be more likely to occur than an exposure that causes injury.

Pursuant to the ESA, the use of explosives during testing activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of explosives during testing activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.2.3 Alternative 2

Training Activities

The total number of explosive detonations throughout the Study Area would decrease by 15 percent under Alternative 2 (Table 3.0-9) as compared to the No Action Alternative. The detonations would include explosive source classes up to E13 (1,000–1,740 lb. net explosive weight). Training activities involving explosive detonations occur throughout the Study Area, but would be concentrated in the SOCAL Range Complex portion of the Study Area, followed in descending order of numbers of activities by HRC, SSTC, and the Transit Corridor. Training activities using explosives generally do not occur within 1.6 nm of shore or within 3 nm of bays, rivers, or estuaries except those used in the San Diego Bay and boat training lanes of SSTC (E1–E7 [less than 60 lb. net explosive weight]). Alternative 2 would introduce the use of high explosive rockets. The majority of these rockets would be used in the SOCAL Range Complex portions of the Study Area, with the remainder being used in the HRC portion of the Study Area, and none would be used in the SSTC portion of the Study Area. A more detailed description of these training activities and their proposed locations are presented in Tables 2.8-2 through 2.8-5 of Chapter 2 (Description of Proposed Action and Alternatives).

Potential impacts on seabirds by explosive detonations are expected to be similar to those under the No Action Alternative, but the potential for exposure would decrease with lower number of explosive detonations. While some seabird mortalities could occur, only a small number of seabirds would be affected. Any impacts on seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term (behavioral) and infrequent and would not impact seabird or migratory bird populations. Repeated exposure of individual seabirds or groups of seabirds would be unlikely, based on the large operational area of the Study Area and the dispersed nature of the activities.

ESA-listed seabirds are known to be present in areas where detonations would occur during training under Alternative 2. While the information known about seabird distribution limits the ability to quantify the impacts of explosions, the likelihood of an injurious exposure seems remote based on the very low density of seabirds and smaller number of explosive detonations. An exposure resulting in a short-term behavioral response would be more likely to occur than an exposure that causes injury.

Pursuant to the ESA, the use of explosives during training activities under Alternative 2 may affect, but is not likely to adversely affect ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of explosives during training activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Explosive detonations associated with testing activities under Alternative 2 would approximately triple as compared to the No Action Alternative. The detonations would include explosive source classes up to E11 (500–650 lb. net explosive weight) (see Table 3.0-9). However, the vast majority (18,244 of 18,561) of explosive detonations are explosive source class E1–E4 (less than 5 lb. net explosive weight).Testing activities involving explosive detonations occur throughout the Study Area, but would be concentrated in the SOCAL Range Complex portion of the Study Area, followed in descending order of numbers of activities by the HRC. A more detailed description of these testing activities and their proposed locations are presented in Tables 2.8-2 through 2.8-5 of Chapter 2 (Description of Proposed Action and Alternatives).

Small detonations close to shore could have a short-term adverse impact on nesting and nearshore foraging species. Most larger detonations would occur near areas with the potential for relatively high concentrations of seabirds (upwelling areas associated with the Pacific Current; productive live/hard bottom habitats; and large algal mats); therefore, any impacts on seabirds are likely to be greater in these areas. However, under Alternative 2, only 317 explosive detonations of explosive class source E5 or greater (greater than 5 lb. net explosive weight) would occur (Table 3.0-9). While the impacts of explosive detonations on seabirds under Alternative 1 cannot be quantified due to limited data on seabird density, lethal injury to some seabirds could occur. Lethal injuries would likely be associated with explosive detonations with larger net explosive weights, although any event employing static targets may attract seabirds to the detonation site. While some seabird mortality could occur, the mortality potential is low, given the number of large net explosive weight detonations and the dispersed nature of seabirds in the study area. Because explosive detonations occur at varying locations over a short time period and seabird presence changes seasonally and on a short-term basis, individual seabirds would not be expected to be repeatedly exposed to explosive detonations. Similar to the No Action Alternative, any impacts on migratory or breeding seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent and would not impact seabird or migratory bird populations.

ESA-listed seabirds are known to be present in areas where detonations would occur during training under the No Action Alternative. While the information known about seabird distribution limits the ability to quantify the impacts of explosions, the likelihood of an injurious exposure seems remote based on the very low density of seabirds and net explosive weight used. An exposure resulting in a short-term behavioral response would be more likely to occur than an exposure that causes injury.

Pursuant to the ESA, the use of explosives during testing activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of explosive detonations during testing activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.3 Impacts from Pile Driving

Acoustic sources from pile driving could occur within the SSTC portion of the Study Area during elevated causeway construction activities. During an elevated causeway event, a pier is constructed off of the beach. The pier is designed to allow for offload of materials and equipment from supply ships. Piles are driven into the sand with an impact hammer. Causeway platforms are then hoisted and secured onto the piles with hydraulic jacks and cranes. The elevated causeway pier, including associated piles, is removed at the conclusion of training. Noise associated with elevated causeway installation activities includes a loud impulsive noise derived from driving piles into the soft sandy substrate of the SSTC waters to temporarily support a causeway of linked pontoons.

Information regarding the impacts from acoustic sources on seabirds and the ability for seabirds to hear underwater is virtually unknown. The exposure to these noises by seabirds, other than pursuit diving species, is likely to be very limited due to spending a very short time under water (plunge-diving or surface-dipping) or foraging only at the water surface. Pursuit divers may remain under water for minutes, increasing the chance of underwater noise exposure.

Responses to noise from pile driving would be limited to short-term behavioral or physiological responses (e.g., alert response, startle response, and temporary increase in heart rate). Startle or alert reactions to muzzle blasts are not likely to disrupt major behavior patterns, such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any seabirds. Birds may be temporarily displaced and there may be temporary increases in stress levels; however, behavior and use of habitat would return shortly after the training is complete. Beason (2004) notes that birds exposed to up to 146 dBA within 325 ft. (99.1 m) of the noise source flushed but then returned within minutes of the disturbance. The range of impacts could depend on the charge size, distance from the charge, and the seabird's life activity at the time of the exposure.

3.6.3.1.3.1 No Action Alternative, Alternative 1, and Alternative 2

Training Activities

Pile driving is associated with four training activities annually under the No Action Alternative, Alternative 1, and Alternative 2. Training activities involving pile driving is limited to the SSTC portion of the Study Area.

Nearshore waters are the primary foraging habitat for many seabird species. Noise from pile driving close to shore could have a short-term adverse impact on nesting and nearshore foraging species. However, human activity such as vessel or boat movement, and equipment setting and movement, could cause seabirds to flee the activity area before the onset of pile driving. If seabirds were in the activity area, they would likely flee the area prior to the release of military expended materials or just after the initial strike of the pile. In-air pile driving noise could elicit short-term behavioral or physiological responses but are not likely to disrupt major behavior patterns, such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any seabirds. Beason (2004) notes that

birds exposed to up to 146 dBA within 325 ft. (99.1 m) of the noise source flushed but then returned within minutes of the disturbance. Pile driving noise is not expected to be at this noise level in air.

Information regarding the impacts from underwater pile driving noise on seabirds and the ability for seabirds to hear underwater is virtually unknown. The exposure to these noises by seabirds, other than pursuit diving species, is likely to be very limited due to spending a very short time under water (plunge-diving or surface-dipping) or foraging only at the water surface. Pursuit divers may remain under water for minutes, increasing the chance of underwater noise exposure. Assuming that a seabird disturbed by an underwater noise would avoid the stressor by swimming to the surface, a physiological impact, such as hearing loss, would only occur if a seabird is close to an intense noise source. In general, birds are less susceptible to both temporary and permanent threshold shift than mammals (Saunders and Dooling 1974), so an underwater noise exposure would have to be intense and of a sufficient duration to cause temporary or permanent threshold shift. Avoiding the noise by returning to the surface would limit extended or multiple noise exposures underwater. Any impacts on migratory or breeding seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent and would not impact seabird or migratory bird populations.

One ESA-listed seabird is known to be present in areas where pile driving would occur during training under the No Action Alternative, Alternative 1, or Alternative 2. California least terns could be exposed to intermittent pile driving noise during the approximate two week period of each elevated causeway event. However, during the elevated causeway activity, any impact based on displacement from the activity area would be minimized due to the availability of suitable foraging habitat in adjacent boat training lanes at SSTC. Further, an exposure resulting in a short-term behavioral response would only be expected if the seabirds did not leave the area prior to the start of the elevated causeway activity. Repeated exposure of individual seabirds is unlikely based on the seabird's capability to avoid or rapidly vacate an area of disturbance and availability of non-impacted foraging habitats.

Pursuant to the ESA, pile driving during training activities under all alternatives may affect, but is not likely to adversely affect, the ESA-listed California least tern. Noise from pile driving events from training activities under all alternatives would have no effect on the remaining ESA-listed seabirds in the Study Area.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), pile driving during training activities under any alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Under the No Action Alternative, Alternative 1, or Alternative 2, no pile driving events are planned during testing activities.

3.6.3.1.4 Impacts from Weapons Firing, Launch, and Impact Noise

Navy activities in the Study Area include firing or launching a variety of weapons, including missiles; rockets; and small-, medium-, and large-caliber projectiles. Types of weapons-firing activities, the sounds they produce, and areas where weapons firing are most likely to occur are described in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise). Because most weapons firing activities occur far from shore, seabirds that forage or migrate greater than 3 nm offshore are most likely to hear

and respond to weapons-firing noise. In addition to noise from weapons firing and launching, birds could be briefly disturbed by the impact of non-explosive practice munitions at the water surface.

Sounds produced by weapons firing (muzzle blast), launch boosters, and projectile travel are potential stressors to birds. Sound generated by a muzzle blast is intense, but very brief. A seabird very close to a large weapons blast could be injured or experience hearing loss due to acoustic trauma or threshold shift. Sound generated by a projectile travelling at speeds greater than the speed of sound can produce a sonic boom in a narrow area around its flight path. Bird responses to weapons-firing and projectile travel noise may include short-term behavioral or physiological responses such as alert responses, startle responses, or temporary increases in heart rate. Once surface weapons firing activities begin, birds would likely disperse away from the area around the ship and the path of projectiles.

Other activities in the general area that precede these activities, such as vessel movement or target setting, potentially would disperse birds away from the area in which weapons-firing noise would occur. Any increased ship activity at a critical time or in an important foraging area could drive these and other species from their natural habitat (Borberg et al. 2005b). On the other hand, some birds commonly follow vessels, including certain species of gulls, storm petrels, and albatrosses (Hyrenbach 2001, 2006). A number of seabird species are attracted to ships because of the increased potential for foraging success (Melvin et al. 2001). The propeller wake generated by all ships, but particularly larger ships, disrupts the water column, causing prey to be brought to the surface where it is more easily captured by a greater variety of seabird species. Seabirds that are attracted to ships are more likely to be exposed to weapons-firing noise.

Airborne weapons firing at airborne targets typically occur at high altitudes of 15,000 to 25,000 ft. during air-to-air gunnery exercises. Noise generated by firing at such high altitudes is unlikely to generate a strong reaction in birds migrating at lower altitudes or foraging at the surface. The altitudes at which migrating birds fly can vary greatly based on the type of bird, where they are flying (over water or over land), and other factors such as weather. Approximately 95 percent of bird flight during migrations occurs below 10,000 ft. (3,048 m) with the majority below 3,000 ft. (914 m) (Lincoln 1998). While there is considerable variation, the favored altitude for most small birds appears to be between 500 ft. (152 m) and 1,000 ft. (305 m).

3.6.3.1.4.1 No Action Alternative

Training Activities

Weapons firing, launch, and non-explosive impact noise would be associated with small-, medium-, and large-caliber munitions; missiles; and bombs (non-explosive impact) used during training under the No Action Alternative. Activities are spread throughout the Study Area as presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). The types of noise produced are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise).

Exposure of seabirds to weapons firing, launch, and impact noise would be very brief and temporary. Bird responses to weapons-firing and projectile travel noise may include short-term behavioral or physiological responses such as alert responses, startle responses, or temporary increases in heart rate. While an individual bird may be exposed to multiple noises during a weapons-firing activity, repeated exposures to individual birds over days is extremely unlikely. Both birds and Navy vessels change location frequently, and weapons-firing and launch activities occur over short periods of time. Startle or alert reactions to muzzle blasts are not likely to disrupt major behavior patterns, such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any seabirds (unless they are very close

to the muzzle blast). Activities with multiple weapons blasts may cause birds to disperse from the area for the duration of the firing activity. Because weapons-firing activities would not occur close to shore where seabird colonies are located, large impacts on breeding seabird populations would not result from weapons-firing noise. For these reasons, the impact on seabirds from noise produced by weapons firing under the No Action Alternative would be minor and short-term and would not have any population-level impacts.

Because weapon firing occurs at varying locations over a short time period and seabird presence changes seasonally and on a short-term basis, individual birds would not be expected to be repeatedly exposed to weapons firing, launch, or projectile noise. Any impacts on migratory or breeding seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent and would not impact seabird or migratory bird populations. If individual birds forage in or migrate through areas where weapons-firing activities are occurring, they could be exposed to and temporarily disturbed by weapons firing and associated noise. Temporary disturbance due to weapons noise is not expected to result in major impacts on ESA-listed species.

Pursuant to the ESA, weapons firing, launch, and impact noise generated during training activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), weapons firing, launch, and impact noise generated during training activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Weapons firing, launch, and non-explosive impact noise would be associated with small-, medium-, and large-caliber munitions; missiles; rockets; and bombs (non-explosive impact) used during testing under the No Action Alternative. Activities are spread throughout the Study Area as presented in Tables 2.8-2 through 2.8-5 of Chapter 2 (Description of Proposed Action and Alternatives). The types of noise produced are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise).

Exposure of seabirds to weapons firing, projectile noise, and launch noise would be very brief and temporary. Bird responses to weapons-firing and projectile travel noise may include short-term behavioral or physiological responses such as alert responses, startle responses, or temporary increases in heart rate. While an individual bird may be exposed to multiple noises during a weapons-firing activity, repeated exposures to individual birds over days is extremely unlikely. Both birds and Navy vessels change location frequently, and weapons-firing and launch activities occur over short periods. Startle or alert reactions to muzzle blasts are not likely to disrupt major behavior patterns, such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any seabirds (unless they are very close to the muzzle blast). Activities with multiple weapons blasts may cause birds to disperse from the area for the duration of the firing activity. Because weapons-firing activities would not occur close to shore where seabird colonies are located, large impacts on breeding seabird populations would not result from weapons-firing noise. For these reasons, the impact of noise produced by weapons firing on seabirds under the No Action Alternative would be minor and short-term, and would not have any population-level impacts.

Because weapon firing occurs at varying locations over a short period and seabird presence changes seasonally and on a short-term basis, individual birds would not be expected to be repeatedly exposed

to weapons firing, launch, or projectile noise. Any impacts on migratory or breeding seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent and would not impact seabird or migratory bird populations. If individual birds forage in or migrate through areas where weapons firing activities are occurring, they could be exposed to and temporarily disturbed by weapons firing and associated noise, but the noise would not result in major impacts.

Pursuant to the ESA, weapons firing, launch, and impact noise generated during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), weapons firing, launch, and impact noise generated during testing activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.4.2 Alternative 1

Training Activities

Weapons firing, launch, and non-explosive impact noise would be associated with small-, medium-, and large-caliber munitions; missiles; and bombs (non-explosive impact) used during training under Alternative 1. The number of weapons firing, launch, and non-explosive would increase from the No Action Alternative (Table 3.0-65). Activities are spread throughout the Study Area, as presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). The types of noise produced are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise). Due to increased numbers of activities, noise produced by these activities would increase under Alternative 1 compared to the No Action Alternative.

Exposure of seabirds to weapons firing, launch, and impact noise would be very brief and temporary. Bird responses to weapons-firing and projectile travel noise may include short-term behavioral or physiological responses such as alert responses, startle responses, or temporary increases in heart rate. While an individual bird may be exposed to multiple noises during a weapons firing activity, repeated exposures to individual birds over days is extremely unlikely. Both birds and Navy vessels change location frequently, and weapons firing and launch activities occur over short periods. Startle or alert reactions to muzzle blasts are not likely to disrupt major behavior patterns, such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any seabirds (unless they are very close to the muzzle blast). Activities with multiple weapons blasts may cause birds to disperse from the area for the duration of the firing activity. Because weapons firing activities would not occur close to shore where seabird colonies are located, large impacts on breeding seabird populations would not result from weapons firing noise. For these reasons, the impact of noise produced by weapons firing on seabirds under Alternative 1 would be minor and short-term and would not have any population-level impacts.

Because weapons firing occurs at varying locations over a short time and seabird presence changes seasonally and on a short-term basis, individual birds would not be expected to be repeatedly exposed to weapons firing, launch, or projectile noise. Any impacts on migratory or breeding seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent and would not impact seabird or migratory bird populations. If individual birds forage in or migrate through areas where weapons-firing activities are occurring, they could be exposed to and temporarily disturbed by weapons firing and associated noise, but the noise would not result in major impacts on ESA-listed species.

Pursuant to the ESA, weapons firing, launch, and impact noise generated during training activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), weapons firing, launch, and impact noise generated during training activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Weapons firing, launch, and non-explosive impact noise would be associated with small-, medium-, and large-caliber munitions; missiles; rockets; and bombs (non-explosive impact) used during testing under Alternative 1. The number of weapons firing, launch, and non-explosive would increase from the No Action Alternative (Table 3.0-65). Activities are spread throughout the Study, as presented in Tables 2.8-2 to 2.8-5 of Chapter 2 (Description of Proposed Action and Alternatives). The types of noise produced are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise). Noise produced by these activities would substantially increase under Alternative 1 compared to the No Action Alternative.

Exposure of seabirds to weapons firing, and launch noise would be very brief and temporary. Bird responses to weapons-firing and projectile travel noise may include short-term behavioral or physiological responses such as alert responses, startle responses, or temporary increases in heart rate. While an individual bird may be exposed to multiple noises during a weapons firing activity, repeated exposures to individual birds over days is extremely unlikely. Both birds and Navy vessels change location frequently, and weapons firing and launch activities occur over short periods. Startle or alert reactions to muzzle blasts are not likely to disrupt major behavior patterns such as migrating, breeding, feeding, and sheltering or to result in serious injury to any seabirds (unless they are very close to the muzzle blast). Activities with multiple weapons blasts may cause birds to disperse from the area for the duration of the firing activity. Because weapons-firing activities would not occur close to shore where seabird colonies are located, large impacts on breeding seabird populations would not result from weapons firing noise. For these reasons, the impact of noise produced by weapons firing on seabirds under Alternative 1 would be minor and short-term, and is not expected to have any population-level impacts.

Because weapon firing occurs at varying locations over a short period and seabird presence changes seasonally and on a short-term basis, individual birds would not be expected to be repeatedly exposed to weapons firing, launch, or projectile noise. Any impacts on migratory or breeding seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent and would not impact seabird or migratory bird populations. If individual birds forage in or migrate through areas where weapons-firing activities are occurring, they could be exposed to and temporarily disturbed by weapons firing and associated noise, but the noise would not result in major impacts on ESA-listed species.

Pursuant to the ESA, weapons firing, launch, and impact noise generated during testing activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), weapons firing, launch, and impact noise generated during testing activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.4.3 Alternative 2

Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be identical as described in Section 3.6.3.1.4.2 (Alternative 1).

Pursuant to the ESA, weapons firing, launch, and impact noise generated during training activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), weapons firing, launch, and impact noise generated during training activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Weapons firing, launch, and non-explosive impact noise would be associated with small-, medium-, and large-caliber munitions; missiles; rockets; and bombs (non-explosive impact) used during testing under Alternative 2. The number of weapons firing, launch, and non-explosive would increase from the No Action Alternative (Table 3.0-65). Activities are spread throughout the Study Area, as presented in Tables 2.8-2 through 2.8-5 of Chapter 2 (Description of Proposed Action and Alternatives). The types of noise produced are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise). Noise produced by these activities would substantially increase under Alternative 2 compared to the No Action Alternative.

Although more birds could be exposed to weapons noise under Alternative 2 than under the No Action Alternative, the types of impacts to individual birds are expected to be the same. Although individual birds may exhibit short-term behavioral reactions, long-term impacts to populations are not expected. In addition, although exposures to weapons noise impacts to ESA-listed species may increase, the types of impacts are not expected to differ from those discussed under Alternative 1.

Pursuant to the ESA, weapons firing, launch, and impact noise generated during testing activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), weapons firing, launch, and impact noise generated during testing activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.5 Impacts from Aircraft and Vessel Noise

The training and testing proposed in the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels). Birds could be exposed to noise from vessels throughout the Study Area, but few exposures would occur based on the infrequency of operations and the low density of vessels within the Study Area at any given time. However, if in the immediate area where vessels are operating, seabirds from any of the six taxonomic groups found within the Study Area (Table 3.6-2 and Table 3.6-3) could potentially be disturbed by vessel noise. Noise impacts on wildlife from recreational and commercial activities, vehicle traffic, and military training operations can include altering habitat use and activity patterns, increasing stress response, decreasing immune response, reducing reproductive success, increasing predation risk, degrading conspecific communication, and damaging hearing (Pater et al. 2009).

Birds respond to vessels in various ways. Some seabirds are commonly attracted to and follow vessels including certain species of gulls, storm petrels, and albatrosses (Hamilton 1958; Hyrenback 2001, 2006), while other species such as frigatebirds and sooty terns seem to avoid vessels (Borberg et al. 2005, Hyrenback 2006). Vessel noise could elicit short-term behavioral or physiological responses but are not likely to disrupt major behavior patterns, such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any seabirds. Beason (2004) notes that birds exposed to up to 146 dBA within 325 ft. (99.1 m) of the noise source flushed but then returned within minutes of the disturbance. Vessel noise is not expected to be at this noise level. Harmful seabird/vessel interactions are commonly associated with commercial fishing vessels because birds are attracted to concentrated food sources around these vessels (Melvin and Parrish 1999); Dietrich and Melvin 2004). The concentrated food sources that attract seabirds to commercial fishing vessels are not present around Navy vessels.

Fixed wing aircraft and helicopters are used for a variety of training and testing activities throughout the Study Area. Impacts of those activities on seabirds are applicable to everywhere in the Study Area that aircraft overflights occur, although some areas experience more aircraft activity than others. Various types of fixed-wing aircraft and helicopters are used in training and testing exercises throughout the Study Area (see Chapter 2, Description of Proposed Action and Alternatives). Seabirds and other migratory birds could be exposed to airborne noise associated with subsonic and supersonic fixed-wing aircraft overflights and helicopter operations while foraging or migrating in open water, near-shore, or coastal environments within the Pacific Ocean. If in an area where overflights are occurring, all taxonomic groups found within the Study Area (Table 3.6-2 and Table 3.6-3) could potentially be temporarily disturbed by aircraft noise.

Seabird exposure to fixed-wing aircraft noise would be brief (seconds) as an aircraft quickly passes overhead. Exposures would be infrequent based on the transitory and dispersed nature of the overflights; repeated exposure of individual seabirds over a short period of time (hours or days) is unlikely. If seabirds were to respond to an overflight, the responses would be limited to short-term behavioral or physiological reactions (e.g., alert response, startle response, temporary increase in heart rate), and the general health of individual seabirds would not be compromised. Birds repeatedly exposed to aircraft noise often become habituated to the noise and do not respond behaviorally (National Park Service 1994, Larkin et al. 1996, Plumpton 2006). However, habituation seems unlikely in the Study Area given the widely dispersed nature of the operations and the relative infrequency of the operations.

Most fixed-wing aircraft flights occur at distances greater than 12 nm offshore. Birds could be exposed to elevated noise levels while foraging or migrating in these open water environments, as well as in near-shore or coastal environments when aircraft flights occur in those areas. Most fixed-wing sorties would occur greater than 3,000 ft. (914.4 m) altitude and would be associated with air combat maneuver training and U.S. Navy Air Systems Command testing. Typical altitudes would range from 5,000 to 30,000 ft. (1,524 to 9,144 km) and typical airspeeds would range from very low (less than 100 knots [kt]) to high subsonic (less than 600 kt). Sound exposure levels at the sea surface from most air combat maneuvers overflights are expected to be less than 85 dBA re 20 µPa, based on an F/A-18 aircraft flying at an altitude of 5,000 ft. and at a subsonic airspeed of 400 knots (kt). Exceptions include sorties associated with air-to-surface ordnance delivery and sonobuoy drops from 500 to 5,000 ft. (152.4 to 1,524 m) altitude. Approximately 95 percent of bird flight during migrations occurs below 10,000 ft. (3,048 m) with the majority below 3,000 ft. (914.4 m) (U.S. Geological Survey 2006). While there is considerable variation, the favored altitude for most small birds appears to be between 500 and 1,000 ft. (152.4 and 304.8 m). Bird exposure to fixed-wing aircraft noise would be brief (seconds) as an

aircraft quickly passes. Unlike the situation at a busy commercial airport or military landing field, repeated exposure of individual seabirds or groups of seabirds would be unlikely based on the dispersed nature of the overflights.

Some air combat maneuver training would involve high altitude, supersonic flight, which would produce sonic booms, but such airspeeds would be infrequent. Boom duration is generally less than 300 milliseconds. Sonic booms would cause seabirds to startle, but the exposure would be brief, and any reactions are expected to be short-term. Startle impacts range from altering behavior (e.g., stop feeding or preening), minor behavioral changes (e.g., head turning), or at worst, a flight response. Because most fixed-wing flights are not supersonic and both seabirds and aircraft are transient in any area, exposure of seabirds in the open ocean to sonic booms would be infrequent. It is unlikely that individual seabirds would be repeatedly exposed to sonic booms in the open ocean.

Unlike fixed-wing aircraft, helicopters typically operate below 1,000 ft. (304.8 m) altitude and often occur as low as 75–100 ft. (22.9–30.5 m) altitude. This low altitude increases the likelihood that seabirds would respond to noise from helicopter overflights. Helicopters travel at slower speeds (less than 100 kt) which increases durations of noise exposure compared to fixed-wing aircraft. In addition, some studies have suggested that birds respond more to noise from helicopters than from fixed-wing aircraft (Larkin et al. 1996; National Park Service 1994). Noise from low-altitude helicopter overflights would be expected to elicit short-term behavioral or physiological responses in exposed seabirds. Repeated exposure of individual seabirds or groups of seabirds is unlikely based on the dispersed nature of the overflights and seabird's capability to avoid or rapidly vacate an area of disturbance. Therefore, the general health of individual seabirds would not be compromised.

3.6.3.1.5.1 No Action Alternative

Training Activities

Under the No Action Alternative, a variety of aircraft and vessels would be used throughout the Study Area, as presented in Tables 2.8-1 through 2.8-5 (Description of Proposed Action and Alternatives). Under the No Action Alternative, 7,846 training activities utilize some types of vessel (Table 3.0-30) and 10,623 fleet training activities utilize some type of aircraft ranging from fixed-wing aircraft to helicopters (Table 3.0-77). Although loud sudden noises can startle and flush birds, Navy vessels are not expected to result in major acoustic disturbance of seabirds in the Study Area. Noise from Navy vessels are similar to or less than those of the general maritime environment. Birds respond to the physical presence of a vessel, regardless of the associated noise. The potential is very low for noise generated by Navy vessels to impact seabirds and would not result in major impacts on seabird populations.

The highest concentrations of aircraft noise would be associated with the greater number of flights in the SOCAL Range Complex compared to other portions of the Study Area, although training flights occur in each range complex and outside of the range complexes. These activities involve low-flying aircraft as part of training. Most of the helicopter training operations occur at low altitudes (75–100 ft. [22.9–30.5 m]), which increases the exposure of seabirds to their noise. Takeoffs and landings occur at established airfields and on vessels at sea at unspecified locations throughout the Study Area. Aircraft noise under the No Action Alternative could elicit short-term behavioral or physiological responses in some individual seabirds. Helicopter overflights are more likely to elicit responses than fixed-wing aircraft, but the general health of individual seabirds would not be compromised.

Navy aircraft training activities over the Pacific Ocean are concentrated near the continental shelfs and surrounding islands, removed from seabird nesting areas. Seabirds that forage in these areas may have

greater presence in these productive areas, so aircraft overflights may cause more behavioral disturbances in these areas. A seabird in the open ocean would be exposed for a few seconds to fixed-wing aircraft noise as the aircraft quickly passes overhead. Seabirds foraging or migrating through a training area in the open ocean may respond by avoiding areas of concentrated aircraft noise. Exposures to seabirds would be infrequent, based on the brief duration and dispersed nature of the overflights. Repeated exposure to individual seabirds over hours or days is unlikely. Startle or alert reactions to aircraft are not likely to disrupt major behavior patterns, such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any seabirds. While behavioral or physiological impacts of airborne activity on individual seabirds may occur, none of these impacts are long-lasting, and none are expected to have an adverse impact on seabirds at the population level.

Birds using wetlands, mud flats, beaches, and other shoreline habitats or shallow coastal foraging areas would be exposed to noise from near-shore helicopter training and aircraft in transit to off-shore training areas. The presence of dense aggregations of seabirds (terns) is a potential concern during low-attitude helicopter operations. Although seabirds may be more likely to react to helicopters than to fixed-wing aircraft, Navy helicopter pilots would avoid large flocks of seabirds to protect aircrews and equipment, thereby reducing disturbance to seabirds as well.

California least terns could be exposed to intermittent aircraft noise from aircraft originating from airfields located along the coast. If present in the open water areas where training activities involving aircraft overflights occur, Hawaiian petrel, short-tailed albatross, marbled murrelet or Newell's shearwater could be temporarily disturbed while foraging or migrating. Short-term behavioral responses such as startle responses, head turning, or flight responses would be expected. Repeated exposures would be limited due to the transient nature of aircraft use and regular movement of seabirds. No long-term or population-level impacts are expected.

Pursuant to the ESA, noise from aircraft and vessels during training activities under the No Action Alternative may affect, but is not likely to adversely affect ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from noise from aircraft and vessels during training activities under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Under the No Action Alternative, 9,419 training activities utilize some types of vessel (Table 3.0-30). Although loud sudden noises can startle and flush birds, Navy vessels are not expected to result in major acoustic disturbance of seabirds in the Study Area. Noise from Navy vessels are similar to or less than those of the general maritime environment. Birds respond to the physical presence of a vessel, regardless of the associated noise. The potential is very low for noise generated by Navy vessels to impact seabirds and would not result in major impacts on seabird populations.

Under the No Action Alternative, approximately 10,172 testing activities involve the use of some type of aircraft ranging from fixed-wing aircraft to helicopters; however, no activities occur within the SSTC portion of the Study Area. Testing activities involving aircraft closely resemble training activities and would therefore have similar aircraft noise impacts.

California least terns could be exposed to intermittent aircraft noise from aircraft originating from airfields located along the coast. If present in the open water areas where testing activities involving

aircraft overflights occur, Hawaiian petrel, short-tailed albatross, marbled murrelet or Newell's shearwater could be temporarily disturbed while foraging or migrating. Short-term behavioral responses such as startle responses, head turning, or flight responses would be expected. Repeated exposures would be limited due to the transient nature of aircraft use and regular movement of seabirds. No long-term or population-level impacts are expected.

Pursuant to the ESA noise from aircraft and vessels during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from noise from aircraft and vessels during testing activities under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.5.2 Alternative 1

Training Activities

Under Alternative 1, the total number of training activities involving vessels throughout the Study Area would increase 20.9 percent over the No Action Alternative, from 7,846 to 9,490 activities (Table 3.0-30). The number of training activities involving aircraft throughout the Study Area would increase 15.6 percent over the No Action Alternative from 10,623 to 12,284 activities (Table 3.0-77), with the highest increase in aircraft training events occurring in the HRC portion of the Study Area (1,982 to 2,842 activities). The locations and types of aircraft or vessels would not differ from the No Action Alternative, as presented in Table 2.8-1 (Description of Proposed Action and Alternatives). The additional aircraft hours would increase noise overall but would not change the nature of the short-term reversible impacts described for the No Action Alternative.

Based on the increased training operations under Alternative 1, more seabirds could be exposed to noise; the number of times an individual seabird is exposed could also increase. Similar to the No Action Alternative, the responses would be limited to short-term behavioral or physiological reactions, and the general health of individual seabirds would not be compromised. While behavioral or physiological impacts of airborne activity on individual seabirds may occur, none of these impacts are long-lasting, and none are expected to have an adverse impact on migratory seabirds at the population level.

California least terns could be exposed to intermittent aircraft noise from aircraft originating from airfields located along the coast. If present in the open water areas where training activities involving aircraft overflights occur, Hawaiian petrel, short-tailed albatross, marbled murrelet or Newell's shearwater could be temporarily disturbed while foraging or migrating. Short-term behavioral responses such as startle responses, head turning, or flight responses would be expected. Repeated exposures would be limited due to the transient nature of aircraft use and regular movement of seabirds. No long-term or population-level impacts are expected.

Pursuant to the ESA, noise from aircraft and vessels during training activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from noise from aircraft and vessels during training activities under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Under Alternative 1, the total number of testing activities involving vessels throughout the Study Area would increase 8.6 percent over the No Action Alternative, from 9,419 to 10,233 activities (Table 3.0-30). Navy vessels are not expected to result in major acoustic disturbance of seabirds in the Study Area. Noise from Navy vessels are similar to or less than those of the general maritime environment. Birds respond to the physical presence of a vessel, regardless of the associated noise. The potential is very low for noise generated by Navy vessels to impact seabirds and would not result in major impacts on seabird populations.

The number of testing activities involving aircraft throughout the Study Area would increase approximately 8.1 percent over the No Action Alternative from 10,172 to 11,001 annual events. The locations and types of aircraft would not differ from the No Action Alternative, as presented in Tables 2.8-2 through 2.8-5 (Description of Proposed Action and Alternatives). The additional aircraft activities would increase noise overall but would not change the nature of the short-term reversible impacts described for the No Action Alternative.

Based on the increased testing operations under Alternative 1, more seabirds could be exposed to noise; the number of times an individual seabird is exposed could also increase. Similar to the No Action Alternative, the responses would be limited to short-term behavioral or physiological reactions, and the general health of individual seabirds would not be compromised. While behavioral or physiological impacts of airborne activity on individual seabirds may occur, no long-term or population level impacts are expected.

California least terns could be exposed to intermittent aircraft noise from aircraft originating from airfields located along the coast. If present in the open water areas where testing activities involving aircraft overflights occur, Hawaiian petrel, short-tailed albatross, marbled murrelet or Newell's shearwater could be temporarily disturbed while foraging or migrating. Short-term behavioral responses such as startle responses, head turning, or flight responses would be expected. Repeated exposures would be limited due to the transient nature of aircraft use and regular movement of seabirds. No long-term or population-level impacts are expected.

Pursuant to the ESA, noise from aircraft and vessels during testing activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from noise from aircraft and vessels during testing activities Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.5.3 Alternative 2

Training Activities

Under Alternative 2, the total number of training activities involving vessels throughout the Study Area would increase 20.9 percent over the No Action Alternative from 7,846 to 9,490 activities (Table 3.0-30). The number of training activities involving the total number of training activities involving aircraft throughout the Study Area would increase 15.6 percent over the No Action Alternative, from 10,623 to 12,284 activities (Table 3.0-77), with the highest increase in aircraft training events occurring in the HRC portion of the Study Area (1,982 to 2,842 activities). The locations and types of aircraft would not differ from the No Action Alternative, as presented in Table 2.8-1 (Description of Proposed Action and

Alternatives). The additional aircraft hours would increase noise overall but would not change the nature of the short-term reversible impacts described for the No Action Alternative.

Pursuant to the ESA, noise from aircraft and vessels during training activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from noise from aircraft and vessels during training activities under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Under Alternative 2, the total number of testing activities involving vessels throughout the Study Area would increase 22.0 percent over the No Action Alternative, from 9,419 to 11,496 activities (Table 3.0-30). Navy vessels are not expected to result in major acoustic disturbance of seabirds in the Study Area. Noise from Navy vessels are similar to or less than those of the general maritime environment. Birds respond to the physical presence of a vessel, regardless of the associated noise. The potential is very low for noise generated by Navy vessels to impact seabirds and would not result in major impacts on seabird populations.

The number of testing activities involving aircraft throughout the Study Area would increase approximately 8.1 percent over the No Action Alternative, from 10,172 to 11,001 annual events. The locations and types of aircraft would not differ from the No Action Alternative, as presented in Tables 2.8-2 through 2.8-5 (Description of Proposed Action and Alternatives). The additional aircraft activities would increase noise overall but would not change the nature of the short-term reversible impacts described for the No Action Alternative.

Based on the increased testing operations under Alternative 2, more seabirds could be exposed to noise; the number of times an individual seabird is exposed could also increase. Similar to the No Action Alternative, the responses would be limited to short-term behavioral or physiological reactions, and the general health of individual seabirds would not be compromised. While behavioral or physiological impacts of airborne activity on individual seabirds may occur, no long-term population level impacts are expected.

Pursuant to the ESA, noise from aircraft and vessel during testing activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from noise from aircraft and vessels during testing activities Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.6 Summary of Impacts of Acoustic Stressors

Under the No Action Alternative, Alternative 1, or Alternative 2, noise from sonar, explosive detonations, pile driving, vessel noise, and aircraft noise would be expected to elicit brief behavioral or physiological responses in exposed seabirds. Repeated exposure of individual seabirds or groups of seabirds would be unlikely, based on the large operational area of the Study Area and the dispersed nature of the overflights, and the ability to easily avoid or rapidly vacate the action area. The general health of individual seabirds would not be compromised. Birds could be exposed to elevated noise levels while foraging or migrating, but would only be exposed to potentially disturbing levels of noise during

low altitude helicopter or fixed wing exercises, especially in nearshore areas, or when in immediate proximity of an in-air explosion, firing event, or underwater detonation. Transiting seabirds or those resting on the water may be startled and also experience concussive injury from in-air explosions, firing events, or underwater detonations. However, protective measures, such as restricting activities to when seabirds are absent from the immediate vicinity of an underwater detonation training or testing activity, are implemented prior to and during these activities to minimize impacts on seabirds from these activities. Individual seabirds may be affected, but in-air explosions, firing events, or underwater detonations would have no impact on species or populations due to (1) the vast area over which training activities occur, (2) the implementation of Navy resource protection measures, and (3) the ability of seabirds to flee disturbance.

3.6.3.2 Energy Stressors

This section analyzes the potential impacts of the various types of energy stressors that can occur during training and testing activities within the Study Area. This section includes analysis of the potential impacts from electromagnetic devices.

3.6.3.2.1 Impacts from Electromagnetic Devices

Several different types of electromagnetic devices are used during training and testing activities throughout the Study Area, as described in Chapter 2 (Description of Proposed Action and Alternatives). Electromagnetic training and testing activities include an array of magnetic sensors used in mine countermeasure operations in the Study Area. Some electromagnetic devices such as a vessel radar and radio are devices that could impact seabirds above the water. Towed electromagnetic device impacts to seabirds would only occur underwater and would only impact diving species or species on the surface in the immediate area where the device is deployed. There is no information available on how birds react to electromagnetic fields underwater.

Electromagnetic devices are used primarily in towed-mine neutralization and port security training. Similar testing activities include the use of electromagnetic devices (e.g., mine detection/neutralization and electromagnetic activities [Littoral Combat Ship mission package testing, unmanned and autonomous surface/underwater vehicle testing, etc.]). The kinetic energy weapon is also included as an electromagnetic testing activity. In most cases, such as mine detection/neutralization, the device simply mimics the electromagnetic signature of a vessel passing through the water. None of the devices emit any type of electromagnetic “pulse.”

Potential impacts of those activities on seabirds are applicable to everywhere in the Study Area that electromagnetic devices are used. Electromagnetic devices used in Navy training and testing activities may potentially impact seabird navigation through disruption of electromagnetic fields. Birds use numerous other orientation cues to navigate in addition to magnetic fields. These include position of the sun, celestial cues, visual cues, wind direction, and scent (Fisher 1971, Haftorn et al. 1988, Wiltschko and Wiltschko 2005, Åkesson and Hedonström 2007). It is believed that by using a combination of these cues birds are able to successfully navigate long distances.

It has been demonstrated that some seabirds use the Earth’s magnetic field as a navigational cue during seasonal migrations (Fisher 1971, Wiltschko and Wiltschko 2005, Åkesson and Hedonström 2007). A magnetite-based receptor mechanism in the upper bill of some birds provides information on position and compass direction (Wiltschko and Wiltschko 2005). Electromagnetic devices send out electromagnetic signals into the environment that seabirds could potentially detect and respond to.

Studies have been conducted on electromagnetic sensitivity in birds typically associated with land, though little information exists specifically on seabird response to electromagnetic changes at sea. Results from a study conducted by Larkin and Sutherland (1977) show that during nocturnal flights, birds are capable of sensing electromagnetic fields emitted from antenna in Wisconsin used for the Navy's Project Seafarer. A study conducted by Hanowski et al. (1993) on the effects of extremely low frequency electromagnetic fields on breeding and migrating birds around the Navy's extra low frequency communication system antenna in Wisconsin found no evidence that bird distribution or abundance was affected by electromagnetic fields produced by the antenna.

Possible effects on birds from disrupting electromagnetic fields include behavioral responses such as temporary disorientation and change in flight direction (Larkin and Sutherland 1977, Wiltschko and Wiltschko 2005). 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 (Åkesson 2003, Alerstam et al. 2006). However, ample evidence exists that displaced birds can successfully reorient and find their way when one or more cues are removed (Haftorn et al. 1988, Åkesson 2003). For example, Haftorn et al. (1988) found that after removal from their nests and release into a different area, snow petrels (*Pagodrama nivea*) were able to successfully navigate back to their nests even when their ability to smell was removed. Furthermore, Wiltschko and Wiltschko (2005) report that electromagnetic pulses administered to birds during an experimental study on orientation do not deactivate the magnetite-based receptor mechanism in the upper beak altogether, but instead cause the receptors to provide altered information, which in turn causes birds to head in different directions. However, these effects were temporary and the ability of the birds to correctly orient themselves returned after a few days.

3.6.3.2.1.1 No Action Alternative

Training Activities

Under the No Action Alternative, electromagnetic activities are planned as presented in Table 2.8-1 (Description of Proposed Action and Alternatives). Training activities that include an electromagnetic component include anti-air warfare and electronic warfare.

The distribution of seabirds in the Study Area is patchy (Fauchald et al. 2002, Schneider and Duffy 1985). Exposure of seabirds would be limited to those foraging at or below the surface (e.g., cormorants, loons, petrels, grebes, etc.) because that is where the devices are used. Birds that forage inshore could be exposed to these electromagnetic stressors because their habitat overlaps with some of the activities that occur in the nearshore portions of SOCAL Range Complex and SSTC. However, the electromagnetic fields generated would be distributed over time and location, and any influence on the surrounding environment would be temporary and localized. More importantly, the electromagnetic devices used are typically towed by a helicopter and it is likely that any seabirds in the vicinity of the approaching helicopter would be dispersed by the noise and disturbance generated by the helicopter (see Section 3.6.3.1.5, Impacts from Aircraft and Vessel Noise) and move away from the device before any exposure could occur.

In the unlikely event that a seabird is temporarily disoriented by an electromagnetic device, it would still be able to re-orient using their internal magnetic compass to aid in navigation (Wiltschko et al. 2011).

California least terns could be exposed to intermittent electromagnetic stressors in nearshore areas where training activities occur. If present in the open water areas where training activities involving electromagnetic stressors occur, Hawaiian petrel, short-tailed albatross, marbled murrelet or Newell's

shearwater could be temporarily disturbed while foraging or migrating. Impacts on seabirds from potential exposure to electromagnetic fields would be temporary and inconsequential based on: (1) relatively low intensity of the magnetic fields generated (0.2 microtesla at 656 ft. [200 m] from the source), (2) very localized potential impact area, (3) temporary duration of the activities (hours), and (4) occurring only underwater. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of electromagnetic devices during training activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabirds.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of electromagnetic devices during training activities under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Under the No Action Alternative, electromagnetic activities are planned as presented in Tables 2.8-2 through 2.8-5 (Description of Proposed Action and Alternatives).

For reasons stated in Section 3.6.3.2.1.1 (No Action Alternative), any behavioral changes are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of seabird populations. California least terns could be exposed to intermittent electromagnetic stressors in nearshore areas where testing activities occur. If present in the open water areas where testing activities involving electromagnetic stressors occur, Hawaiian petrel, short-tailed albatross, marbled murrelet or Newell's shearwater could be temporarily disturbed while foraging or migrating. Any temporary disorientation experienced by seabirds from electromagnetic changes caused by testing activities in the Study Area may be considered a short-term impact and would not hinder seabird navigation abilities. Repeated exposures would be limited due to the transient nature of the testing activities using electromagnetic devices and regular movement of seabirds. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of electromagnetic devices during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabirds.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of electromagnetic devices during testing activities under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.2.1.2 Alternative 1

Training Activities

The number of electromagnetic activities proposed for the Study Area under Alternative 1 each year does not increase from the No Action Alternative, as presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). Therefore, the impacts on seabirds from activities performed during Alternative 1 would be the same as for the No Action Alternative.

Pursuant to the ESA, the use of electromagnetic devices during training activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabirds.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of electromagnetic devices during training activities under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

The number of electromagnetic activities proposed for the Study Area under Alternative 1 each year increases from the No Action Alternative by less than one percent, as presented in Tables 2.8-2 through 2.8.5 of Chapter 2 (Description of Proposed Action and Alternatives). Under Alternative 1, kinetic energy weapon testing would be introduced in the HRC portion of the Study Area, with 200 events per year. The electromagnetic kinetic energy weapon uses electrical energy to accelerate projectiles to supersonic velocities. The kinetic energy weapon would be operated from ships, firing projectiles toward land targets.

This unique weapons system charges for approximately two minutes and discharges in less than a second. The duration of the firing event is extremely short (about 8 milliseconds [ms]), which makes it quite unlikely that a seabird would fly over at the precise moment of firing. The short duration of each firing event also means that the likelihood of affecting any animal using magnetic fields for orientation is extremely small. Further, the high magnetic field levels experienced within 80 ft. (24.4 m) of the launcher quickly dissipate and return to background levels beyond 80 ft. (24.4 m) The magnetic field levels outside of the 80 ft. (24.4 m) buffer zone would be below the most stringent guidelines for humans (i.e., people with pacemakers or active implantable medical devices). Therefore, the electromagnetic impacts would be temporary in nature and not expected to result in impacts on organisms (U.S. Department of the Navy 2009).

The increase in activities and introduction of activities would not measurably increase the probability of seabirds being exposed to electromagnetic energy as compared to the No Action Alternative. The species and groups with potential to co-occur with these activities remain the same and potential impacts would be temporary and inconsequential, as discussed above for the No Action Alternative.

California least terns could be exposed to intermittent electromagnetic stressors in nearshore areas where testing activities occur. If present in the open water areas where testing activities involving electromagnetic stressors occur, Hawaiian petrel, short-tailed albatross, marbled murrelet or Newell's shearwater could be temporarily disturbed while foraging or migrating. Any temporary disorientation experienced by seabirds from electromagnetic changes caused by testing activities in the Study Area may be considered a short-term impact and would not hinder seabird navigation abilities. Repeated exposures would be limited due to the transient nature of the testing activities using electromagnetic devices and regular movement of seabirds. For reasons stated in Section 3.6.3.2.1.1 (No Action Alternative, Testing Activities), any behavioral changes are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of seabird populations. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of electromagnetic devices during testing activities under Alternative 1 may affect, but are is likely to adversely affect, ESA-listed seabirds.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of electromagnetic devices during testing activities under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.2.1.3 Alternative 2

Training Activities

The number of electromagnetic activities proposed for the Study Area under Alternative 2 each year does not increase from the No Action Alternative, as presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). Therefore, the impacts on seabirds from activities performed during Alternative 2 would be the same as for the No Action Alternative.

Pursuant to the ESA the use of electromagnetic devices during training activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabirds.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of electromagnetic devices during training activities under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

The number of electromagnetic activities proposed for the Study Area under Alternative 2 each year increases less than one percent from the No Action Alternative, as presented in Tables 2.8-2 through 2.8.5 of Chapter 2 (Description of Proposed Action and Alternatives). Under Alternative 2, kinetic energy weapon testing would be introduced in the HRC portion of the Study Area, with 200 events per year. The electromagnetic kinetic energy weapon uses electrical energy to accelerate projectiles to supersonic velocities. The kinetic energy weapon would be operated from ships, firing projectiles toward land targets.

This unique weapons system charges for approximately 2 minutes and discharges in less than a second. The duration of the firing event is extremely short (about 8 ms), which makes it quite unlikely that a seabird would fly over at the precise moment of firing. The short duration of each firing event also means that the likelihood of affecting any animal using magnetic fields for orientation is extremely small. Further, the high magnetic field levels experienced within 80 ft. (24.4 m) of the launcher quickly dissipate and return to background levels beyond 80 ft. (24.4 m). The magnetic field levels outside of the 80 ft. (24.4 m) buffer zone would be below the most stringent guidelines for humans (i.e., people with pacemakers or active implantable medical devices). Therefore, the electromagnetic impacts would be temporary in nature and not expected to result in impacts on organisms (U.S. Department of the Navy 2009).

The increase in activities and introduction of activities would not measurably increase the probability of seabirds being exposed to electromagnetic energy as compared to the No Action Alternative. The species and groups with potential to co-occur with these activities remain the same and potential impacts would be temporary and inconsequential, as discussed above for the No Action Alternative.

California least terns could be exposed to intermittent electromagnetic stressors in nearshore areas where testing activities occur. If present in the open water areas where testing activities involving electromagnetic stressors occur, Hawaiian petrel, short-tailed albatross, marbled murrelet or Newell's shearwater could be temporarily disturbed while foraging or migrating. Any temporary disorientation experienced by seabirds from electromagnetic changes caused by testing activities in the Study Area may be considered a short-term impact and would not hinder seabird navigation abilities. Repeated exposures would be limited due to the transient nature of the testing activities using electromagnetic devices and regular movement of seabirds. For reasons stated in Section 3.6.3.2.1.1 (No Action Alternative, Testing Activities), any behavioral changes are not expected to have lasting effects on the

survival, growth, recruitment, or reproduction of seabird populations. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of electromagnetic devices during testing activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabirds.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of electromagnetic devices used during testing activities under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.2.2 Summary of Impacts of Energy Stressors

The impact of electromagnetic devices on seabirds is expected to be negligible based on (1) the limited geographic area in which they are used, (2) the rare chance that an individual seabird might encounter these devices in use, (3) the startle behavior of seabirds and the mobility of seabirds to temporarily leave the area when the devices are in use, and (4) the absence of physiological damage and the temporary nature of any impacts if an individual seabird encountered these devices.

The impacts of electromagnetic devices would be limited to individual cases where a seabird might become temporarily disoriented and change flight direction. Although individuals may be temporarily impacted, these behaviors would have no direct impact at the population level.

3.6.3.3 Physical Disturbance and Strike Stressors

This section describes the potential impacts to seabirds by aircraft and aerial target strikes, vessels (disturbance and strike), and military expended material strike. Aircraft include fixed-wing and rotary-wing aircraft; vessels include various sizes and classes of ships, submarines, and other boats, towed devices, unmanned surface vehicles, and unmanned underwater vehicles; military expended material includes non-explosive practice munitions, target fragments, parachutes, and other objects.

Physical disturbance and strike risks, primarily from aircraft, have the potential to impact all taxonomic groups found within the Study Area if seabirds are in the same area with aircraft, vessels, and military expended material. Impacts of physical disturbance include behavioral responses such as temporary disorientation, collision, change in flight direction, and avoidance response behavior. 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 seabirds and can cause foraging and nesting seabirds to flush from or abandon their habitats and or nests. Aircraft strikes often result in bird mortalities or injuries.

Although seabirds likely hear and see approaching vessels and aircraft, they cannot avoid all collisions. Birds are known to be attracted to lights which can lead to collisions (Gehring et al. 2009; Poot et al. 2008). High-speed collisions with large objects can be fatal to birds. Training and testing activities around concentrated numbers of seabirds would cause greater disturbance and increase the potential for strikes.

3.6.3.3.1 Impacts from Aircraft and Aerial Target Strikes

Wildlife aircraft strikes are a grave concern for the Navy because they can harm aircrews. Wildlife aircraft strikes can also damage equipment, and injure or kill wildlife (Bies et al. 2006). The Naval

Aviation Safety Program Instruction, Chief of Naval Operations Instruction 3750.6R, identifies measures to evaluate and reduce or eliminate bird/aircraft strike hazards to aircraft, aircrews, and birds and requires the reporting of all strikes when damage or injuries occur as a result of a bird/aircraft strike. However, the numbers of bird deaths that occur annually from all Navy activities are insignificant from a bird population standpoint. From 2000 to 2009, the Navy Bird Aircraft Strike Hazard program recorded 5,436 bird strikes with the majority occurring during the fall period from September to November. During the 10-year period, bird strikes were greatest in 2007 with 827 strikes and lowest in 2001 with 48. Bird strike potential is greatest in foraging or resting areas, in migration corridors, and at low altitudes. For example, birds can be attracted to airports because they often provide foraging and nesting resources.

While bird strikes can occur anywhere aircraft are operated, Navy data indicate that they occur most often over land or close to shore. The potential for bird strikes to occur in offshore areas is relatively low because Navy activities are widely dispersed and above 3,000 ft. (914.4 m) (for fixed-wing aircraft) where bird densities are low. The majority of bird flight is below 3,000 ft. (914.4 m) and approximately 95 percent of bird flight during migrations occurs below 10,000 ft. (3,048 m) (U.S. Geological Survey 2006). Bird and aircraft encounters are more likely to occur during aircraft takeoffs and landings than when the aircraft is engaged in level low-altitude flight. Approximately 97 percent of aircraft-wildlife collisions occur at or near airports when aircraft are operating at or below 2,000 ft. (609.6 m). In a study that examined 38,961 bird and aircraft collisions, Dobson (2010) found that the majority (74 percent) of collisions occurred below 500 ft. (152.4 m). However, collisions have been recorded at elevations as great as 12,139 ft. (3,699.9 m) (Dobson 2010).

3.6.3.3.1.1 No Action Alternative

Training Activities

Various types of fixed-wing aircraft and helicopters are used in training throughout the Study Area, (see Tables 2.8-1 through 2.8-5). Certain portions of the Study Area, such as areas near Navy airfields, installations, and ranges are used more heavily by Navy aircraft than other portions as presented in further detail in Tables 2.8-2 to 2.8-3 in Chapter 2 (Description of Proposed Action and Alternatives). Under the No Action Alternative, approximately 10,623 activities involve the use of aircraft (Table 3.0-77). Flight altitudes for all fixed-wing activities would be above 3,000 ft. (914.4 m) mean sea level (above the typical flight level of seabirds) with the exception of sorties associated with air-to-surface bombing exercises. Typical flight altitudes during air-to-surface bombing exercises are from 500 to 5,000 ft. (152.4 to 1,524 m) above mean sea level. Most fixed-wing aircraft flight hours (greater than 90 percent) occur at distances greater than 12 nm offshore. Most of the helicopter training operations occur at low altitudes (75–100 ft. [22.9–30.5 m]), which increases the exposure of seabirds.

In general, seabird populations consist of hundreds or thousands of individuals, ranging across a large geographical area. In this context, the loss of several or even dozens of birds due to physical strikes may not constitute a population-level impact, although some species gather in large flocks. Some bird strikes and associated bird mortalities or injuries could occur as a result of aircraft and aerial target use in the Study Area under the No Action Alternative; however, population-level impacts to seabirds would not likely result from aircraft strikes. If in the immediate area where aircraft are operating at low altitudes, ESA-listed species could be impacted by aircraft disturbance and strike during migration.

Bird exposure to strike potential would be relatively brief as an aircraft quickly passes. Birds actively avoid interaction with aircraft; however, disturbances or strike of various bird species may occur from aircraft on a site-specific basis. As a standard operating procedure, aircraft avoid large flocks of birds to

minimize the personnel safety risk involved with a potential bird strike. Some seabird and aircraft strikes and associated seabird mortalities or injuries could occur in the Study Area under the No Action Alternative; however, no increased risk of impacts on seabird populations would result from aircraft strikes. No long-term or population-level impacts are expected.

California least terns could be exposed to intermittent aircraft overflights and strike potential in nearshore areas where training activities occur. If present in the open water areas where training activities involving aircraft occur, Hawaiian petrel, short-tailed albatross, marbled murrelet or Newell's shearwater could be briefly exposed to strike potential. However, the data that Navy has collected on bird strikes reports that no ESA-listed species have been struck in the past, so it is not likely they would be struck by aircraft or aerial targets during training activities.

Pursuant to the ESA, use of aircraft and aerial targets during training activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), use of aircraft and aerial targets during training activities under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Under the No Action Alternative, a total of approximately 10,172 testing events are planned using fixed wing aircraft and helicopters (Table 3.0-77). These aircraft would be used in all portions of the Study Area.

In general, seabird populations consist of hundreds or thousands of individuals, ranging across a large geographical area. In this context, the loss of several or even dozens of birds due to physical strikes may not constitute a population-level impact, although some species gather in large flocks. Strikes to species listed under the ESA may have more impact because the population size has already been reduced to near or below sustainable levels.

Seabird exposure to strike potential would be relatively brief as an aircraft quickly passes. Seabirds actively avoid interaction with aircraft; however, disturbances of various seabird species may occur from aviation operations on a site-specific basis. As a standard operating procedure, aircraft avoid large flocks of birds to minimize the safety risk involved with a potential bird strike. Some seabird and aircraft strikes and associated seabird mortalities or injuries could occur in the Study Area under the No Action Alternative; however, the potential impacts from aircraft testing activities would be the same as for Training activities, albeit at a lesser degree.

California least terns could be exposed to intermittent aircraft overflights and strike potential in nearshore areas where testing activities occur. If present in the open water areas where testing activities involving aircraft occur, Hawaiian petrel, short-tailed albatross, marbled murrelet or Newell's shearwater could be briefly exposed to strike potential. However, the data that Navy has collected on bird strikes reports that no ESA-listed species have been struck in the past, so it is not likely they would be struck by aircraft or aerial targets during testing activities.

Pursuant to the ESA, use of aircraft and aerial targets during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), use of aircraft and aerial targets during testing activities under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.3.1.2 Alternative 1

Training Activities

Under Alternative 1, the number of training activities involving aircraft in the Study Area would increase by 1,661 activities as compared to the No Action Alternative, for a total of 12,284 activities involving aircraft, potentially leading to an increase in aircraft and aerial disturbance and strikes in some portions of the Study Area, as presented in Table 2.8-1 (Description of Proposed Action and Alternatives). While bird strikes can occur anywhere aircraft are operated, Navy data indicate that they occur most often over land or close to shore. The potential for seabird strikes to occur in offshore areas is relatively low because Navy activities are widely dispersed and above 3,000 ft. (914.4 m) (for fixed-wing aircraft) where seabird densities are low. Because seabird exposure to aircraft disturbance and strikes would be relatively brief and infrequent, no major impacts on seabirds would result from aircraft strikes. Furthermore, protective measures, such as avoiding large flocks of birds to minimize the safety risk involved with a potential bird strike, minimize impacts on seabirds (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

California least terns could be exposed to intermittent aircraft overflights and strike potential in nearshore areas where training activities occur. If present in the open water areas where training activities involving aircraft occur, Hawaiian petrel, short-tailed albatross, marbled murrelet or Newell's shearwater could be briefly exposed to strike potential. However, the data that Navy has collected on bird strikes reports that no ESA-listed species have been struck in the past, so it is not likely they would be struck by aircraft or aerial targets during training activities.

Pursuant to the ESA, use of aircraft and aerial targets during training activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), use of aircraft and aerial targets during training activities under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Under Alternative 1, the number of testing activities involving aircraft in the Study Area would increase by 829 activities as compared to the No Action Alternative, for a total of 11,001 activities involving aircraft, potentially leading to an increase in aircraft and aerial disturbance and strikes in some portions of the Study Area, as presented in Tables 2.8-2 through 2.8-5 (Description of Proposed Action and Alternatives). As described for the No Action Alternative, because seabird exposure to aircraft disturbance and strikes would be relatively brief and infrequent, no major impacts on seabirds would result from aircraft strikes. Furthermore, protective measures, such as avoiding large flocks of birds to minimize the safety risk involved with a potential seabird strike, minimize impacts on seabirds (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

California least terns could be exposed to intermittent aircraft overflights and strike potential in nearshore areas where testing activities occur. If present in the open water areas where testing activities involving aircraft occur, Hawaiian petrel, short-tailed albatross, marbled murrelet or Newell's shearwater could be briefly exposed to strike potential. However, the data that Navy has collected on

bird strikes reports that no ESA-listed species have been struck in the past, so it is not likely they would be struck by aircraft or aerial targets during testing activities.

Pursuant to the ESA, use of aircraft and aerial targets during testing activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), use of aircraft and aerial targets during testing activities under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.3.1.3 Alternative 2

Training Activities

Under Alternative 2, the number of training activities involving aircraft in the Study Area would increase by 1,661 activities as compared to the No Action Alternative, for a total of 12,284 activities involving aircraft, potentially leading to an increase in aircraft and aerial disturbance and strikes in some portions of the Study Area, as presented in Table 2.8-1 (Description of Proposed Action and Alternatives). As described for the No Action Alternative, because seabird exposure to aircraft disturbance and strikes would be relatively brief and infrequent, no major impacts on seabirds would result from aircraft strikes. Furthermore, protective measures, such as avoiding large flocks of birds to minimize the safety risk involved with a potential seabird strike, minimize impacts on seabirds (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

California least terns could be exposed to intermittent aircraft overflights and strike potential in nearshore areas where testing activities occur. If present in the open water areas where testing activities involving aircraft occur, Hawaiian petrel, short-tailed albatross, marbled murrelet or Newell's shearwater could be briefly exposed to strike potential. However, the data that Navy has collected on bird strikes reports that no ESA-listed species have been struck in the past, so it is not likely they would be struck by aircraft or aerial targets during testing activities.

Pursuant to the ESA, use of aircraft and aerial targets during training activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), use of aircraft and aerial targets during training activities under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Under Alternative 2, the number of testing activities involving aircraft in the Study Area would increase by 1,950 activities as compared to the No Action Alternative, for a total of 12,122 activities involving aircraft, potentially leading to an increase in aircraft and aerial disturbance and strikes in some portions of the Study Area, as presented in Tables 2.8-2 through 2.8-5 (Description of Proposed Action and Alternatives). However, as described for the No Action Alternative, because seabird exposure to aircraft disturbance and strikes would be relatively brief and infrequent, no major impacts on seabirds would result from aircraft strikes. Furthermore, protective measures, such as avoiding large flocks of birds to minimize the safety risk involved with a potential seabird strike, minimize impacts on seabirds (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

California least terns could be exposed to intermittent aircraft overflights and strike potential in nearshore areas where testing activities occur. If present in the open water areas where testing activities involving aircraft occur, Hawaiian petrel, short-tailed albatross, marbled murrelet or Newell's shearwater could be briefly exposed to strike potential. However, the data that Navy has collected on bird strikes reports that no ESA-listed species have been struck in the past, so it is not likely they would be struck by aircraft or aerial targets during testing activities.

Pursuant to the ESA, use of aircraft and aerial targets during testing activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), use of aircraft and aerial targets during testing activities under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.3.2 Impacts from Vessel and In-water Devices

Several different types of vessels (ships, submarines, boats) and in-water devices (towed devices, unmanned underwater vehicles) are used during training and testing activities throughout the Study Area, as described in Chapter 2 (Description of Proposed Action and Alternatives). Potential impacts of those activities on seabirds are applicable to everywhere in the Study Area that vessels and in-water devices are used. Training and testing activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines. The number of Navy ships and smaller vessels in the Study Area varies based on training schedules. Activities involving vessel movements occur intermittently, ranging from a few hours to a few weeks. Events involving large vessels are widely spread over the open ocean, while smaller vessels are more active and more concentrated in nearshore areas.

Vessel transit speed of various types of Navy vessels ranges from 10 to 20 kt. During training, speeds generally range from 10 to 14 kt; however, vessels can and will on occasion operate within the entire spectrum of their specific operational capabilities. It is necessary for vessels to operate at higher speeds during specific events, such as pursuing and overtaking hostile vessels, taking evasive maneuvers, and performing maintenance and performance checks, such as in ship trials. During these events, vessels may often operate at the high end of the vessel's speed capability.

In addition to vessels, mine warfare devices that are towed through the water and remotely operated vehicles used during mine neutralization training could also strike seabirds. No documented instances of seabirds being struck by towed devices have occurred in the Study Area. Additionally, based on the low altitudes and relatively slow air speeds, seabirds would be able to detect and avoid the aircraft and cables that connect the aircraft to the towed device.

Impacts would be the physiological and behavioral disturbance from a vessel. Birds respond to moving vessels in various ways. Some species, such as gulls and albatross, commonly follow vessels (Hamilton 1958; Hyrenback 2001, 2006), while other species, such as plovers and curlews, seem to avoid vessels (Borberg et al. 2005; Hyrenback 2006). There could be a slightly increased risk of impacts during the winter, or fall/spring migrations when migratory birds are concentrated in coastal areas. However, despite this concentration, most birds would still be able to avoid collision with a vessel. Vessel movements could elicit brief behavioral or physiological responses, such as alert response, startle response, or fleeing the immediate area. Such responses typically conclude as rapidly as they occur. However, the general health of individual seabirds would not be compromised.

The possibility of collision with an aircraft carrier or surface combatant vessels (or a vessel's rigging, cables, poles, or masts) could increase at night, especially during inclement weather. Birds can become disoriented at night in the presence of artificial light (Black 2005), and lighting on vessels may attract some birds (Hunter et al. 2006b), increasing the potential for harmful encounters. Lighting on boats and vessels have also contributed to bird fatalities in open-ocean environments when birds are attracted to these lights (Merkel and Johansen 2011). This could be a scenario that Navy vessels could face, especially during the migration season when migrating birds are using celestial clues during night time flight. Many seabird species are attracted to artificial lighting, particularly Procrocellariiformes. In particular, Newell's shearwater and Hawaiian petrel fledglings are particularly susceptible to light attraction, which can cause exhaustion and increase potential for collision with land-based structures (Reed et al. 1985). Other harmful seabird-vessel interactions are commonly associated with commercial fishing vessels because seabirds are attracted to concentrated food sources around these vessels (Dietrich and Melvin 2004, Melvin and Parrish 2001). However, birds following vessels would not be the case for Navy vessels.

Navy aircraft carriers, surface combatant vessels, and amphibious warfare ships are minimally lighted for tactical purposes. For vessels of this type there are two white lights that shine forward and one that shines behind the boat, these lights must be visible for at least 6 nm. There is one red light the shines port and a green one that shines starboard, and these must be visible for at least 3 nm. Solid white lighting appears more problematic for birds, especially nocturnal migrants (Gehring et al. 2009, Poot et al. 2008). Navy vessel lights are mostly solid, but sometimes may not appear solid because of the constant movement of the vessel (wave action), making vessel lighting potentially less problematic for birds in some situations.

In addition to vessels, towed devices and unmanned vehicles are also used; however, no documented instances of birds being struck by in-water devices exist. It would be anticipated that most seabird species would move away from an unmanned vehicle or a towed device.

The other type of vessel movements in the Study Area with the potential to strike a seabird are those used during amphibious landings. These amphibious warfare vessels have the potential to impact shorebirds and seabirds by disturbing or striking individual animals as well as trampling nest sites. Amphibious vessel movements could elicit short-term behavioral or physiological responses such as alert response, startle response, cessation of feeding, fleeing the immediate area, nest abandonment, and a temporary increase in heart rate. Amphibious vessels have the potential to disturb nesting or foraging shorebirds such as the ESA-listed California least tern. However, the general health of individual seabirds would not be compromised, unless a direct strike occurred. However, it is highly unlikely that a seabird would be struck in this scenario because most foraging shorebirds in the vicinity of the approaching amphibious vessel would likely be dispersed by the noise of the approaching vessel before it could come close enough to strike a seabird.

3.6.3.3.2.1 No Action Alternative, Alternative 1, and Alternative 2

Training Activities

As indicated in 3.6.3.3.2 (Impacts from Vessel and In-water Devices), the majority of training activities utilize some type of vessel ranging from ships to submarines. Training involving vessel movements occurs intermittently and ranges in duration from a few hours up to a few weeks. These activities are widely dispersed throughout the Study Area. Training activities involving vessels occur throughout the Study Area, but would be concentrated in the SOCAL Range Complex portion of the Study Area, followed in descending order of numbers of activities by SSTC, HRC, and the Transit Corridor. Ship movements on

the ocean surface have the potential to affect seabirds by disturbing or striking individual animals. The probability of ship and seabird interactions occurring in the Study Area depends on several factors, including the presence and density of seabirds; numbers, types, and speeds of vessels; duration and spatial extent of activities; and protective measures implemented by the Navy. The number of Navy ships operating in the Study Area varies based on training schedules and can range up to 10 ships at any given time.

Vessel movements could result in short-term behavioral responses and low potential for injury/mortality from collisions, though based on the lower density of Navy vessels in pelagic waters, the generally intermittent and short duration of activities, and the high mobility of seabirds, the probability of seabird/vessel interaction is low. There would be a higher likelihood of vessel strikes over the higher productivity portions of the Study Area because of the concentration of seabirds is expected to be higher in those areas. However, even in areas of concentrated vessel use or seabird density, the probability of seabird/vessel interaction is low because of the high mobility of seabirds. Navy protective measures, which include avoidance of seabird colonies and habitats where seabirds may concentrate, would further reduce the probability of seabird/vessel collisions. The combination of these procedures, the relatively lower vessel density in pelagic waters in the Study Area, and the ability of seabirds to detect and avoid vessels reduce the probability that vessel strikes would impact seabird populations under the No Action Alternative.

Birds would not be exposed to unmanned underwater vehicles or remotely operated vehicles because they are typically used on or near the seafloor. The other in-water devices used are typically towed by a helicopter. As discussed for electromagnetic devices, it is likely that any seabirds in the vicinity of the approaching helicopter would be dispersed by the noise of the helicopter (see Section 3.6.3.1.5, Impacts from Aircraft and Vessel Noise) and move away from the in-water device before any exposure could occur.

Amphibious landings are the primary activity that could potentially impact ESA-listed seabird species, specifically California least tern. California least terns use the beaches of SSTC as a resting area and are typically found foraging in the waters near the beach. While they could be present, it is highly unlikely that a California least tern would be struck in this scenario because most foraging or resting seabirds in the vicinity of the approaching amphibious vessel would likely be dispersed by the noise of the approaching vessel before it could come close enough to strike a seabird. Therefore, amphibious assault activities would not cause any potential risk to California least tern in the Study Area. Furthermore, Naval Base Coronado has a specific Integrated Natural Resource Management Plan for addressing ESA-listed seabird species and those plans already include project avoidance and minimization actions that reduce threats from military activities to terns to a minimal level.

Pursuant to the ESA, the use of vessels and in-water devices during training activities under the No Action Alternative, Alternative 1, or Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of vessels and in-water devices during training activities under the No Action Alternative, Alternative 1 or Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

As indicated in Section 3.6.3.3.2 (Impacts from Vessel and In-water Devices), the majority of testing activities utilize some type of vessel ranging from ships to submarines. Testing activities involving vessels occur throughout the Study Area, but would be concentrated in the SOCAL Range Complex portion of the Study Area, followed in descending order of numbers of activities by HRC, SSTC, and the Transit Corridor. All of the Naval Sea Systems Command testing activities utilize some type of vessel ranging from ships to submarines.

The potential for interaction is greater in coastal areas than pelagic areas where Navy vessel use is less concentrated. However, even in areas of concentrated vessel use, the probability of seabird/vessel interaction is low because of the high mobility of seabirds and intermittent and temporary vessel use. Certain portions of the Study Area, such as areas near ports, naval installations, or testing locations are used more heavily by vessels than other portions of the Study Area. Ship movements on the ocean surface have the potential to affect seabirds by disturbing or striking individual seabirds. The probability of ship and seabird interactions occurring in the Study Area depends on several factors, including the presence and density of seabirds; numbers, types, and speeds of vessels; duration and spatial extent of activities; and protective measures implemented by the Navy. The number of Navy ships operating in the Study Area varies based on the testing activity and can range up to 10 vessels at any given time.

The potential for interaction is greater in coastal areas than pelagic areas where Navy vessel use is less concentrated. However, even in areas of concentrated vessel use, the probability of seabird/vessel interaction is low because of the high mobility of seabirds that they could move away from an oncoming vessel. Flushing of seabirds is expected to be greatest with fast-moving, agile vessels. Impacts from Navy vessels would be limited to short-term behavioral responses and are not expected to have long-term effects. While such flushing or other effects of vessels on individual seabirds may occur, none of these temporary effects are expected to have an adverse effect on seabirds at the population level.

The relatively lower vessel density in pelagic waters in the Study Area, and the ability of seabirds to detect and avoid vessels reduce the probability that vessel strikes would impact seabird populations under the No Action Alternative. The impacts of vessel movements would be short-term, temporary, and localized disturbances of individual seabirds in the vicinity. No increased risk of impact to seabirds would result from physical disturbance and strikes with Navy vessels. If in the immediate area where vessels or in-water devices are operating, ESA-species could be disturbed, but this would not result in adverse impacts (impacts would be limited to short-term behavioral responses and are not expected to have long-term effects). No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of vessels and in-water devices during testing activities under the No Action Alternative, Alternative 1, or Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of vessels and in-water devices during testing activities under the No Action Alternative, Alternative 1, or Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.3.3 Impacts from Military Expendable Materials

Many different types of military expended materials are left at sea during training and testing activities throughout the Study Area, as described in Chapter 2 (Description of Proposed Action and Alternatives).

During these training and testing events, various items may be introduced and expended into the marine environment and are referred to as military expended materials. Chapter 2 includes quantities of military expended materials used during training and testing activities in the Study Area.

Expended materials do have the potential to strike seabirds as they travel through the air. Statistical modeling to estimate the probability of seabird and military expended material strikes is not practical. The widely dispersed area in which bombs and missiles would be expended in the Study Area annually (see Chapter 2, Description of Proposed Action and Alternatives), coupled with the often patchy distribution of seabirds (Schneider and Duffy 1985, Haney 1986, Fauchald et al. 2002), suggest that the probability of these types of ordnance striking a seabird would be low. The number of small-caliber projectiles that would be expended annually during gunnery exercises is much higher than the number of large-caliber projectiles. However, the total number of rounds expended is not a good indicator of strike probability during gunnery exercises because multiple rounds are fired at individual targets.

Human activity such as vessel movement, aircraft overflights, and target setting, could cause seabirds to flee a target area before the onset of firing, thus avoiding harm. If seabirds were in the target area, they would likely flee the area prior to the release of military expended materials or just after the initial rounds strike the target area (assuming seabirds were not struck by the initial rounds). Additionally, the force of military expended material fragments dissipates quickly once the pieces hit the water, so direct strikes on seabirds foraging below the surface would not be likely. Also, munitions would not be used in shallow/nearshore areas. Individual seabirds may be impacted, but ordnance strikes would likely have no impact on seabird populations.

The potential for seabirds to experience strikes would remain quite low based on the large area over which ordnance is used, the relatively small size of the seabirds, and the ability of seabirds to readily flee. Individual seabirds may be impacted, but ordnance strikes would likely have no impact on seabird populations.

3.6.3.3.3.1 No Action Alternative

Training Activities

Current military training in the Study Area includes firing a variety of weapons employing a variety of non-explosive training rounds and explosive rounds including bombs, missiles, naval gunshells, cannon shells, and small-, medium-, and large-caliber projectiles, as well as sonobuoys released from aircraft. The majority of material expended in the Study Area consists of non-explosive training rounds (Table 3.0-65). While gunnery exercises are a common training activity, few Sinking Exercises per year are proposed under the No Action Alternative. During a sinking exercise, aircraft, ship, and submarine crews deliver ordnance on a seaborne target, usually a clean deactivated ship, which is deliberately sunk using multiple weapon systems. Sinking exercises occur in open-ocean areas and expend target fragments that could have the potential to strike seabirds. The potential impact of military expended material to seabirds in the Study Area is dependent on the ability of seabirds to detect and avoid foreign objects through their visual and auditory sensory systems and the relatively-fast flying speeds and good maneuverability of most seabird species.

The small number of bombs that would be expended in the Study Area annually, coupled with the often patchy distribution of seabirds suggest that the probability of this type of strike for a seabird would be extremely low. The number of small-caliber projectiles that would be expended annually during gunnery exercises is much higher. However, the total number of rounds expended is not a good indicator of strike probability during gunnery exercises because multiple rounds are fired at individual targets. Given

the implementation of protective measures, and the lower density of seabirds away from nesting or roosting areas, non-explosive ordnance or sonobuoys dropped from aircraft, under the No Action Alternative would have limited potential to affect seabirds.

Direct strikes from firing weapons or air-launched devices (e.g., sonobuoys, torpedoes) are a potential stressor to seabirds. Seabirds in flight, resting on the water's surface, or foraging just below the water surface would be vulnerable to a direct strike. Strikes have the potential to injure or kill seabirds in the Study Area. However, there would not be long-term population level impacts. The vast area over which training activities occur combined with the ability of seabirds to flee disturbance, would make direct strikes unlikely. Individual seabirds may be affected, but strikes would have no impact on species or populations.

If in the immediate area where military expended materials are present, ESA-listed species could be impacted by military expended material strikes. It is highly unlikely that a seabird would be struck by military expended material because most seabirds in the vicinity of the approaching aircraft or vessel, from which the military expended material is released, would likely be dispersed by the noise of the approaching aircraft or vessel before it could come close enough to strike a seabird. Therefore, activities that release military expended materials would not cause any potential strike risk to ESA-listed seabirds in the Study Area.

Pursuant to the ESA, the use of military expended materials during training activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of military expended materials during training activities under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Under the No Action Alternative, testing activities would result in military expended material left in the Study Area, as presented in Table 2.8-2 (Description of Proposed Action and Alternatives). The potential impact of military expended material to seabirds in the Study Area is dependent on the ability of seabirds to detect and avoid foreign objects through their visual and auditory sensory systems and the relatively-fast flying speeds and good maneuverability of most seabird species.

Direct strikes from firing weapons and air-launched devices (e.g., sonobuoys, torpedoes) are a potential stressor to seabirds. Seabirds in flight, resting on the water's surface, or foraging just below the water surface would be vulnerable to a direct strike. Strikes have the potential to injure or kill seabirds in the Study Area. However, there would not be long-term population level impacts. The vast area over which testing activities occur combined with the ability of seabirds to flee disturbance, would make direct strikes unlikely. Individual seabirds may be affected, but strikes would have no impact on species or populations.

If in the immediate area where military expended materials are present, ESA-listed species could be impacted by military expended material strikes. It is highly unlikely that a seabird would be struck by military expended material because most seabirds in the vicinity of the approaching aircraft or vessel, from which the military expended material is released, would likely be dispersed by the noise of the approaching aircraft or vessel before it could come close enough to strike a seabird. Therefore, activities

that release military expended materials would not cause any potential strike risk to ESA-listed seabirds in the Study Area.

Pursuant to the ESA, the use of military expended materials during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of military expended materials during testing activities under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.3.3.2 Alternative 1

Training Activities

The total number of military expended materials throughout the Study Area would increase under Alternative 1. Under Alternative 1, the number of bombs decreases by 522 high explosive bombs and increases by 492 non-explosive bombs as compared to the No Action Alternative, for a total of 240 high explosive bombs and 1,609 non-explosive bombs. The number of small-caliber projectiles fired would increase by 2,084,500 as compared to the No Action Alternative, for a total of 3,065,800 small-caliber rounds. The number of medium-caliber rounds would increase by 260,480 as compared to the No Action Alternative for a total of 657,180 medium-caliber rounds (636,600 non-explosive). The number of non-explosive large-caliber rounds would decrease by 16,960 as compared to the No Action Alternative, for a total of 7,440 non-explosive large-caliber projectiles expended during training events and activities. The number of missiles utilized during training activities would increase by 182 as compared to the No Action Alternative, for a total of 570 explosive missiles expended (94 non-explosive). The number of sonobuoys dropped would increase by 9,850 over the No Action Alternative, for a total of 52,100.

While the number of military expended materials increases under Alternative 1 as compared to the No Action Alternative, the potential for direct strikes remains low. The vast area over which training activities occur combined with the ability of seabirds to flee disturbance, would make direct strikes unlikely. Individual seabirds may be affected, but strikes would not be responsible for long-term population level impacts.

If in the immediate area where military expended materials are present, ESA-listed species could be impacted by military expended material strikes. It is highly unlikely that a seabird would be struck by military expended material because most seabirds in the vicinity of the approaching aircraft or vessel, from which the military expended material is released, would likely be dispersed by the noise of the approaching aircraft or vessel before it could come close enough to strike a seabird. Therefore, activities that release military expended materials would not cause any potential strike risk to ESA-listed seabirds in the Study Area.

Pursuant to the ESA, the use of military expended materials during training activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of military expended materials during training activities under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

The total number of military expended materials throughout the Study Area would increase under Alternative 1. Alternative 1 also introduces the use of 20,200 small-caliber projectiles. Under Alternative 1, the number of non-explosive medium-caliber rounds would increase by 74,500 as compared to the No Action Alternative for a total of 81,000 medium-caliber rounds. Alternative 1 would also increase the use of high explosive medium-caliber projectiles by 15,300 as compared to the No Action Alternative, for a total of 17,800 high explosive medium-caliber projectiles. The number of non-explosive large-caliber rounds would increase compared to the No Action Alternative, for a total of 14,120 non-explosive large-caliber projectiles expended during testing events and activities. Alternative 1 would also introduce the usage of 6,160 high explosive large-caliber projectiles. The number of high explosive missiles utilized during testing activities would increase by 85 as compared to the No Action Alternative for a total of 118 high explosive missiles expended. The number of sonobuoys dropped would increase by 5,112 over the No Action Alternative, for a total of 15,247. Alternative 1 would also increase the usage of non-explosive missiles from 78 to 206. Alternative 1 would introduce the use of 284 high explosive rockets. The number of non-explosive rockets utilized during testing activities would increase by 681 as compared to the No Action Alternative, for a total of 696 non-explosive rockets.

These increases would result in increased strike potential from ordnance, however, the vast area over which testing activities occur, combined with the ability of seabirds to flee disturbance, would make direct strikes unlikely. Individual seabirds may be affected, but ordnance strikes would have no impact on species or community populations.

If in the immediate area where military expended materials are present, ESA-listed species could be impacted by military expended material strikes. It is highly unlikely that a seabird would be struck by military expended material because most seabirds in the vicinity of the approaching aircraft or vessel, from which the military expended material is released, would likely be dispersed by the noise of the approaching aircraft or vessel before it could come close enough to strike a seabird. Therefore, activities that release military expended materials would not cause any potential strike risk to ESA-listed seabirds in the Study Area.

Pursuant to the ESA, the use of military expended materials during testing activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of military expended materials during testing activities under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.3.3.3 Alternative 2

Training Activities

The total number of military expended materials throughout the Study Area would increase under Alternative 2. Under Alternative 2, the number of bombs decreases by 522 high explosive bombs and increases by 492 non-explosive bombs as compared to the No Action Alternative, for a total of 240 high explosive bombs and 1,609 non-explosive bombs. The number of small-caliber projectiles fired would increase by 2,084,500 as compared to the No Action Alternative, for a total of 3,065,800 small-caliber rounds. The number of medium-caliber rounds would increase by 260,480 as compared to the No Action Alternative for a total of 657,180 medium-caliber rounds (636,600 non-explosive). The number of non-explosive large-caliber rounds would decrease by 16,960 as compared to the No Action Alternative, for a total of 7,440 non-explosive large-caliber projectiles expended during training events and activities.

The number of missiles utilized during training activities would increase by 182 as compared to the No Action Alternative for a total of 570 explosive missiles expended (94 non-explosive). The number of sonobuoys dropped would increase by 9,850 over the No Action Alternative, for a total of 52,100.

These increases would result in increased strike potential from ordnance, however, the vast area over which testing activities occur, combined with the ability of seabirds to flee disturbance, would make direct strikes unlikely. Individual seabirds may be affected, but ordnance strikes would have no impact on species or community populations.

If in the immediate area where military expended materials are present, ESA-listed species could be impacted by military expended material strikes. It is highly unlikely that a seabird would be struck by military expended material because most seabirds in the vicinity of the approaching aircraft or vessel, from which the military expended material is released, would likely be dispersed by the noise of the approaching aircraft or vessel before it could come close enough to strike a seabird. Therefore, activities that release military expended materials would not cause any potential strike risk to ESA-listed seabirds in the Study Area.

Pursuant to the ESA, the use of military expended materials during training activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of military expended materials during training activities under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

The total number of military expended materials throughout the Study Area would increase under Alternative 2. Alternative 2 would introduce the use of 8,250 small-caliber projectiles. The number of non-explosive medium-caliber rounds would increase by 78,500 as compared to the No Action Alternative for a total of 85,000 medium-caliber rounds. Alternative 2 would also increase the use of high explosive medium-caliber projectiles by 17,500 as compared to the No Action Alternative, for a total of 20,000 high explosive medium-caliber projectiles. The number of non-explosive large-caliber rounds would increase by 5,700 as compared to the No Action Alternative, which utilized zero non-explosive large-caliber projectiles. The number of high explosive missiles utilized during testing activities would increase by 93 as compared to the No Action Alternative for a total of 126 high explosive missiles expended. The number of sonobuoys dropped would increase by 6,496 over the No Action Alternative, for a total of 16,631. Alternative 2 would increase the usage of non-explosive missiles from 78 to 218. Alternative 2 would introduce the use of 297 high explosive rockets and increase the number of non-explosive rockets utilized during testing activities by 766 as compared to the No Action Alternative, for a total of 781 non-explosive rockets.

There is the potential for individual seabirds to be injured or killed by direct strikes. However, there would not be long-term population level impacts. The vast area over which testing activities occur and implementation of Navy resource protection measures, combined with the small size and ability of seabirds to flee disturbance, would make direct strikes unlikely. Individual seabirds may be affected, but ordnance strikes would have no impact on species or community populations.

If in the immediate area where military expended materials are present, ESA-listed species could be impacted by military expended material strikes. It is highly unlikely that a seabird would be struck by

military expended material because most seabirds in the vicinity of the approaching aircraft or vessel, from which the military expended material is released, would likely be dispersed by the noise of the approaching aircraft or vessel before it could come close enough to strike a seabird. Therefore, activities that release military expended materials would not cause any potential strike risk to ESA-listed seabirds in the Study Area.

Pursuant to the ESA, the use of military expended materials during testing activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of military expended materials during testing activities under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.3.4 Summary of Impacts of Physical Stressors

Three physical disturbance or strike sub-stressors were identified and analyzed that have potential to affect seabirds: aircraft or aerial target strikes, vessel and in-water device strikes, and military expended materials. While bird strikes can occur anywhere aircraft are operated, Navy data indicate that they occur most often over land or close to shore. The potential for seabird strikes to occur in offshore areas is relatively low because (1) activities are widely dispersed, (2) seabird densities are low, (3) the seabirds are small and have the ability to flee disturbance, and (4) Navy protective measures include avoidance of seabird colonies and habitats where seabirds may concentrate.

Vessel movements could result in short-term behavioral responses and potential for injury/mortality from collisions. However, the probability of seabird/vessel collisions is extremely low based on (1) the low Navy vessel density, (2) the patchy distribution of seabirds throughout the Study Area, and (3) the implementation of Navy protective measures, which include avoidance of seabird colonies and habitats where seabirds may concentrate further reducing the probability of seabird/vessel collisions.

There is the potential for individual seabirds to be injured or killed by ordnance. However, there would not be long-term population level impacts. Individual seabirds may be affected, but ordnance strikes would have no impact on species or populations due to (1) the vast area over which training and testing activities occur, (2) implementation of Navy resource protection measures as described in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring), and (3) the small size of seabirds and their ability to flee disturbance.

3.6.3.4 Ingestion Stressors

This section analyzes the potential impacts of the various types of expended materials used by the Navy during training and testing activities within the Study Area. Birds could potentially ingest expended materials used by the Navy during training and testing activities within the Study Area. The Navy expends the following types of materials that could become ingestion stressors for seabirds during training and testing in the Study Area: chaff and flare endcaps/pistons. Ingestion of expended materials by seabirds could occur in all large marine ecosystems and open ocean areas and would occur either at the surface or just below the surface portion of the water column, depending on the size and buoyancy of the expended object and the feeding behavior of the seabirds. Floating material of ingestible size could be eaten by seabirds that feed at or near the water surface, while materials that sink pose a potential risk to diving seabirds that feed just below the water's surface. Some items, such as parachutes or sonobuoys are too large to be ingested and will not be discussed further. Also, parachutes sink rapidly to the seafloor.

Foraging depths of most diving seabirds are generally restricted to shallow depths, so it is highly unlikely that benthic, nearshore, or intertidal foraging would occur in areas of munitions use, and these seabirds would not encounter any type of munitions or fragments from munitions in nearshore or intertidal areas. Ingestion of military expended material from munitions is not expected to occur because the solid metal and heavy plastic objects from these ordnances sink rapidly to the seafloor, beyond the foraging depth range of most seabirds. Therefore, no impact of ingestion of military expended material from munitions would result for seabirds. As a result, the analysis in this section includes the potential ingestion of military expended materials other than munitions, all of which are expended away from nearshore habitats and close to the water surface.

A variety of ingestible materials may be released into the marine environment by Navy training and testing activities. Birds of all sizes and species are known to ingest a wide variety of items, which they might mistake for prey. For example, 21 of 38 seabird species (55 percent) collected off the coast of North Carolina from 1975 to 1989 contained plastic particles (Moser and Lee 1992). The mean particle sizes of ingested plastic were positively correlated with the birds' size though the mean mass of plastic found in the stomachs and gizzards of 21 species was below 3 grams (g) (0.11 oz.).

Plastic is often mistaken for prey and the incidence of plastic ingestion appears to be related to a species' feeding mode and diet. Seabirds that feed by pursuit-diving, surface-seizing, and dipping tend to ingest plastic, while those that feed by plunging or piracy typically do not ingest plastic. Birds of the family Procellariidae, which include petrels and shearwaters, tend to accumulate more plastic than do other species. Some seabirds, including gulls and terns, regularly regurgitate indigestible parts of their food items such as shell and fish bones. However, most procellariiforms have small gizzards and an anatomical constriction between the gizzard and stomach that make it difficult to regurgitate solid material such as plastic (Azzarello and Van Vleet 1987, Pierce et al. 2004). Two species of albatross (Diomedeidae) have also been reported to ingest plastic while feeding at sea. While such studies have not conclusively shown that plastic ingestion is a significant source of direct mortality, it may be a contributing factor to other causes of albatross mortality (Naughton et al. 2007).

Moser and Lee (1992) found no evidence that seabird health was affected by the presence of plastic, but other studies have documented adverse consequences of plastic ingestion. As summarized by Pierce et al. (2004) and Azzarello and Van Vleet (1987), documented consequences of plastic ingestion by seabirds include blockage of the intestines and ulceration of the stomach, reduction in the functional volume of the gizzard leading to a reduction of digestive capability, and distention of the gizzard leading to a reduction in hunger. Studies have found negative correlations between body weight and plastic load, as well as body fat, a measure of energy reserves, and the number of pieces of plastic in a seabird's stomach (Auman et al. 1997, Ryan 1987, Sievert and Sileo 1993). Other possible concerns that have been identified include toxic plastic additives and toxic contaminants that could be adsorbed to the plastic from ambient seawater. Pierce et al. (2004) described a case where plastic ingestion caused seabird mortality from starvation of a member of family Procellariidae. Dissection of an adult greater shearwater gizzard revealed that a 1.5 in. (3.81 centimeters [cm]) by 0.5 in. (1.27 cm) fragment of plastic blocked the pylorus, obstructed the passage of food, and resulted in death from starvation.

Species such as storm-petrels, albatrosses, and shearwaters that forage by picking prey from the surface may have a greater potential to ingest any floating plastic debris. Ingestion of plastic military expended material by any species from the taxonomic groups found within the Study Area (Table 3.6-2) has the potential to impact individual seabirds. The risk of plastic ingestion and impaction in chicks of many species of seabirds may be different from the risks to adults. Albatross chicks appear to be at greater risk

than adults, because of their high rates of ingestion and apparent low frequency of regurgitative casting of indigestible material. Fry et al. (1987) demonstrated that a very high proportion of chicks of albatrosses breeding in the North Western Hawaiian Islands ingest plastics during the pre-fledging period when they are dependent upon food brought to the breeding colony by parents. Floating plastic items are ingested by adult albatrosses and regurgitated to chicks along with normal food items. Large amounts of plastic appeared to cause impaction of the upper GI tract and interfere with passage of food through the digestive system. The sub-lethal effects of plastic impaction and minor ulcerations may contribute to reduced resistance to disease and lowered post-fledging survival. These results suggest that plastics appear to present risks only when they are consumed in sufficient quantity to cause physical obstruction or ulcerations of birds' stomachs.

The distribution of floating expended items would be irregular in both space and time, as training activities do not occur in the same place each time. The random distribution of items across the large Study Area yields very low probabilities that seabirds will encounter a floating item. However, when a seabird does encounter a floating item of ingestible size, an ingestion risk may exist. Although most military expended material components are expected to sink to the sea floor and spend limited periods within the water column, some items remain buoyant for an extended period. Expended training material, such as missile and target components that float, may be encountered by seabirds in the waters of the Study Area, increasing the potential for ingestion of smaller components.

3.6.3.4.1 Chaff

Based on the dispersion characteristics of chaff, large areas of air space and open water within the Study Area would be exposed to chaff, but the chaff concentrations would be very low. A general discussion of chaff as an ingestion stressor is presented in Section 3.0.5.3.5 (Ingestion Stressors). It is unlikely that chaff would be selectively ingested (U.S. Department of the Air Force 1997). Ingestion of chaff fibers is not expected to cause physical damage to a bird's digestive tract based on the small size (ranging in lengths of 0.25 to 3 in. [0.64 to 7.6 cm] with a diameter of about 40 micrometers [µm] [0.001574 in.]) and flexible nature of the fibers and the small quantity that could reasonably be ingested. In addition, concentrations of chaff fibers that could reasonably be ingested are not expected to be toxic to seabirds. Scheuhammer (Scheuhammer 1987) reviewed the metabolism and toxicology of aluminum in birds and mammals and found that intestinal adsorption of orally ingested aluminum salts was very poor, and the small amount adsorbed was almost completely removed from the body by excretion. Dietary aluminum normally has small effects on healthy birds and mammals, and often high concentrations (greater than 0.016 oz./lb. [~1,000 mg/kg]) are needed to induce detrimental effects (Nybo 1996). It is highly unlikely that a seabird would ingest a toxic dose of chaff based on the anticipated environmental concentration of chaff for a worst-case scenario of 360 chaff cartridges simultaneously released at a single drop point (1.8 fibers/square feet [0.2 fibers/square meter]).

3.6.3.4.2 Flares

Ingestion of flare end caps 1.3 in. (3.3 cm) in diameter and 0.13 in. (0.33 cm) thick (U.S. Department of the Air Force 1997) by birds may result in gastrointestinal obstruction or reproductive complications. If a seabird were to ingest a plastic end cap or piston, the response would vary based on the species and individual seabird. The responses could range from none, to sublethal (reduced energy reserves), to lethal (digestive tract blockage leading to starvation). Ingestion of end caps and pistons by species that regularly regurgitate indigestible items would likely have no adverse impacts. However, end caps and pistons are similar in size to those plastic pieces described above that caused digestive tract blockages and eventual starvation. Therefore, ingestion of plastic end caps and pistons could be lethal to some

individuals of some species of seabirds. Species with small gizzards and anatomical constrictions that make it difficult to regurgitate solid material would likely be most susceptible to blockage (such as Procellariiformes). Based on available information, it is not possible to accurately estimate actual ingestion rates or responses of individual seabirds.

3.6.3.4.2.1 No Action Alternative

Training Activities

Current Navy training activities in the Study Area include firing a variety of weapons. As listed in Chapter 2 (Description of Proposed Action and Alternatives), these weapons employ a variety of non-explosive and explosive training rounds, including bombs, missiles, naval gunshells, cannon shells, chaff or flares and small-caliber ammunition. These materials are used in the open ocean away from shore. These activities account for the majority of naval shells and rounds used in the Study Area. Expended materials resulting from ordnance use include remnants and shrapnel from explosive rounds and non-explosive training rounds. These solid materials, many of which have a high metal content, quickly drop through the water column to the sea floor. Ingestion of expended ordnance would not occur in the water column because ordnance-related materials quickly sink.

Ordnance related materials would sink in relatively deep waters, would not present an ingestion risk to seabirds, and therefore, would likely have a negligible impact. However, seabirds could be exposed to some materials such as chaff fibers used during air combat maneuver, electronic warfare operations, or chaff exercises (Tables 2.8-2 through 2.8-5) in the air or at the sea surface through direct contact or inhalation. Seabirds could also ingest some types of expended materials if the materials float on the sea surface.

Other expended materials that could be ingested by seabirds include small plastic end caps and pistons associated with chaff and self-protection flares. The chaff end cap and piston are both round and are 1.3 in. (3.3 cm) in diameter and 0.13 in. (0.33 cm) thick (U.S. Department of the Navy 2011). This plastic expended material sinks in saltwater, which reduces the likelihood of ingestion.

Birds would have the potential to ingest military expended material. However, the concentration of military expended material in the Study Area is low and seabirds are patchily distributed (Schneider and Duffy 1985, Haney 1986, Fauchald et al. 2002). As discussed in Chapter 2 (Description of Proposed Action and Alternatives) and presented in Table 3.0-85, the highest density of chaff and flare end caps/pistons would be expended in the SOCAL Range Complex portion of the Study Area. Assuming that all end caps and pistons expended in the SOCAL Range Complex potion of the Study Area would be evenly distributed, the relative end-cap and piston concentration would be very low (0.17 pieces/square nautical miles [nm^2]/year, based on an area of 120,000 nm^2 and 20,950 end caps/pistons per year). The overall likelihood that seabirds would be impacted by ingestion of military expended material in the Study Area under the No Action Alternative is negligible.

Pursuant to the ESA, the potential for ingestion of military expended materials other than munitions from training activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from ingestion of military expended materials from training activities under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Current Navy testing activities in the Study Area include firing a variety of weapons. As listed in Chapter 2 (Description of Proposed Action and Alternatives), these weapons employ a variety of non-explosive and explosive rounds, including missiles, naval gunshells, cannon shells, and small-caliber ammunition. These materials are used in the open ocean away from shore. These activities account for the majority of naval shells and rounds used in the Study Area. Expended materials resulting from ordnance use include remnants and shrapnel from explosive rounds and non-explosive rounds. These solid materials, many of which have a high metal content, quickly drop through the water column to the sea floor. Ingestion of expended ordnance does not occur in the water column because ordnance-related materials quickly sink. Under the No Action Alternative, ordnance related materials would sink in relatively deep waters, would not present a low ingestion risk to seabirds. However, seabirds could ingest some types of expended materials if the materials float on the sea surface. No flares (plastic end caps or pistons) or chaff is utilized under the No Action Alternative, therefore the ingestion risk of expended materials from testing activities is very low.

Pursuant to the ESA, ingestion of military expended materials from testing activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from ingestion of military expended materials from testing activities under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.4.2.2 Alternative 1

Training Activities

Under Alternative 1, an overall increase of military expended material would be expended in the Study Area from the No Action Alternative, as presented in Table 3.0-85. Of the expended materials that could be ingested (chaff canisters, flares, and plastic end caps), there is an increase of 2,400 events that could result in chaff from the No Action Alternative. Therefore the ingestion risk is slightly greater than for the No Action Alternative. As discussed in Chapter 2 (Description of Proposed Action and Alternatives) and Section 3.6.3.4.2.1 (No Action Alternative), the highest density of chaff and flare end caps/pistons would be expended in the SOCAL Range Complex portion of the Study Area. The concentration of military expended material in the Study Area is low and seabirds are patchily distributed. The overall likelihood that seabirds would be impacted by ingestion of military expended material in the Study Area under Alternative 1 is negligible. If foraging in an area where military expended material are present seabirds could potentially be impacted by ingestion of military expended material, but this would not result in impacts on populations of these ESA-listed species.

Pursuant to the ESA, ingestion of military expended materials from training activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from ingestion of military expended materials from training activities under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Under Alternative 1, the number of expended materials that could be ingested (chaff canisters, flares, and plastic end caps) would increase by 504 from the No Action Alternative (where none were used). The chaff end cap and piston are both round and are 1.3 in. (3.3 cm) in diameter and 0.13 in. (0.33 cm)

thick (U.S. Department of the Navy 2011). This plastic expended material sinks in saltwater, which reduces the likelihood of ingestion.

Birds would have the potential to ingest military expended material. However, the concentration of military expended material in the Study Area is low and seabirds are patchily distributed. The overall likelihood that seabirds would be impacted by ingestion of military expended material in the Study Area under Alternative 1 is low. Assuming that all end caps and pistons expended throughout the entire Study Area would be evenly distributed, the relative end-cap and piston concentration would be extremely low (0.001 pieces/nm^2/year, based on an area of 355,000 nm^2 and 504 end caps/pistons per year). The concentration of military expended material in the Study Area is low and seabirds are patchily distributed. The overall likelihood that seabirds would be impacted by ingestion of military expended material in the Study Area under Alternative 1 is negligible. If foraging in an area where military expended material are present seabirds could potentially be impacted by ingestion of military expended material, but this would not result in impacts on populations of these ESA-listed species.

Pursuant to ESA, the ingestion of military expended materials from testing activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from ingestion of military expended materials from testing activities under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.4.2.3 Alternative 2

Training Activities

Under Alternative 2, an overall increase of military expended material would be expended in the Study Area from the No Action Alternative, as presented in Table 3.0-85. Of the expended materials that could be ingested (chaff canisters, flares, and plastic end caps), there is an increase of 2,400 events that could result in chaff from the No Action Alternative. Therefore the ingestion risk is slightly greater than for the No Action Alternative. The concentration of military expended material in the Study Area is low and seabirds are patchily distributed. Therefore, the overall likelihood that seabirds would be impacted by ingestion of military expended material in the Study Area under Alternative 2 is negligible. If foraging in an area where military expended material are present seabirds could potentially be impacted by ingestion of military expended material, but this would not result in impacts on populations of these ESA-listed species.

Pursuant to the ESA, ingestion of military expended materials from training activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from ingestion of military expended materials from training activities under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Under Alternative 2, the number of expended materials that could be ingested (chaff canisters, flares, and plastic end caps), would increase by 554 from the No Action Alternative (where none were used). The chaff end cap and piston are both round and are 1.3 in. (3.3 cm) in diameter and 0.13 in. (0.33 cm) thick (U.S. Department of the Navy 2011). This plastic expended material sinks in saltwater, which reduces the likelihood of ingestion.

Birds would have the potential to ingest military expended material. However, the concentration of military expended material in the Study Area is low and seabirds are patchily distributed. The overall likelihood that seabirds would be impacted by ingestion of military expended material in the Study Area under Alternative 1 is low. Assuming that all end caps and pistons expended throughout the entire Study Area would be evenly distributed, the relative end-cap and piston concentration would be extremely low (0.001 pieces/nm^2/year, based on an area of 355,000 nm^2 and 554 end caps/pistons per year). The concentration of military expended material in the Study Area is low and seabirds are patchily distributed. Therefore, the overall likelihood that seabirds would be impacted by ingestion of military expended material in the Study Area under Alternative 2 is negligible. If foraging in an area where military expended material are present seabirds could potentially be impacted by ingestion of military expended material, but this would not result in impacts on populations of these ESA-listed species.

Pursuant to the ESA, ingestion of military expended materials from testing activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed seabird species.

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from ingestion of military expended materials from testing activities under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.4.3 Summary of Impacts of Ingestion Stressors

It is possible that persistent expended materials could be accidentally ingested by seabirds while they were foraging for natural prey items, though the probability of this event is low as (1) foraging depths of diving seabirds is generally restricted to the surface of the water or shallow depths, (2) the material is unlikely to be mistaken for prey, and (3) the material remains at or near the sea surface for a short length of time.

Based on available information, it is not possible to accurately estimate actual ingestion rates or responses of individual seabirds. Nonetheless, the number of end caps or pistons ingested by seabirds is expected to be very low and only an extremely small percentage of the total would be potentially available to seabirds due to their relatively low concentration throughout the Study Area. Anatomical characteristics of species within family Procellariidae may elevate the risk of plastic ingestion relative to other species or families; however, exposure to species of family Procellariidae would still remain low. Plastic ingestion under the No Action Alternative, Alternative 1, or Alternative 2 would not result in a significant adverse impact on seabird populations. Sublethal and lethal impacts, if they occur, would be limited to a few individual seabirds.

3.6.3.5 Secondary Stressors

The potential of water and air quality stressors associated with training and testing activities to indirectly affect seabirds was analyzed. The assessment of potential water and air quality stressors refers to previous sections in this EIS/OEIS (Section 3.1, Sediments and Water Quality, and Section 3.2, Air Quality), and addresses specific activities in local environments that may affect seabird habitats. At-sea activities that may impact water and air include general emissions.

As noted in Section 3.1.3 (Sediments and Water Quality, Environmental Consequences), implementation of the No Action Alternative, Alternative 1, or Alternative 2 would not adversely affect water or sediment quality. Any physical impacts on seabird habitats would be temporary and local because training activities would occur infrequently. Impacts from activities would not be expected to adversely impact seabirds or seabird habitats.

Indirect impacts on water or air quality under the No Action Alternative, Alternative 1, or Alternative 2 would have no effect on ESA-listed seabird species due to: (1) the temporary nature of impacts on water or air quality, (2) the distribution of temporary water or air quality impacts, (3) the wide distribution of seabirds in the Study Area, and (4) the dispersed spatial and temporal nature of the training and testing activities that may have temporary water or air quality impacts. No long-term or population-level impacts are expected.

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

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from secondary stressors from training or testing activities under the No Action Alternative, Alternative 1, or Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.4 Summary of Potential Impacts (Combined Impacts of All Stressors) on Seabirds

This section evaluates the potential for combined impacts of all the stressors from the Proposed Action. The analysis and conclusions for the potential impacts from each of the individual stressors are discussed in the analyses of each stressor in the sections above. There are generally two ways that a seabird could be exposed to multiple stressors. The first would be if a seabird were exposed to multiple sources of stress from a single activity or activity (e.g., an amphibious landing activity may include an amphibious vessel that would introduce potential acoustic and physical strike stressors). The potential for a combination of these impacts from a single activity would depend on the range of effects to each of the stressors and the response or lack of response to that stressor. Most of the activities as described in the Proposed Action involve multiple stressors; therefore, it is likely that if a seabird were within the potential impact range of those activities, they may be impacted by multiple stressors simultaneously. This would be more likely to occur during large-scale exercises or activities that span a period of days or weeks (such as a sinking exercise or composite training unit exercise).

Secondly, an individual seabird could be exposed to a combination of stressors from multiple activities over the course of its life. This is most likely to occur in areas where testing and training activities are more concentrated (e.g., near ports, testing ranges, and routine activity locations) and in areas that individual seabirds frequent because it is within the animal's home range, migratory route, breeding area, or foraging area. Except for in the few concentrated areas mentioned above, combinations are unlikely to occur because training and testing activities are generally separated in space and time in such a way that it would be very unlikely that any individual seabirds would be exposed to stressors from multiple activities. However, animals with a small home range intersecting an area of concentrated Navy activity have elevated exposure risks relative to animals that simply transit the area through a migratory route. The majority of the proposed training and testing activities occur over a small spatial scale relative to the entire Study Area, have few participants, and are of a short duration (the order of a few hours or less).

Multiple stressors may also have synergistic effects. For example, seabirds that experience temporary hearing loss or injury from acoustic stressors could be more susceptible to physical strike and disturbance stressors via a decreased ability to detect and avoid threats. Birds that experience behavioral and physiological consequences of ingestion stressors could be more susceptible to physical strike stressors via malnourishment and disorientation. These interactions are speculative, and without

data on the combination of multiple Navy stressors, the synergistic impacts from the combination of Navy stressors on seabirds are difficult to predict.

Although potential impacts to certain seabird species from the Proposed Action could include injury or mortality, impacts are not expected to decrease the overall fitness or result in long-term population-level impacts of any given population. In cases where potential impacts rise to the level that warrants mitigation, mitigation measures designed to reduce the potential impacts are discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring). The potential impacts anticipated from the Proposed Action are summarized below in Endangered Species Act Determinations (3.6.5) and Migratory Bird Act Determinations (3.6.6) with respect to each regulation applicable to seabirds.

3.6.5 Endangered Species Act Determinations

Table 3.6-6 summarizes the ESA determinations for each substressor analyzed.

3.6.6 Migratory Bird Act Determinations

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the stressors introduced during training and testing activities would not result in a significant adverse effect on migratory bird populations.

Table 3.6-6: Summary of Endangered Species Act Effects Determinations for Birds, for the Preferred Alternative

Navy Activities and Stressors		California least tern	Hawaiian petrel	Short-tailed albatross	Marbled murrelet	Newell's shearwater
Acoustic Stressors						
Sonar and other active sources	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Explosives	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Pile Driving	Training Activities	May affect, not likely to adversely affect	No effect	No effect	No effect	No effect
	Testing Activities	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Weapons Firing, Launch, and Impact Noise	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Aircraft And Vessel Noise	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Energy Stressors						
Electromagnetic devices	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Physical Disturbance and Strike Stressors						
Aircraft and Aerial Target	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect

Table 3.6 6: Summary of Endangered Species Act Effects Determinations for Birds, for the Preferred Alternative (continued)

Navy Activities and Stressors		California least tern	Hawaiian petrel	Short-tailed albatross	Marbled murrelet	Newell's shearwater
Physical Disturbance and Strike Stressors (continued)						
Vessels and in-water devices	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Military expended materials	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Ingestion Stressors						
Military expended materials other than munitions	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Secondary Stressors						
Secondary Stressors	Training Activities	No effect	No effect	No effect	No effect	No effect
	Testing Activities	No effect	No effect	No effect	No effect	No effect

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REFERENCES

Aebischer, N. J., Coulson, J. C. & Colebrook, J. M. (1990). Parallel long-term trends acrows four marine trophic levels and weather. *Nature, 347*(6295), 753–755.

Ainley, D. G., Allen, S. G. & Spear, L. B. (1995). Offshore occurrence patterns of marbled murrelets in central California. In C. J. Ralph, G. L. Hunt, Jr., M. G. Raphael and J. F. Piatt (Eds.), *Ecology and Conservation of the Marbled Murrelet*. (General Technical Report PSW-GTR-152, pp. 361-369). Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Ainley, D. G., Thomas, C. T. & Reynolds, M. H. (1997). Townsend's and Newell's Shearwater (*Puffinus auricularis*). [Electronic Article]. *The Birds of North America Online*(297). doi: 10.2173/bna.297

Akesson, S. & Hedenstrom, A. (2007). How migrants get there: Migratory performance and orientation. [electronic version]. Bioscience, 57(2), 123–133.

American Ornithologists' Union. (1998). *The AOU Check-List of North American Birds* (7th ed., pp. 829). Washington, DC: American Ornithologists' Union. Retrieved from http://www.aou.org/checklist/north/print.php.

Anderson, D. W., Henny, C. J., Godinez-Reyes, C., Gress, F., Palacios, E. L., Santos del Prado, K. & Bredy, J. (2007). *Size of the California Brown Pelican Metapopulation during a non-El Niño year*. (Open-File Report 2007-1299, pp. 35). Reston, VA: U.S. Geological Survey.

Atwood, J. L. & Minsky, D. E. (1983). Least tern foraging ecology at three major california breeding colonies. *Western Birds, 14*(2), 57–71.

Auman, H., Ludwig, J., Giesy, J. & Colborn, T. (1997). Plastic ingestion by Laysan Albatross chicks on Sand Island, Midway Atoll, in 1994 and 1995 *Chapter Twenty Albatross Biology and Conservation*.

Azzarello, M. & Van Vleet, E. (1987, May). Marine birds and plastic pollution. *Marine Ecology - Progress Series, 37*, 295–303.

Bearzi, M., Saylan, C. A. & Feenstra, J. (2009). Seabird observations during cetacean surveys in Santa Monica Bay, California. *Bulletin of Southern California Academy of Sciences, 108*(2), 63–69.

Beason, R. (2004). What Can Birds Hear?, *Wildlife Damage Management, Internet Center for USDA National Wildlife Research Center - Staff Publications* (pp. 6). University of Nebraska - Lincoln.

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

Bies, L., Balzer, T. B. & Blystone, W. (2006). Pocosin Lakes National Wildlife Refuge: Can the Military and Migratory Birds Mix? [Electronic version]. *Wildlife Society Bulletin 34*, 502–503

Bureau of Land Management and the U.S. Fish and Wildlife Service. (2010). Memorandum of Understanding between the U.S. Department of the Interior Bureau of Land Management and the U.S. Fish and Wildlife Service. BLM MOU WO-230-2010-04.

Birding Hawaii. (2004). *Annotated list of Hawai'i's breeding birds*. [Web Page]. Retrieved from http://www.birdinghawaii.co.uk/Annotatedlist2.htm, 22 September 2005.

BirdLife International. (2009). *Sterna antillarum*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3*. Retrieved from www.iucnredlist.org, 10 September 2010.

BirdLife International. (2010). *Data Zone*. [Web Page]. Retrieved from http://www.birdlife.org/datazone/index.html, 10 June 2010.

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. 10.1017/S0954102005002439

Borberg, J., Ballance, L., Pitman, R. & Ainley, D. (2005). A Test for Bias Attributable to Seabird Avoidance of Ships During Surveys Conducted in the Tropical Pacific. *Marine Ornithology, 33*, 173–179.

Bowles, A. E., Awbrey, F. T. & Jehl, J. R. (1991). The effect of high-amplitude impulsive noise on hatching success: a reanalysis of the Sooty Tern incident S. b. N. a. S. B. I. Technology (Ed.). (HSD-TP-91-0006). Wright Patterson Airforce Base, Ohio.

Brand, A. R. and P. P. Kellogg. (1939). Auditory responses of starlings, English Sparrows and domestic pigeons. Wilson Bull., 51: 38–41

Briggs, K. T., Tyler, W. M. B., Lewis, D. B. & Carlson, D. R. (1987). Bird Communities at Sea off California: 1975 to 1983 F. A. Pitelka (Ed.). (Studies in Avian Biology No. 11, pp. 74). Santa Cruz, CA: Institute of Marine Sciences, University of California.

Brown, J. W. & Harshman, J. (2008). *Pelecaniformes* Version 27 June 2008 (under construction). Retrieved from http://tolweb.org/Pelecaniformes/57152/2008.06.27 *in* The Tree of Life Web Project, http://tolweb.org/

Burger, A. E. (1995). Marine distribution, abundance, and habitats of Marbled murrelets in British Columbia. In C. J. Ralph, G. L. Hunt, Jr., M. G. Raphael and J. F. Piatt. (Eds.), *Ecology and Conservation of the Marbled Murrelet*. (General Technical Report PSW-GTR-152, pp. 295–312). Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Burger, A. E. (2001). Diving Depths of Shearwaters. *The Auk, 118*(3), 755–759. Retrieved from http://www.jstor.org/stable/4089940

Burger, A. E. (2002). *Conservation Assessment of Marbled Murrelets in British Columbia, a Review of the Biology, Populations, Habitat Associations and Conservation*. (Technical Report Series No. 387, pp. 168). Pacific and Yukon Region, BC: Canadian Wildlife Service, Environmental Conservation Branch.

Burger, A.E., C. L. Hitchcock, G. K. Davoren. (2004). Spatial aggregations of seabirds and their prey on the continental shelf off SW Vancouver Island. Marine Ecology Progress Series, 283: 279–292

Burkett, E. E., Rojek, N. A., Henry, A. E., Fluharty, M. J., Comrack, L., Kelly, P. R., Fien, K. M. (2003). *Status review of Xantus's Murrelet (*Synthliboramphus*) in California*. (Status Report 2003-01, pp. 99 + appendices) California Department of Fish and Game, Habitat Conservation Planning Branch.

California Department of Fish and Game. (2010). *State and Federally listed Endangered and Threatened Animals of California*. (pp. 13). Sacramento, CA: California Natural Resources Agency, Department of Fish and Game, Biogeographic Data Branch.

California Department of Transportation. (2009). Final Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish.

Carter, H. R. & Kuletz, K. J. (1995). Mortality of Marbled murrelets due to oil pollution in North America. In C. J. Ralph, G. L. Hunt, Jr., M. G. Raphael and J. F. Piatt (Eds.), *Ecology and Conservation of the Marbled Murrelet*. (General Technical Report PSW-GTR-152, pp. 261–269). Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Carter, H. R., Sealy, S. G., Burkett, E. E. & Piatt, J. F. (2005). Biology and conservation of Xantus's Murrelet: discovery, taxonomy, and distribution. *Marine Ornithology, 33*, 81–87.

Chesser, R.T., Banks, R.C., Barker, F.K., Cicero, C., Dunn, J.L., Kratter, A.W., Lovette, I.J., Rasmussen, P.C., Remsen Jr., J.V., Rising, J.D., Stotz, D.F. & Winker K. (2012). Fifty-third Supplement to the American Ornithologists' Union Check-list of North American Birds. *The Auk, 129(*3), 573–588.

Church, J. A. & White, N. J. (2006). A 20th century acceleration in global sea-level rise. *Geophysical Research Letters, 33*(L01602), 1–4. doi: 10.1029/2005GL024826

Clavero, M., Brotons, L., Pons, P. & Sol, D. (2009). Prominent role of invasive species in avian biodiversity loss. *Biological Conservation, 142*(10), 2043–2049. doi: 10.1016/j.biocon.2009.03.034

Committee on the Status of Endangered Wildlife in Canada. (2003). *COSEWIC Assessment and Status Report on the Short-tailed Albatross* Phoebastrie albatrus *in Canada*. (pp. vi+25). Ottawa, Ontario: Committee on the Status of Endangered Wildlife in Canada. Available from www.sararegistry.gc.ca/status/status_e.cfm

Congdon, B. C., Erwin, C. A., Peck, D. R., Baker, G. B., Double, M. C. & O'Neill, P. (2007). Vulnerability of seabirds on the Great Barrier Reef to climate change. In J. E. Johnson and P. A. Marshall (Eds.), *Climate Change and the Great Barrier Reef: A Vulnerability Assessment* (pp. 427–463). Townsville, Australia: Great Barrier Reef Marine Park Authority and Australian Greenhouse Office.

Damon, E.G., D.R. Richmond, E.R. Fletcher, and R.K. Jones. (1974). The tolerance of birds to airblast. Final Report prepared for Defense Nuclear Agency, July.

Davis, R. W., Evans, W. E., Wursig, B. & eds. (2000). Cetaceans, Sea Turtles and Seabirds in the Northern Gulf of Mexico: Distribution, Abundance and Habitat Associations. Volume I: Executive Summary. New Orleans, Louisiana.

Day, R. H. & Cooper, B. A. (1995). Patterns of movement of Dark-rumped petrels and Newell's shearwaters on Kauai. *The Condor, 97*, 1011–1027.

Day, R. H., Cooper, B. A. & Blaha, R. J. (2003). Movement patterns of Hawaiian petrels and Newell's shearwaters on the island of Hawai'i. *Pacific Science, 57*(2), 147–159.

Day, R. H. & Nigro, D. A. (2000). Feeding ecology of Kittlitz's and marbled murrelets in Prince William Sound, Alaska. *Waterbirds, 23*(1), 1–14.

Dearborn, D. C., Anders, A. D. & Parker, P. G. (2001). Sexual dimorphism, extrapair fertilizations, and operational sex ratio in great frigatebirds (*Fregata minor*). *Behavioral Ecology, 12*(6), 746-752. doi:10.1093/beheco/12.6.746

Dietrich, K. & Melvin, E. (2004). *Annotated Bibliography: Seabird Interactions with Trawl Fishing Operations and Cooperative Research*. (pp. 4) Washington Sea Grant Program, University of Washington.

Dobson, A. (2010). Bird Report. [Electronic newsletter]. Bermuda Audubon Society Newsletter, 21(1). Retrieved from http://www.audubon.bm/Newsletters.htm

Dooling, R. J., Lohr, B., & Dent, M. L. (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: Springer-Verlag.

Dooling, R. J. and S. C. Therrien (2012). Hearing in Birds: What Changes from Air to Water. The Effects of Noise Oil Aquatic Life. Advances in Experimental Medicine and Biology. A. N. P. a. A. H. (eds.), Springer Science+Business Media, LLC 2012.Drost, C. A. & Lewis, D. B. (1995). Xantus's Murrelet (Synthliboramphus hypoleucus). [Electronic Article]. The Birds of North America Online(164). doi: 10.2173/bna.164.

Elphick, C., Dunning, J. B., Jr. & Sibley, D. A. (Eds.). (2001). *National Audubon Society: The Sibley Guide to Bird Life and Behavior* (pp. 587). New York, NY: Chanticleer Press.

Enticott, J. & Tipling, D. (1997). *Seabirds of the World: The Complete Reference* (1st ed., pp. 234). Mechanicsburg, PA: Stackpole Books.

Erickson, R. A., Hamilton, R. A., Howell, S. N. G., Pyle, P. & Patten, M. A. (1995). First record of the Marbled murrelet and third record of the Ancient murrelet for Mexico. *Western Birds, 26*, 39–45.

Ericson, P. G. P., Envall, I., Irestedt, M. & Norman, J. A. (2003). Inter-familial relationships of the shorebirds (Aves: Charadriiformes) based on nuclear DNA sequence data. *BMC Evolutionary Biology, 3*(16), 1-14. Retrieved from http://www.biomedcentral.com/1471-2148/3/16

Eriksson, M. O. G. (1985). Prey detectability for fish-eating birds in relation to fish density and water transparency *Ornis Scandinavica, 16*, 1–7.

Fain, M. G. & Houde, P. (2007). Multilocus perspectives on the monophyly and phylogeny of the order Charadriiformes (Aves). *BMC Evolutionary Biology, 7*(35), 1–17. doi: 10.1186/1471-2148-7-35.

Fauchald, P., Erikstad, K. E. & Systad, G. H. (2002). Seabirds and marine oil incidents: is it possible to predict the spatial distribution of pelagic seabirds? [Electronic Version]. Journal of Applied Ecology, 39(2), 349–360.

Fisher, H. I. (1971). Experiments in homing in Laysan Albatrosses, Diomedea immutabilis. The Condor, 73(4), 389–400.

Gehring, J., Kerlinger, P. & Manville, A. M. (2009). Communication towers, lights, and birds: successful methods of reducing the frequency of avian collisions. *Ecological Applications, 19*(2), 505–514. 10.1890/07-1708.1.

Gilman, E. L. & Ellison, J. (2009). Relative sea-level rise tipping points for coastal ecosystems. In P. Leadley, H. Pereira, R. Alkemade, V. Proenca, J. Scharlemann and M. Walpole (Eds.), *Biodiversity Scenarios Synthesis for the Global Biodiversity Outlook 3: Projections of 21st Century Change in Biodiversity and Associated Ecosystem Services* (pp. 42–57). Montreal, Canada: Convention on Biological Diversity.

Gilman, E. L., Ellison, J., Duke, N. C. & Field, C. (2008). Threats to mangroves from climate change and adaptation options: A review. *Aquatic Botany, 89*(2), 237–250. doi: 10.1016/j.aquabot.2007.12.009.

Grenier, J. J. & Nelson, S. K. (1995). Marbled Murrelet habitat associations in Oregon. In C. J. Ralph, G. L. Hunt, Jr., M. G. Raphael and J. F. Piatt (Eds.), *Ecology and Conservation of the Marbled Murrelet*. (General Technical Report PSW-GTR-152, pp. 191–204). Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Hamer, T. E. & Nelson, S. K. (1995). Nesting chronology of the marbled murrelet. In C. J. Ralph, G. L. Hunt, Jr., M. G. Raphael and J. F. Piatt (Eds.), *Ecology and Conservation of the Marbled Murrelet*. (General Technical Report PSW-GTR-152, pp. 49–56) Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Hamilton, W. (1958, May). Pelagic Birds Observed on a North Pacific Crossing. *The Condor, 60*, 159–164.

Haney, J. C. (1986). Seabird Patchiness in Tropical Oceanic Waters: The Influence of Sargassum "Reefs". *The Auk, 103*, 141–151.

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

Hanowski, J. M., Blake, J. G., Niemi, G. J. & Collins, P. T. (1993). Effects of extremely low electromagnetic field on breeding and migrating birds. American Midland Naturalist, 129(1), 96–115.

Harrison, P. (1983). *Seabirds, an Identification Guide* (pp. 445). Boston, MA: Houghton Mifflin Company.

Hashino, E., Sokabe, M. & Miyamoto, K. (1988). Frequency specific susceptibility to acoustic trauma in the budgerigar (*Melopsittacus undulatus*). *Journal of the Acoustical Society of America, 83*(6), 2450–2453.

Hertel, F. & Ballance, L. T. (1999). Wing ecomorphology of seabirds from Johnston Atoll. [Electronic Version]. *The Condor, 101*(3), 549–556.

Hitipeuw, C., Dutton, P. H., Benson, S., Thebu, J. & Bakarbessy, J. (2007). Population status and internesting movement of leatherback turtles, *Dermochelys coriacea*, nesting on the northwest coast of Papua, Indonesia. *Chelonian Conservation and Biology, 6*(1), 28–36.

Hunt, G. L., Jr. & Butler, J. L. (1980). Reproductive ecology of Western gulls and Xantus' murrelets with respect to food resources in the Southern California Bight. *CalCOFI Reports, XXI*, 62–67.

Hunter, W. C., Golder, W., Melvin, S. & Wheeler, J. (2006a). Southeast United States Regional Waterbird Conservation Plan North American Bird Conservation Initiative (Ed.).

Hunter, W. C., Golder, W., Melvin, S. & Wheeler, J. (2006b). *Southeast United States Regional Waterbird Conservation Plan*. (pp. 134) North American Bird Conservation Initiative. Available from United States Geological Service website: http://www.pwrc.usgs.gov/nacwcp/pdfs/regional/seusplanfinal906.pdf

Hyrenback, K. (2001). Albatross response to survey vessels: implications for studies of the distribution, abundance, and prey consumption of seabird populations. *Marine Ecology Progress Series, 212*, 283–295.

Hyrenback, K. (2006). Waterbird monitoring Techniques Workshop, *IV North American Ornithological Conference* (pp. 34). Veracruz, Mexico.

International Union for Conservation of Nature and Natural Resources. (2010). *The IUCN Red List of Threatened Species Version 2010.1*. [Web Page] International Union for Conservation of Nature and Natural Resources. Retrieved from http://www.iucnredlist.org/, 25 June 2010.

International Union for the Conservation of Nature. (2010a). *Brachyramphus marmoratus*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3*. Retrieved from www.iucnredlist.org, 10 September 2010.

International Union for the Conservation of Nature (2010b). *Oceanodroma castro*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3*. Retrieved from www.iucnredlist.org, 10 September 2010.

International Union for the Conservation of Nature. (2010c). *Phoebastria albatrus*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3*. Retrieved from www.iucnredlist.org, 10 September 2010.

International Union for the Conservation of Nature. (2010d). *Pterodroma sandwichensis*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3*. Retrieved from www.iucnredlist.org, 09 September 2010.

International Union for the Conservation of Nature. (2010e). *Puffinus newelli*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3*. Retrieved from www.iucnredlist.org, 09 September 2010.

International Union for the Conservation of Nature. (2010f). *Synthliboramphus hypoleucus*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3*. Retrieved from www.iucnredlist.org, 10 September 2010.

Jessup, D. A., Miller, M. A., Ryan, J. P., Nevins, H. M., Kerkering, H. A., Mekebri, A., Kudela, R. M. (2009). Mass stranding of marine birds caused by a surfactant-producing red tide. [Electronic version]. *PLoS ONE, 4*(2), e4550. doi: 10.1371/journal.pone.0004550

Jones, I. L. (2001). Auks C. Elphick, J. Dunning, J.B. and D. A. Sibley (Eds.), The Sibley Guide to Bird Life and Behavior (pp. 309–318). New York: Alfred A. Knopf, Inc.

Karnovsky, N. J., Spear, L. B., Carter, H. R., Ainley, D. G., Amey, K. D., Ballance, L. T., . . . Tynan, C. T. (2005). At-sea distribution, abundance and habitat affinities of Xantus's Murrelets. Marine Ornithology, 33, 89–104.

Larkin, R. P., Pater, L. L. & Tazik, D. J. (1996). Effects of military noise on wildlife: A literature review (pp. 1–107).

Larkin, R. P. & Sutherland, P. J. (1977, February). Migrating birds respond to Project Seafarer's electromagnetic field. [electronic version]. Science, 195(4280), 777–779. Retrieved from http://www.jstor.org/stable/1743979

Lincoln, F. C., Peterson, S. R. & Zimmerman, J. L. (1998). Migration of birds. U.S. Department of the Interior and U.S. Fish and Wildlife Service (Eds.). (Vol. Circular 16). Washington, D.C.

Marschalek, D. A. (2008). *California Least Tern Breeding Survey, 2007 Season*. (Nongame Wildlife Program Report 2008-01, pp. 24+ app.). Sacramento, CA: California Department of Fish and Game, Wildlife Branch.

Manci, K. M., D. N. Gladwin, R. Villella and M. G. Cavendish (1988). *Effects of Aircraft Noise and Sonic Booms on Domestic Animals and Wildlife: A Literature Synthesis*. Ft. Collins, CO, U. S. Fish and Wildlife Service, National Ecology Research Center**:** 88.

Massey, B. W. & Fancher, J. M. (1989). Renesting by California Least terns. *Journal of Field Ornithology, 60*(3), 350–357.

McCaskie, G. & Garrett, K. L. (2001). Southern Pacific coast. *North American Birds, 55*(2), 226–230.

McCaskie, G. & Garrett, K. L. (2002). Southern Pacific coast. *North American Birds, 56*(2), 222–226.

Melvin, E. & Parrish, J. (2001). Seabird Bycatch: Trends, Roadblocks, and Solutions, February 26–27. Presented at the Annual Meeting of the Pacific Seabird Group, Blaine, Washington.

Melvin, E.F., J. K. Parrish, and L.L. Conquest. (1999). Novel tools to reduce seabird bycatch in coastal gillnet fisheries. Conservation Biology 13: 1386–1397.

Melvin, E. F., Parrish, J. K., Dietrich, K. S. & Hamel, O. S. (2001). Solutions to seabird bycatch in Alaska's demersal longline fisheries. Washington Sea Grant Program.

Merkel, F. R. & Johansen, K. L. (2011). Light-induced bird strikes on vessels in Southwest Greenland. Marine Pollution Bulletin, 62(11), 2330–2336.

Miller, S. L. & Ralph, C. J. (1995). Relationship of Marbled murrelets with habitat characteristics at inland sites in California. In C. J. Ralph, G. L. Hunt, Jr., M. G. Raphael and J. F. Piatt (Eds.), *Ecology and Conservation of the Marbled Murrelet*. (General Technical Report PSW-GTR-152, pp. 205–214). Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Mitchell, C., Ogura, C., Meadows, D. W., Kane, A., Strommer, L., Fretz, S., . . . McClung, A. (2005). Seabirds: Ake ake or Band-rumped Storm-petrel Oceandroma castro. In Hawaii's Comprehensive Wildlife Conservation Strategy [Electronic Fact Sheet]. Honolulu, HI: Department of Land and Natural Resources. Available from http://www.state.hi.us/dlnr/dofaw/cwcs/Conservation_need.htm

Moser, M. & Lee, D. (1992). A Fourteen-Year Survey of Plastic Ingestion by Western North Atlantic Seabirds. *Colonial Waterbirds, 15*(1), 83-94.

Mullane, R. & Suzuki, D. (1997). *Beach Management Plan for Maui*. (pp. 71) County of Maui, State of Hawaii. Prepared by University of Hawaii Sea Grant Extension Service and County of Maui Planning Department.

Naslund, N. L. (1993). Why do marbled murrelets attend old-growth forest nesting areas year-round? *The Auk, 110*(3), 594–602.

National Park Service. (1994). Report on Effects of Aircraft Overflights on the National Park System. Prepared for Report to Congress.

NatureServe. (2004, Last updated November 2004). *Comprehensive report:* Phoebastria albatrus - *(Pallas, 1769): Short-tailed albatross*. [Web Page]. Retrieved from http://www.natureserve.org, 23 November 2004.

Naughton, M., Romano, M. & Zimmerman, T. (2007). A Conservation Action Plan for Black-footed Albatross (*Phoebastria nigripes*) and Laysan Albatross (*P. immutabilis*) Version 1.0.

Necker, R. (1983). Effects of temperature on afferent synaptic transmission in the dorsal horn of the spinal cord of pigeons. *J. Therm. Biol (*8), 15-18.

Nelson, S. K. (1997). Marbled Murrelet (*Brachyramphus marmoratus*). [Electronic Article]. *The Birds of North America Online*(276). doi: 10.2173/bna.276

North American Bird Conservation Initiative, U.S. Committee. (2010). *The State of the Birds 2010 Report on Climate Change, United States of America* [Electronic Version]. (pp. 32). Washington, DC: U.S. Department of the Interior. Available from http://www.stateofthebirds.org/

Nybo, S. (1996). Effects of Dietary Aluminum on Chicks *Gallus gallus domesticus* with Different Dientary Intake of Calcium and Phosphorus. [electronic version]. *Archives of Environmental Contamination and Toxicology, 31*, 177-183.

Onley, D. & Scofield, P. (2007). *Albatrosses, Petrels and Shearwaters of the World* (pp. 256). Princeton, NJ: Princeton University Press.

Pater, L.L., T.G. Grubb, Delaney, D.K. (2009). Recommendations for Improved Assessment of Noise Impacts on Wildlife. Journal of Wildlife Management, 73(5): 788-795.

Piatt, J. F., Kuletz, K. J., Burger, A. E., Hatch, S. A., Friesen, V. L., Birt, T. P., Bixler, K. S. (2007). *Status Review of the Marbled Murrelet (*Brachyramphus marmoratus*) in Alaska and British Columbia*. (Open-File Report 2006-1387, pp. 258). Reston, VA: U.S. Geological Survey.

Piatt, J. F. & Naslund, N. L. (1995). Abundance, distribution, and population status of Marbled Murrelets in Alaska. In C. J. Ralph, G. L. Hunt, Jr., M. G. Raphael and J. F. Piatt (Eds.), *Ecology and Conservation of the Marbled Murrelet*. (General Technical Report PSW-GTR-152, pp. 285-294). Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Piatt, J. F., Wetzel, J., Bell, K., DeGange, A. R., Balogh, G. R., Drew, G. S., Byrd, G. V. (2006). Predictable hotspots and foraging habitat of the endangered short-tailed albatross (*Phoebastria albatrus*) in the North Pacific: Implications for conservation. *Deep-Sea Research II, 53*(3-4), 387-398. doi:10.1016/j.dsr2.2006.01.008

Pierce, K., Harris, R., Larned, L. & Pokras, M. (2004). Obstruction and Starvation Associated with Plastic Ingestion in a Northern Gannet *Morus Bassanus* and a Greater Shearwater *Puffinus Gravis*. [electronic version]. *Marine Ornithology, 32*, 187-189.

Plumpton, D. (2006). Review of Studies Related to Aircraft Noise Disturbance of Waterfowl A Technical Report in Support of the Supplemental Environmental Impact Statement (SEIS) for Introduction of F/A-18 E/F (Super Hornet) Aircraft to the East Coast of the United States. (pp. 93). Prepared for U.S. Department of the Navy.

Poot, H., Ens, B. J., de Vries, H., Donners, M. A. H., Wernand, M. R. & Marquenie, J. M. (2008). Green Light for Nocturnally Migrating Birds. *Ecology and Society, 13*(2). 47

Ralph, C. J. & Miller, S. L. (1995). Offshore population estimates of Marbled murrelets in California. In C. J. Ralph, G. L. Hunt, Jr., M. G. Raphael and J. F. Piatt (Eds.), *Ecology and Conservation of the Marbled Murrelet*. (General Technical Report PSW-GTR-152, pp. 353-360). Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Ramos, J., Monteiro, L., Sola, E. & Moniz, Z. (1997). Characteristics and competition for nest cavities in burrowing procellariiformes. *The Condor, 99*, 634-641.

Raphael, M. G., Baldwin, J., Falxa, G. A., Huff, M. H., Lance, M., Miller, S. L., Thompson, C. (2007). *Regional Population Monitoring of the Marbled Murrelet: Field and analytical methods*. (General Technical Report PNW-GTR-716, pp. 70). Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Reed, J., Sincock, J. & Hailman, J. (1985, April). Light Attraction in Endangered Procellariiform Birds: Reduction by Shielding Upward Radiation. *The Auk 102*, 377-383.

Reynolds, M. H. & Ritchotte, G. L. (1997). Evidence of Newell's Shearwater breeding in Puna District, Hawaii. *Journal of Field Ornithology, 68*(1), 26-32.

Roberson, D. (2000, Last updated May 2000). *California short-tailed albatrosses. A summary at the turn of the 21st Century*. [Web Page] Creagrus at Montereay Bay. Retrieved from http://www.montereybay.com/creagrus/CA_STAL.html

Ronconi, R. A., Ryan, P. G. & Ropert-Coudert, Y. (2010). Diving of Great Shearwaters (Puffinus gravis) in Cold and Warm Water Regions of the South Atlantic Ocean. *Plos One, 5*(11). e15508.

Ryals, B. M., Dooling, R. J., Westbrook, E., Dent, M. L., MacKenzie, A. & Larsen, O. N. (1999). Avian species differences in susceptibility to noise exposure. *Hearing Research, 131*, 71-88.

Ryals, B. M., Stalford, M. D., Lambert, P. R. & Westbrook, E. W. (1995). Recovery of noise-induced changes in the dark cells of the quail tegmentum vasculosum. *Hearing Research, 83*, 51-61.

Ryan, P. (1987, January). The Effects of Ingested Plastic on Seabirds: Correlations between Plastic Load and Body Condition. *Environmental Pollution, 46*, 119-125.

Saunders, J. & Dooling, R. (1974). Noise-Induced Threshold Shift in the Parakeet (*Melopsittacus undulatus*). *Proc Natl Acad Sci U S A, 71*(5), 1962-1965.

Scheuhammer, A. (1987, February). The Chronic Toxicity of Aluminium, Cadmium, Mercury, and Lead in Birds: A Review. *Environmental Pollution, 46*, 263-295.

Schneider, D. C. & Duffy, D. C. (1985). Scale-dependent variability in seabird abundance. Marine Ecology Progress Series, 25, 211-218.

Schreiber, R. W. & Chovan, J. L. (1986). Roosting by pelagic seabirds: Energetic, populational, and social considerations. [Electronic Version]. *The Condor, 88*(4), 487-492.

Sibley, D. A. (2000). *National Audubon Society: The Sibley Guide to Birds* (9th ed., pp. 544). New York, NY: Chanticleer Press.

Sibley, D. A. (2007). *National Audubon Society: The Sibley Guide to Birds* (Printed Book, 9th ed., pp. 544). New York, NY: Chanticleer Press.

Sidle, J. G., D. E. Carlson, E. M. Kirsh, and J. J. Dinan. (1992). Flooding: mortality and habitat renewal for least terns and piping plovers. Colonial Waterbirds 15:132-136.

Siegel-Causey, D. & Kharitonov, S. P. (1990). The Evolution of Coloniality. In D. M. Power (Ed.), *Current Ornithology* (Printed Book, Vol. 7, pp. 285-330). New York, NY: Plenum Press.

Sievert, P. & Sileo, L. (1993). The effects of ingested plastic on growth and survival of albatross chicks. *National Wildlife Health Research Center*.

Solomon, S., Qin, D., Manning, M., Alley, R. B., Berntsen, T., Bindoff, N. L., Wratt, D. (2007). Technical summary. In S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (Eds.), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. (pp. 74). Cambridge, United Kingdom and New York, NY: Cambridge University Press. Available from http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-ts.pdf

Spear, L. B. & Ainley, D. G. (1998). Morphological differences relative to ecological segregation in petrels (Family: Procellariidae) of the Southern Ocean and Tropical Pacific. *The Auk, 115*(4), 1017-1033.

Spear, L. B., Ainley, D. G., Nur, N. & Howell, S. N. G. (1995). Population size and factors affecting at-sea distributions of four endangered procellariids in the tropical Pacific. *The Condor, 97*(3), 613-638.

Spear, L. B., Ainley, D. G. & Pyle, P. (1999). Seabirds in Southeastern Hawaiian waters. *Western Birds, 30*(1), 1-32.

Strong, C. S., Keitt, B. S., McIver, W. R., Palmer, C. J. & Gaffney, I. (1995). Distribution and population estimates of marbled murrelets at sea in Oregona during the summers of 1992 and 1993. In C. J. Ralph, G. L. Hunt, Jr., M. G. Raphael and J. F. Piatt (Eds.), *Ecology and Conservation of the Marbled*

Murrelet. (General Technical Report PSW-GTR-152, pp. 339-352). Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

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

Therrien, S. C., Carr, C. E., Dooling, R. J., Popper, A. N., Therrien, R. E. & Wells-Berlin, A. M. (2011, May). Training diving ducks for behavioral audiograms *Animal Bioacoustics: General Topics in Passive Acoustic Monitoring of Animals II*. Presented at the 161st Meeting: Acoustical Society of America.

Thompson, B. C., Jackson, J. A., Burger, J., Hill, L. A., Kirsch, E. M. & Atwood, J. L. (1997). Least tern *Sterna antillarum*. [Electronic Article]. *The Birds of North America Online*(290). doi: 10.2173/bna.290

Tickell, W. L. N. (2000). *Albatrosses* (pp. 448). New Haven, CT: Yale University Press.

U.S. Air Force. (1997). Environmental Effects of Self-Protection Chaff and Flares. (pp. 241).

U.S. Bureau of Land Management and U.S. Fish and Wildlife Service. (2010). Memorandum of Understanding between the U.S. Department of the Interior Bureau of Land Management and the U.S. Fish and Wildlife Service To Promote the Conservation of Migratory Birds.

U.S. Department of the Navy - Southwest Division. (2001). San Clemente Island Integrated Natural Resources Management Plan [Draft Final]. (pp. 926). San Diego, CA. Prepared by Tierra Data Systems.

U.S. Department of the Navy. (2002). *Naval Base Coronado Integrated Natural Resources Management Plan*. San Diego, CA. Prepared by Tierra Data Systems. Prepared for U.S. Department of the Navy, Navy Region Southwest Natural Resources Office.

U.S. Department of the Navy. (2009). Environmental Assessment for Construction & Operation of Electromagnetic Railgun MILCON P-306. (pp. 366). Naval Support Facility Dahlgren, Virginia: Research, Development, Test, and Evaluation Facility.

U.S. Department of the Navy. (2011). Gulf of Alaska Environmental Impact Statement. Prepared by U.S. Pacific Fleet.

U.S. Fish and Wildlife Service. (1983). *Hawaiian Dark-rumped Petrel and Newell's Manx Shearwater Recovery Plan*. (pp. 57). Portland, OR: U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service. (1985). *Recovery Plan for the California Least Tern,* Sterna antillarum browni. (pp. 112). Portland, OR: U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service. (1990). Recovery plan for the interior population of the least tern (Sterna antillarum). U.S. Fish and Wildlife Service, Twin Cities, Minnesota. 90 pp.

U.S. Fish and Wildlife Service. (1992). Endangered and threatened wildlife and plants; determination of threatened status for the Washington, Oregon, and California population of the Marbled murrelet. [Final Rule]. *Federal Register, 57*(191), 45328–45337.

U.S. Fish and Wildlife Service. (1997). *Recovery Plan for the Threatened Marbled Murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California*. (pp. 203). Portland, Oregon: U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service. (2000). Endangered and threatened wildlife and plants; final rule to list the short-tailed albatross as endangered in the United States. [Final Rule]. *Federal Register, 65*(147), 46643–46654.

U.S. Fish and Wildlife Service. (2001). *Short-tailed Albatross (*Phoebastria albatrus*) Threatened and Endangered Species*. (pp. 2). Fairbanks, AK: U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service. (2003, Last updated 02 May 2003). *Hawaiian Islands Birds and Draft Scores (May 2003)*. [Data] U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region

U.S. Fish and Wildlife Service. (2004). *Species Assessment and Listing Priority Assignment form:* Oceanodroma castro. (pp. 24). Available from http://ecos.fws.gov/docs/candforms_pdf/r1/B08V_V01.pdf

U.S. Fish and Wildlife Service. (2005a). *Hawaiian dark-rumped petrel,* Pterodroma phaeopygia sandwichensis. [Fact Sheet]. Retrieved from http://ecos.fws.gov/docs/life_histories/B00N.html, 20 September 2005.

U.S. Fish and Wildlife Service. (2005b). *Regional Seabird Conservation Plan, Pacific Region*. (pp. 264). Portland, OR: U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region.

U.S. Fish and Wildlife Service. (2005c). *Short-tailed Albatross Draft Recovery Plan*. (pp. 62). Anchorage, AK.

U.S. Fish and Wildlife Service. (2006). *California Least Tern (*Sternula antillarum browni*) 5-year Review. Summary and Evaluation*. (pp. 35). Carlsbad, CA: U.S. Fish and Wildlife Service Carlsbad Fish and Wildlife Office.

U.S. Fish and Wildlife Service. (2007). Species Assessment and Listing Priority Assignment Form: Synthliboramphus hypoleucus. (pp. 26). Washington, DC: U.S. Fish and Wildlife.

U.S. Fish and Wildlife Service. (2008a). *Birds of Conservation Concern 2008*. (pp. 85). Arlington, VA: U.S. Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management. Available from http://www.fws.gov/migratorybirds/

U.S. Fish and Wildlife Service. (2008b). *Short-tailed Albatross Recovery Plan*. (pp. 105). Anchorage, AK.

U.S. Fish and Wildlife Service. (2010a, Last updated May 2010). *Endangered Species Program: Species Information*. [Web Page]. Retrieved from http://www.fws.gov/endangered/wildlife.html, 24 June 2010.

U.S. Fish and Wildlife Service. (2010b, Last updated October 2007). *Species Account: California least tern (*Sternula antillarum browni*)*. [Fact Sheet]. Retrieved from http://fws.gov/sacramento/es/animal_spp_acct/acctbird.htm, 12 May 2010.

United States Geological Survey. (2006, Last updated August 2006). *Migration of Birds: Routes of Migration*. In *Northern Prairie Wildlife Research Center*. [Web Page]. Retrieved from http://www.npwrc.usgs.gov/resource/birds/migratio/routes.htm, 05/29/2010.

Vandenbosch, R. (2000). Effects of ENSO and PDO events on seabird populations as revealed by Christmas bird count data. *Waterbirds, 23*(3), 416–422.

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

Wiltschko, R., Denzau, S., Gehring, D., Thalau, P. & Wiltschko, W. (2011). Magnetic orientation of migratory robins, Erithacus rubecula, under long-wavelength light. Journal of Experimental Biology, 214(18), 3096-3101. 10.1242/jeb.059212

Wiltschko, W. & Wiltschko, R. (2005). Magnetic orientation and magnetoreception in birds and other animals. Journal of Comparative Physiology, 191, 675-693. doi: 10.1007/s00359-005-0627-7

Whitworth, D.L., Takekawa, J.Y., Carter, H.R.,Newman, S.H., Keeney, T.W. and Kelly, P.R. (2000). At-sea distribution of Xantus' Murrelets (Synthliboramphus hypoleucus)in the Southern California Bight. Ibis 142: 268–279.

Whitworth, D. L., Koepke, J. S., Carter, H. R., Gress, F. & Fangman, S. (2005). Nest Monitoring of Xantus's Murrelets (Synthliboramphus hypoleucus) at Anacapa Island, California: 2005 Annual Report [Unpublished Report]. (pp. 24). Davis, CA: California of Environmental Studies. Prepared for The American Trader Trustee Council and Channel Islands National Park.

Wolf, S., Phillips, C., Zepeda-Dominguez, J. A., Albores-Barajas, Y. & Martin, P. (2005). Breeding biology of Xantus's murrelet at the San Benito Islands, Baja California, Mexico. Marine Ornithology, 33, 123–129.

Yelverton, J., Richmond, D. & Fletcher E. (1973). Safe Distances from Underwater Explosions for Mammals and Birds. Prepared for Director Defense Nuclear Agency.

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3.7 Marine Vegetation

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3.7 MARINE VEGETATION

MARINE VEGETATION SYNOPSIS

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

- Acoustic (underwater explosives)
- Physical disturbance and strike (vessels and in-water devices, military expended materials, seafloor devices)
- Secondary

Preferred Alternative

- No Endangered Species Act listed marine vegetation species are found in the Hawaii-Southern California Training and Testing Study Area.
- Acoustics: Explosives could affect marine vegetation by destroying individual plants or damaging parts of plants. The impacts of these stressors are not expected to result in detectable changes in growth, survival, or propagation, and are not expected to result in population-level impacts on marine plant species.
- Physical Disturbance and Strike: Physical disturbance and strikes could affect marine vegetation by destroying individual plants or damaging parts of plants. The impacts of these stressors are not expected to result in detectable changes in growth, survival, or propagation, and are not expected to result in population-level impacts on marine plant species.
- Secondary: Secondary stressors are not expected to result in detectable changes in growth, survival, propagation, or population-level impacts because changes in sediment and water quality or air quality are not likely to be detectable.
- Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of explosives and other impulsive sources, vessel movement, in-water devices, military expended materials, and seafloor devices during training and testing activities may have an adverse effect on Essential Fish Habitat by reducing the quality and quantity of marine vegetation that constitutes Essential Fish Habitat or Habitat Areas of Particular Concern.

3.7.1 INTRODUCTION

This section analyzes potential impacts on marine vegetation found in the Hawaii-Southern California Training and Testing (HSTT) Study Area (Study Area). Marine vegetation, including marine algae and flowering plants, are found throughout the Study Area. United States (U.S.) Department of the Navy (Navy) training and testing activities are evaluated for their potential impacts on species designated under the Endangered Species Act (ESA) and for their impacts on six major taxonomic groups of marine vegetation, as appropriate (Table 3.7-1). Marine vegetation, including marine algae and flowering plants, is found throughout the Study Area. Marine vegetation species designated as Essential Fish Habitat under the Magnuson-Stevens Fishery Conservation and Management Act are described in the Essential Fish Habitat Assessment (U.S. Department of the Navy 2012), and conclusions from the Essential Fish Habitat Assessment are summarized in each substressor section. No ESA-listed species are found in the Study Area. Marine vegetation species designated as Essential Fish Habitat are discussed in Section 3.9 (Fish).

The distribution and condition of offshore abiotic (non-living) substrates associated with attached macroalgae and the impact of stressors on those substrates are described in Section 3.3 (Marine Habitats). Additional information on the biology, life history, and conservation of marine vegetation can be found on the websites of the following agencies and groups:

- National Marine Fisheries Service (NMFS), Office of Protected Resources (including ESA-listed species distribution maps)
- Conservation International
- Algaebase
- National Resources Conservation Service
- National Museum of Natural History

To cover all marine vegetation types that are representative of the Study Area, the major taxonomic groups are discussed in Section 3.7.2 (Affected Environment). The major taxonomic groups consist of five groups of marine algae and one group of flowering plants (Table 3.7-1).

Table 3.7-1: Major Taxonomic Groups of Marine Vegetation in the Study Area

Marine Vegetation Groups[1]		Vertical Distribution in the Study Area[2]	
Common Name (Taxonomic Group)	**Description**	**Open Ocean**	**Coastal Waters**
Dinoflagellates (phylum Dinophyta)	Most are photosynthetic single-celled algae that have two whip-like appendages (flagella); Some live inside other organisms. Some produce toxins that can result in red tides or ciguatera poisoning.	Sea surface	Sea surface
Blue-green algae (phylum Cyanobacteria)	Many form mats that attach to reefs and produce nutrients for other marine species through nitrogen fixation.	Sea surface	Seafloor
Green algae (phylum Chlorophyta)	Marine species occur as unicellular algae, filaments, and large seaweeds.	None	Sea surface, seafloor
Diatoms, brown and golden-brown algae (phylum Heterokontophyta)	Single-celled algae that form the base of the marine food web; brown and golden-brown algae are large multi-celled seaweeds that form extensive canopies, providing habitat and food for many marine species.	Sea surface	Sea surface, seafloor
Red algae (phylum Rhodophyta)	Single-celled algae and multi-celled large seaweeds; some form calcium deposits.	Sea surface	Seafloor
Seagrass, cordgrass, and mangroves (phylum Spermatophyta)	Flowering plants, which are adapted to salty marine environments in mudflats, marshes, intertidal and subtidal coastal waters, providing habitat and food for many marine species.	None	Seafloor

[1] Species groups are based on the Catalogue of Life (Bisby et al. 2010).
[2] Presence in the Study Area includes open ocean areas (North Pacific Subtropical Gyre and North Pacific Transition Zone) and coastal waters of two Large Marine Ecosystems (California Current and Insular Pacific-Hawaiian). "None" indicates absence of the taxonomic group within the Study Area portion (see map of the Study Area in Figure 3.0-1).

3.7.2 AFFECTED ENVIRONMENT

Factors that influence the distribution and abundance of vegetation in the large marine ecosystems and open ocean areas of the Study Area are the availability of light and nutrients, water quality, water clarity, salinity level, seafloor type (important for rooted or attached vegetation), currents, tidal schedule, and temperature (Green and Short 2003). Marine ecosystems in the Study Area depend almost entirely on the energy produced by photosynthesis of marine plants and algae, which is the

transformation of the sun's energy into chemical energy, as well as oxygen-producing bacteria (Castro and Huber 2000). In surface waters of the open ocean and coastal waters, as well as within the portion of the water column illuminated by sunlight, marine algae and flowering plants provide oxygen, food, and habitat for many organisms (Dawes 1998).

Marine vegetation along the California coast is represented by more than 700 varieties of seaweeds (such as corallines and other red algae, brown algae including kelp, and green algae), seagrasses (Leet et al. 2001; Wyllie-Echeverria and Ackerman 2003), and canopy-forming kelp species (Wilson 2002). Extensive mats of red algae provide habitat in areas of exposed sediment along the California coast (Adams et al. 2004; U.S. Department of the Navy and San Diego Unified Port District 2011). Although historically important, large-scale harvesting of kelp beds no longer occurs along the California coast. Small-scale commercial operations, however, continue to harvest kelp, primarily for abalone feed (Wilson 2002). The canopy coverage of kelp beds varies under changing oceanographic conditions, and is also influenced by the level of harvesting and coastal pollution (Wilson 2002).

Red coralline algae and green calcareous (calcium-containing) algae (*Halimeda* species) secrete calcareous skeletons that bind sediments in coral reefs in Hawaii (Spalding et al. 2003). In the Northwestern Hawaiian Islands, beyond the coral reef habitat, algal meadows dominate the terraces and banks at depths of 98–131 feet (ft.) (30–40 meters [m]). There are approximately 1,740 square miles (mi.^{2}) (4,507 square kilometers [km^2]) of this type of substrate, an estimated 65 percent of which is covered by algal meadows (Parrish and Boland 2004). In Hawaii, there are two species of seagrasses and at least 204 species of red algae, 59 species of brown algae, and 92 species of green algae (Friedlander et al. 2005). Seaweeds are important in native Hawaiian culture, and are used in many foods (Preskitt 2002a). Coastal pollution, invasive species, and an increasing demand for fresh seaweed threaten native species (Friedlander et al. 2005).

Certain species of microscopic algae (dinoflagellates and diatoms, for example) can form algal blooms, which can pose serious threats to human health and wildlife species. Harmful algal blooms can deplete oxygen within the water column and block sunlight that other organisms need to live, and some algae within algal blooms release toxins that are dangerous to human and ecological health (Center for Disease Control and Prevention 2004). These algal blooms have a negative economic impact of hundreds of millions of dollars annually world-wide (National Centers for Coastal Ocean Science 2010).

The marine vegetation in the taxonomic groups of seagrass, cordgrass, and mangroves has more limited distributions; none of them occur in open ocean areas. The relative distribution of seagrass is influenced by the availability of suitable substrate in low-wave-energy areas at depths that allow sufficient light exposure. Cordgrasses form dense colonies in salt marshes that develop in temperate areas in protected, low-energy environments, along the intertidal portions of coastal lagoons, tidal creeks or rivers, or estuaries, wherever the sediment can support plant root development. Mangroves form in similar environments in the tropics and subtropics (Mitsch et al. 2009).

3.7.2.1 General Threats

Environmental stressors on marine vegetation are products of human activities (industrial, residential, and recreational) and natural occurrences. Species-specific information is discussed, where applicable, in Sections 3.7.3.2 (Physical Disturbance and Strike Stressors) and 3.7.3.3 (Secondary Stressors), and the cumulative impacts from these threats are analyzed in Chapter 4 (Cumulative Impacts).

Human-made stressors that act on marine vegetation include excessive nutrient input (pollutants, such as fertilizers), siltation (the addition of fine particles to the ocean), pollution (oil, sewage, trash), climate change, overfishing (Mitsch et al. 2009; Steneck et al. 2002), shading from structures (National Marine Fisheries Service 2002), habitat degradation from construction and dredging (National Marine Fisheries Service 2002), and invasion by exotic species (Hemminga and Duarte 2000; Spalding et al. 2003). The seagrass, cordgrass, and mangrove taxonomic group is more sensitive to stressors than the algal taxonomic groups. The great diversity of algae makes generalization difficult but, overall, algae are resilient and colonize disturbed environments (Levinton 2009b).

Seagrasses, cordgrasses, and mangroves are all susceptible to human-made stressors on marine vegetation, and their presence in the Study Area has decreased because of these stressors. Each of these types of vegetation is sensitive to additional unique stressors. Seagrasses are uprooted by dredging and scarred by boat propellers (Hemminga and Duarte 2000; Spalding et al. 2003). Seagrass that is scarred from boat propellers can take years to recover. Cordgrasses are damaged by sinking salt marsh habitat, a process known as marsh subsidence. Likewise, the global mangrove resource has decreased by 50 percent from aquaculture, changes in hydrology (water movement and distribution), and sea level rise (Feller et al. 2010).

Oil in runoff from land-based sources, natural seeps, and accidental spills (such as offshore drilling and oil tanker leaks) are some of the major sources of oil pollution in the marine environment (Levinton 2009a). The types and amounts of oil spilled, weather conditions, season, location, oceanographic conditions, and the method used to remove the oil (containment or chemical dispersants) are some of the factors that determine the severity of the effects. Sensitivity to oil varies among species and within species, depending on the life stage; generally, early-life stages are more sensitive than adult stages (Hayes et al. 1992).

Oil pollution, as well as chemical dispersants used in response to oil spills, can impact seagrasses directly by smothering the plants, or indirectly by lowering their ability to combat disease and other stressors (U.S. National Response Team 2010). Seagrasses that are totally submerged are less susceptible to oil spills because they largely escape direct contact with the pollutant. Depending on various factors, oil spills such as the Gulf War oil spill in 1991 (Kenworthy et al. 1993) can have no impact on seagrasses, or can have long-term impacts, such as the 4-year decrease in eelgrass density caused by the *Exxon Valdez* oil spill in 1989 (Peterson 2001). Algae are relatively resilient to oil spills, while mangroves are highly sensitive to oil exposure. Contact with oil can cause death, leaf loss, and failure to germinate (Hoff et al. 2002). Salt marshes can also be severely impacted by oil spills, and the effects can be long term (Culbertson et al. 2008).

3.7.2.2 Taxonomic Groups

3.7.2.2.1 Dinoflagellates (Phylum Dinophyta)

Dinoflagellates are single-celled organisms with two flagella (whiplike structures used for locomotion) in the phylum Dinophyta (Bisby et al. 2010). Dinoflagellates are predominantly marine algae, with an estimated 1,200 species living in surface waters of the ocean worldwide (Castro and Huber 2000). Most dinoflagellates can use the sun's energy to produce food through photosynthesis and also can ingest small food particles. Photosynthetic dinoflagellates are important primary producers in coastal waters (Waggoner and Speer 1998). Organisms such as zooplankton (microscopic animals that drift passively in the water column), feed on dinoflagellates.

Dinoflagellates are also valuable for their close relationship with reef-building corals. Some species of dinoflagellates (zooxanthellae) live inside corals. This mutually beneficial relationship provides shelter and food (in the form of coral waste products) for the dinoflagellates; in turn, the corals receive essential nutrients produced by dinoflagellates (Spalding et al. 2001). Dinoflagellates cause some types of harmful algal blooms which result from sudden increases in nutrients (e.g., fertilizers) from land into the ocean or changes in temperature and sunlight (Levinton 2009c). Additional information on harmful algal blooms can be accessed on the Centers for Disease Control and the National Oceanic and Atmospheric Administration websites.

3.7.2.2.2 Blue-Green Algae (Phylum Cyanobacteria)

Blue-green algae are single-celled, photosynthetic bacteria that inhabit the lighted surface waters and seafloors of the world's oceans (Bisby et al. 2010). Blue-green algae are key primary producers in the marine environment, and provide valuable ecosystem services such as producing oxygen and nitrogen. The blue-green algae *Prochlorococcus* is responsible for a large part of the oxygen produced globally by photosynthetic organisms. Other species of blue-green algae have specialized cells that convert nitrogen gas into a form that can be used by other marine plants and animals (nitrogen fixation) (Hayes et al. 2007; Sze 1998). In nutrient-poor waters of coral reef ecosystems in the Hawaiian archipelago in the Hawaiian portion of the Study Area, blue-green algae are an important source of food. Coral reefs in Hawaii exposed to physical and biological disturbance may be colonized by highly productive or invasive blue-green algae that may persist if animals that feed on them are not present (Cheroske et al. 2000).

3.7.2.2.3 Green Algae (Phylum Chlorophyta)

Green algae are single-celled organisms in the phylum Chlorophyta that may form large colonies of individual cells (Bisby et al. 2010). Green algae are predominately found in freshwater, with only 10 percent of the estimated 7,000 species living in the marine environment (Castro and Huber 2000). These species are important primary producers that play a key role at the base of the marine food web. Green algae are found in areas with a wide range of salinity, such as bays and estuaries, and are eaten by various organisms, including zooplankton and snails. Green seaweeds harvested for human consumption in Hawaii's coastal waters include *Ulva fasciata, Enteromorpha prolifera,* and *Codium edule* (Preskitt 2002a).

Invasive marine green algal species are found in coastal waters of the Study Area. *Caulerpa taxifolia* and *Codium fragile tomentosoide* are found in the Southern California portion of the Study Area (Global Invasive Species Database 2005). The invasive green algae *Avrainvillea amadelpha* has been recorded in the main Hawaiian Islands (Preskitt 2010). Invasive green algae represent a serious threat to coral reefs, and may displace, outcompete, or hybridize with non-invasive native green algae species, resulting in the loss of native biodiversity or alteration of ecosystem processes. Native Hawaiian green algal species that may become invasive include *Cladophora sericea*, *Caulerpa taxifolia*, *Dictyosphaeria cavernosa*, *Ulva fasciata*, and *Enteromorpha flexuasa.* These species are a valuable food source for green sea turtles (Preskitt 2010).

3.7.2.2.4 Brown Algae (Phylum Heterokontophyta)

Brown and golden-brown algae are single-celled (diatoms) and large multi-celled marine species with structures varying from fine filaments to thick leathery forms (Castro and Huber 2000). Most species are attached to the seafloor in coastal waters, although a free-floating type of brown algae (*Sargassum*) occurs in the Study Area.

Invasive marine brown algal species are found in coastal waters of the Southern California portion of the Study Area. *Undaria pinnatifida*, native to Japan, is found along the California coast (Global Invasive Species Database 2005). Two introduced species of *Sargassum* inhabit the Study Area. The brown alga *Sargassum muticum* was introduced from the Sea of Japan, and now occupies portions of the California coast (Monterey Bay Aquarium Research Institute 2009). *Sargassum horneri,* which is native to western Japan and Korea, occurs in Long Beach Harbor and in Southern California waters off San Diego, Orange County, San Clemente Island, and Santa Catalina Island (Miller et al. 2007).

3.7.2.2.4.1 Diatoms

Diatoms are single celled organisms with cell walls made of silicon dioxide. Two major groups of diatoms are generally recognized, centric diatoms and pinnate diatoms. Centric diatoms exhibit radial symmetry (symmetry about a point), while the pinnate diatoms are bilaterally symmetrical (symmetry about a line). Diatoms such as *Coscinodiscus* species (spp.) commonly occur in the Study Area. Some strains of another genus of diatoms, *Pseudo-nitzschia*, produce a toxic compound called domoic acid. Humans, marine mammals, and seabirds become sick or die when they eat organisms that feed on *Pseudo-nitzschia* strains that produce the toxic compound. The Southern California portion of the Study Area off the coasts of Los Angeles and Orange Counties had some of the highest concentrations of the toxic compound ever recorded in U.S. waters (Schnetzer et al. 2007). *Pseudo-nitzschia* blooms in the Southern California Bight during 2003 and 2004 were linked to over 1,400 marine mammal strandings (Schnetzer et al. 2007). Pollutants carried from land to the ocean by rainwater (Kudela and Cochlan 2000) and decreases in the movement of cool, nutrient-rich waters by the wind are believed to be the main causes of these harmful algal blooms in the Southern California portion of the Study Area (Kudela et al. 2004).

3.7.2.2.4.2 Kelp and *Sargassum*

Kelp is the most conspicuous brown algae occurring extensively along the coast in the Southern California portion of the Study Area. The giant kelp (*Macrocystis pyrifera*) can live up to eight years, and can reach lengths of 197 ft. (60 m). The leaf-like fronds can grow up to 24 inches (in.) (61 centimeters [cm]) per day (Leet et al. 2001). Bull kelp (*Nereocystis luetkeana*) can grow up to 5 in. (13 cm) per day. Bull kelp attaches to rocky substrates, and can grow up to 164 ft. (50 m) in length in nearshore areas. In turbid waters, the offshore edge of kelp beds occurs at depths of 50–60 ft. (15–18 m), which can extend to a depth of 100 ft. (30 m) in the clear waters around the Channel Islands off the coast of Southern California (Wilson 2002). The kelp beds along the California coast and in waters off the Channel Islands are the most extensive and elaborate submarine forests in the world (Rodriguez et al. 2001).

Six species of canopy-forming kelp occur in the coastal waters of the California coast: the giant kelp (*Macrocystis pyrifera*), bull kelp (*Nereocystis luetkeana*), elk horn kelp (*Pelagophycus porra*), feather boa kelp (*Egregia menziesii*), chain bladder kelp (*Stephanocystis osmundacea*), and winged kelp (*Alaria marginata*) (Dayton 1985). The dominant kelp in the Southern California portion of the Study Area is giant kelp (see Figure 3.3-2 for a map of kelp bed locations near San Diego Bay). Since the first statewide survey in 1967, the total area of kelp canopies has generally declined; the greatest decline occurred along the mainland coast of Southern California (Wilson 2002).

Kelp is managed by the California Department of Fish and Game, which issues exclusive leases to harvest designated beds for up to 20 years. Although they are not limited in the amount, harvesters cannot take kelp from deeper than 4 ft. (1.2 m) below the water's surface to protect the reproductive structures at the kelp's base (Wilson 2002). Edible brown seaweeds that are collected in Hawaii's coastal waters

include *Sargassum echinocarpu*m and *Dictyopteris plagiograma* (Preskitt 2002a). Collection is regulated by the State of Hawaii Department of Land and Natural Resources.

3.7.2.2.5 Red Algae (Phylum Rhodophyta)

Red algae are predominately marine, with approximately 4,000 species worldwide (Castro and Huber 2000). Red algal species exist in a range of forms, including single and multicellular forms (Bisby et al. 2010), from fine filaments to thick calcium carbonate crusts. Within the Study Area, they occur in coastal waters, primarily in reef environments and intertidal zones of Hawaii and California. Abbott (1999) identified 343 species of red algae in Hawaiian waters. Representative native species in Hawaii include *Laurencia* spp., *Gracilaria coronopifolia*, *Hypnea cervicornis*, and *Gracilaria parvispora*. Representative non-native invasive species include *Acanthophora spicifera*, *Gracilaria salicornia*, *Hypnea musciformis*, *Kappaphycus alvarezii*, and *Gracilaria tikvahiaea*. Many Rhodophyta species support coral reefs by hardening the reef and by cementing coral fragments (Veron 2000), and are food for various sea urchins, fishes, and chitons. In California waters, common species include *Endocladia muricata*, *Mastocarpus papillatus*, and *Mazaella* spp.

3.7.2.2.6 Seagrasses, Cordgrasses, and Mangroves (Phylum Spermatophyta)

Seagrasses, cordgrasses, and mangroves are flowering marine plants in the phylum Spermatophyta (Bisby et al. 2010). These marine flowering plants create important habitat, and are a food source for many marine species.

3.7.2.2.6.1 Seagrasses

Seagrasses are unique among flowering plants because they grow submerged in shallow marine environments. Except for some species that inhabit the rocky intertidal zone, seagrasses grow in shallow, subtidal, or intertidal sediments, and can extend over a large area to form seagrass beds (Garrison 2004; Phillips and Meñez 1988). Seagrass beds provide important ecosystem services as a structure-forming keystone species (Harborne et al. 2006). They provide suitable nursery habitat for commercially important organisms (e.g., crustaceans, fish, and shellfish) and also is a food source for numerous species (e.g., turtles) (Heck et al. 2003; National Oceanic and Atmospheric Administration 2001). Seagrass beds combat coastal erosion, promote nutrient cycling through the breakdown of detritus (Dawes 1998), and improve water quality. Seagrasses also contribute a high level of primary production to the marine environment, which supports high species diversity and biomass (Spalding et al. 2003).

Seagrasses that occur in the coastal areas of the Southern California portion of the Study Area in the California Current Large Marine Ecosystem include eelgrass (*Zostera marina* and *Zostera asiatica*), surfgrass (*Phyllospadix scouleri* and *Phyllospadix torreyi*), widgeon grass (*Ruppia maritima*), and shoal grass (*Halodule wrightii*) (Spalding et al. 2003). The distribution of underwater vegetation is patchy along the California coast. In the Southern California portion of the Study Area, eelgrass and surfgrass are the dominant native seagrasses (see Figure 3.3-2 for a map of eelgrass beds within San Diego Bay) (Wyllie-Echeverria and Ackerman 2003).

In Hawaii, the most common seagrasses are Hawaiian seagrass (*Halophila hawaiiana*) and paddle grass (*Halophila decipiens*). Hawaiian seagrass is a native species found at 1.6–3.1 ft. (0.5–0.9 m) in subtidal, sandy areas surrounding reefs, in bays, or in fishponds. It occurs in coastal waters of Oahu near Mamala Bay (southern coast), in Maunalua Bay (southeastern coast), in Kaneohe Bay (northeast coast), in coastal waters of Maui, in the inner reef flats of southern Molokai, at Anini Beach on the northern shore of Kauai, and at Midway Atoll in the Northwestern Hawaiian Islands (Phillips and Meñez 1988). Paddle

grass is possibly a nonnative species that occurs only on Oahu in waters to 115 ft. (35 m) deep; it is apparently restricted to the southern shore of Oahu (see Figure 3.3-3 for a map of seagrass locations off Oahu) (Maragos 2000; Preskitt 2001, 2002b).

3.7.2.2.6.2 Cordgrasses

Cordgrasses are temperate salt-tolerant land plants that inhabit salt marshes, mudflats, and other soft-bottom coastal habitats (Castro and Huber 2000). Salt marshes develop in intertidal, protected low-energy environments, usually in coastal lagoons, tidal creeks, rivers, or estuaries (Mitsch et al. 2009). The structure and composition of salt marshes provide important ecosystem services. Salt marshes support commercial fisheries by providing habitat for wildlife, protecting the coastline from erosion, filtering fresh water discharges into the open ocean, taking up nutrients, and breaking down or binding pollutants before they reach the ocean (Dreyer and Niering 1995; Mitsch et al. 2009). Salt marshes also are carbon sinks (carbon reservoirs) and facilitate nutrient cycling (Bouillon 2009; Chmura 2009). Carbon sinks are important in reducing the impact of climate change (Laffoley and Grimsditch 2009), and nutrient cycling facilitates the transformation of important nutrients through the environment. In salt marshes and mudflats along the California coast, native cordgrass species include California cordgrass (*Spartina foliosa*). Atlantic cordgrass (*Spartina alterniflora*) is a native cordgrass species from the Atlantic and Gulf coasts, and is considered an invasive species in California because it produces seeds at higher rates than the native cordgrass, and can quickly colonize mudflats (Howard 2008).

3.7.2.2.6.3 Mangroves

Mangroves are a group of woody plants that have adapted to salt water flooded environments with tidal and salinity fluctuations in the tropics and subtropics (Ruwa 1996). All mangrove trees have root systems (prop roots or pneumatophores-structures) that stick up in the air for oxygen intake in oxygen poor soils and secrete salts from the leaves after to process fresh water from the saline environment. Mangroves can trap sediments and pollution from terrestrial environments and can shield and stabilize coastlines from wave action. The red mangrove, *Rhizophora mangle*, and several other species of mangroves were introduced to Hawaii (Allen 1998). Since the introduction of this species, mangroves have invaded intertidal areas formerly devoid of trees. The red mangrove is now well-established in the main Hawaiian Islands. The red mangrove is considered to be an invasive species in the main Hawaiian Islands, and various resource agencies and organizations (e.g., Hawaii Department of Land and Natural Resources, Pacific Cooperative Studies Unit, Malama O Puna) have eradication programs targeting the red mangrove and other mangrove infestations. Red mangrove infestations can damage cultural sites (e.g., fish pond structures) and create an anoxic pond of slowly decomposing litter. These depleted oxygen environments can kill fish and aquatic biota (much of it endemic and rare). No mangroves are found within California coastal environments.

3.7.3 ENVIRONMENTAL CONSEQUENCES

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) potentially impact marine vegetation. General characteristics of all Navy stressors were introduced in Section 3.0.5.3 (Identification of Stressors for Analysis), and living resources' general susceptibilities to stressors were introduced in Section 3.0.5.7 (Biological Resource Methods). Each marine vegetation stressor is introduced, analyzed by alternative, and analyzed for training activities and testing activities. Table F-3 in Appendix F shows the warfare areas and associated stressors that were considered for analysis of marine vegetation.

The stressors vary in intensity, frequency, duration, and location within the Study Area. Based on the general threats to marine vegetation discussed in Section 3.7.2 (Affected Environment) the stressors applicable to marine vegetation are:

- Acoustic (underwater explosives)
- Physical disturbance and strikes (vessels and in-water devices, military expended materials, seafloor devices)
- Secondary (sediments and water quality)

Because marine vegetation is not susceptible to energy, entanglement, or ingestion stressors, those stressors will not be assessed. Only the Navy training and testing activity stressors and their components that occur in the same geographic location as marine vegetation are analyzed in this section. Details of all training and testing activities, stressors, components that cause the stressor, and geographic occurrence within the Study Area, are summarized in Section 3.0.5.3 (Identification of Stressors for Analysis) and detailed in Appendix A (Navy Activities Descriptions).

3.7.3.1 Acoustic Stressors

This section analyzes the potential impacts from acoustic stressors that may occur during Navy training and testing activities on marine vegetation within the Study Area. The acoustic stressors that may impact marine vegetation include explosives that are detonated on or near the surface of the water, or underwater; therefore, only these types of explosions are discussed in this section.

3.7.3.1.1 Impacts from Explosives

Various types of explosives are used during training and testing activities. The type, number, and location of activities that use explosives under each alternative are discussed in Section 3.0.5.3.1.2 (Explosions). Explosive sources are the only acoustic stressor applicable to this resource because explosives could physically damage marine vegetation.

The potential for an explosion to injure or destroy marine vegetation would depend on the amount of vegetation present, the number of munitions used, and their net explosive weight. In areas where marine vegetation and locations for explosions overlap, vegetation on the surface of the water, in the water column, or rooted in the seafloor may be impacted. Seafloor macroalgae and single-celled algae may overlap with underwater and sea surface explosion locations. If these vegetation types are near an explosion, only a small number of them are likely to be impacted relative to their total population level. The low number of explosions relative to the amount of seafloor macroalgae and single-celled algae in the Study Area also decreases the potential for impacts on these vegetation types. Based on these factors, the impact on these types of marine vegetation would not be detectable and they will not be discussed further. In addition, seafloor macroalgae are resilient to high levels of wave action (Mach et al. 2007), which may aid in their ability to withstand underwater explosions that occur near them. Underwater explosions also may temporarily increase the turbidity (sediment suspended in the water) of nearby waters, incrementally reducing the amount of light available to marine vegetation. Reducing light availability will decrease, albeit temporarily, the photosynthetic ability of marine vegetation.

The potential for seagrass to overlap with underwater and surface explosions is limited to bayside areas of Silver Strand Training Complex (SSTC), as well as to protected areas along oceanside portions of SSTC. For instance, eelgrass is known to occur off Breakers Beach, but no explosives training occurs in known locations. Eelgrass primarily occurs in bayside areas, and may overlap with explosives training areas. Seagrasses could be uprooted or damaged by sea surface or underwater explosions. They are much less

resilient to disturbance than *Sargassum* and other marine algae; regrowth after uprooting can take up to 10 years (Dawes et al. 1997). Explosions may also temporarily increase the turbidity (sediment suspended in the water) of nearby waters, but the sediment would settle to pre-explosion conditions within a number of days. Sustained high levels of turbidity may reduce the amount of light that reaches vegetation. This scenario is not likely because of the low number of explosions planned in areas with seagrass.

3.7.3.1.1.1 No Action Alternative

Training Activities

Under the No Action Alternative, training activities that use explosives do not generally occur near shorelines, bays, rivers, or estuaries. In addition, the majority of underwater explosions in the Study Area would likely occur over unvegetated seafloor because it is the predominant bottom-type in the areas proposed for these activities. However, areas of marine algae may overlap with underwater explosions. In the Southern California Range Complex (SOCAL), nearshore explosions occur within SSTC Boat Lanes and training areas surrounding San Clemente Island. An area off Breakers Beach supports eelgrass, however, no explosives training occurs in this area. Eelgrass and other seagrasses are found in portions of SSTC bayside areas where Navy training involves simulated explosives, but no actual detonations. Within the coastal waters of Hawaii, explosives training occurs at Puuloa Underwater Range, Barbers Point Underwater Range, Lima Landing area, and Ewa Training Minefield. These areas, all located on the underwater portion of the Ewa Plain, are characterized by benthic algae beds (primarily green algae) and uncolonized pavement (U.S. Department of the Navy 1998). MK-8 marine mammal training occurs within Hawaiian coastal waters; however, the training in Hawaii does not involve explosives.

Underwater and surface explosions conducted for training activities are not expected to cause any risk to kelp beds, other marine algae, or seagrass because: (1) the relative coverage of marine algae is low, (2) new growth may result from marine algae exposure to explosives, (3) the impact area of underwater explosions is very small relative to kelp beds and other marine algae distribution (see Section 3.3.3.1, Acoustic Stressors [Explosives] in Section 3.3, Marine Habitats), and (4) seagrass does not overlap with areas where the stressor occurs. Based on these factors, potential impacts on multi-cellular marine algae from underwater and surface explosions are not expected to result in detectable changes to its growth, survival, or propagation, and are not expected to result in population-level impacts; and there are no potential impacts on seagrass species.

Testing Activities

Under the No Action Alternative, testing activities that involve explosions are limited to open ocean portions of the Study Area, primarily within SOCAL. Therefore, seagrasses would not be impacted by explosions because the depth of water where testing activities occur is too deep to support benthic vegetation. Only marine algae floating at the surface or suspended near the surface would be impacted by explosions. As stated previously, this type of algae is capable of recovering quickly from wave action, and will likely demonstrate rapid recovery rates after explosions.

Underwater and surface explosions conducted for testing activities are not expected to pose a risk to marine algae or seagrass because: (1) the relative coverage of marine multi-cellular algae is low, (2) new growth may result from marine algae exposure to explosives, (3) the impact area of underwater explosions is very small relative to kelp beds and other marine algae distribution, and (4) seagrass does not overlap with areas where the stressor occurs. Based on these factors, potential impacts on marine algae from underwater and surface explosions are not expected to result in detectable changes to its

growth, survival, or propagation, and are not expected to result in population-level impacts; and there are no potential impacts on seagrass species.

3.7.3.1.1.2 Alternative 1

Training Activities

Under Alternative 1, the total number of explosive training events would increase by approximately 12 percent relative to the No Action Alternative. Most of these increases would occur within SOCAL open ocean training areas. The number of explosions within SSTC Boat Lanes would increase slightly, from 408 under the No Action Alternative to 414 under Alternative 1. This increase would only occur as part of Mine Neutralization – Explosive Ordinance Disposal training activities. All other activities within SSTC involving explosions would not increase relative to the No Action Alternative. As stated previously, the SSTC Boat Lanes explosive activity areas do not overlap with eelgrass or other seagrass habitats.

The potential impacts on marine algae from exposure to underwater and surface explosions are as described in Section 3.7.3.1.2.1 (No Action Alternative). The impact of underwater explosions from mine neutralization activities on bottom habitats provides some perspective on the potential impact area. The impact footprint of underwater explosions on bottom habitats is 0.04 square nautical miles (nm^2); see Table 3.3-3, Section 3.3.3.1.1.1 (Training Activities). This impact footprint is small relative to the distribution of marine algae, such as kelp, in the Study Area (see Figure 3.3-2).

In comparison to the No Action Alternative, the increase in activities presented in Alternative 1 may increase the risk to marine algae from exposure to underwater and surface explosions. The majority of the difference is because of the increase in medium-caliber projectiles, which are the smallest type of explosive described in Chapter 2 (Description of Proposed Action and Alternatives). Despite the increase in underwater and surface explosions, the potential impacts on exposed marine algae are expected to be the same as under the No Action Alternative because the overlap with the resource is limited. Underwater and surface explosions conducted for training activities are not expected to pose a risk to seagrass because: (1) the impact area of underwater explosions is very small relative to seagrass distribution, (2) the low number of charges reduces the potential for impacts, and (3) disturbance would be temporary. For the same reasons as stated in Section 3.7.3.1.1.1 (No Action Alternative) for marine algae and here for seagrass, the use of surface and underwater explosions is not expected to result in detectable changes to their growth, survival, or propagation, and are not expected to result in population-level impacts.

Testing Activities

Under Alternative 1, underwater and surface explosions in the Study Area would increase by approximately 200 percent compared to the No Action Alternative (see Table 3.0-9). As under the No Action Alternative, testing activities would continue to occur in open ocean portions of SOCAL and Hawaii Range Complex (HRC). No explosives are used during testing activities within SSTC training areas, therefore, seagrasses in and around San Diego Bay would not be impacted by acoustic stressors from testing activities.

The general conditions described for testing activities, the overlap with multi-cellular marine algae, lack of overlap with seagrass, and the potential impacts on marine algae from exposure to underwater and surface explosions are as described in Section 3.7.3.1.2 (No Action Alternative). The impact footprint of underwater explosions on bottom habitats is 0.06 nm^2; see Table 3.3-4, Section 3.3.3.1.2.1 (Training Activities). This impact footprint is small relative to the distribution of marine algae in the Study Area.

In comparison to the No Action Alternative, the increase in activities presented in Alternative 1 may increase the risk to marine algae from exposure to underwater and surface explosions. The majority of the difference is due to the increase in medium-caliber projectiles, which are the smallest type of explosive described in Table 3.0-9 (Explosives for Training and Testing Activities in the Hawaii-Southern California Training and Testing Study Area). Despite the increase in underwater and surface explosions, the potential impacts on exposed marine algae are expected to be the same as under the No Action Alternative because the overlap with the resource is limited. For the same reasons as stated in Section 3.7.3.1.2 (No Action Alternative), the use of surface and underwater explosions is not expected to result in detectable changes in marine algae growth, survival, or propagation, and are not expected to result in population-level impacts.

3.7.3.1.1.3 Alternative 2

Training Activities

Under Alternative 2, the same number of training activities and underwater detonations would occur as under Alternative 1. Therefore, underwater detonations under Alternative 2 would have the same impacts on marine vegetation as under Alternative 1.

In comparison to the No Action Alternative, the increase in activities presented in Alternative 2 may increase the risk of marine algae from exposure to underwater and surface explosions. It should be noted that the majority of the difference is because of the increase in medium-caliber projectiles, which are the smallest type of explosive described in Chapter 2 (Description of Proposed Action and Alternatives). Despite the increase in underwater and surface explosions, the potential impacts on exposed marine algae are expected to be the same as under the No Action Alternative because the overlap with the resource is limited. Underwater and surface explosions conducted for training activities are not expected to pose a risk to seagrass because: (1) the impact area of underwater explosions is very small relative to seagrass distribution, (2) the low number of charges reduces the potential for impacts, and (3) disturbance would be temporary.

Testing Activities

Under Alternative 2, underwater and surface explosion use in the Study Area would increase by 11-fold compared to the No Action Alternative; see Table 3.0-9 (Explosives for Training and Testing Activities in the Hawaii-Southern California Training and Testing Study Area). As under the No Action Alternative, testing activities would continue to occur in open ocean portions of SOCAL and HRC. No explosives are used during testing activities within SSTC training areas, therefore, seagrasses in and around San Diego Bay would not be impacted.

The general conditions described for testing activities, the overlap with *Sargassum*, lack of overlap with seagrass, and the potential impacts on marine algae from exposure to underwater and surface explosions are as described in Section 3.7.3.1.1.1 (No Action Alternative). The impact footprint of underwater explosions on bottom habitats is 0.04 nm^2; see Table 3.3-6, Section 3.3.3.1.1 (Underwater Explosions). This impact footprint is small relative to the distribution of marine algae in the Study Area.

In comparison to the No Action Alternative, the 11-fold increase in activities in Alternative 2 may increase the risk to marine algae from exposure to underwater and surface explosions. The majority of the difference is because of the increase in medium-caliber projectiles, which are the smallest type of explosive described in Table 3.0-9 (Explosives for Training and Testing Activities in the Hawaii-Southern California Training and Testing Study Area). Despite the increase in underwater and surface explosions, the potential impacts to exposed marine algae are expected to be the same as under the No Action

Alternative because the overlap with the resource is limited. For the same reasons as stated in Section 3.7.3.1.1.1 (No Action Alternative), surface and underwater explosions are not expected to result in detectable changes in marine algae growth, survival, or propagation, and are not expected to result in population-level impacts.

3.7.3.1.1.4 Substressor Impact on Marine Vegetation as Essential Fish Habitat (Preferred Alternative)

Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of explosives during training and testing activities may have an adverse effect on Essential Fish Habitat by reducing the quality and quantity of marine vegetation that constitutes Essential Fish Habitat or Habitat Areas of Particular Concern. The HSTT Essential Fish Habitat Assessment report states that the impact on attached macroalgae is determined to be minimal and temporary to short-term throughout the Study Area (U.S. Department of the Navy 2012). The impact on floating macroalgae is determined to be minimal and short-term throughout the Study Area (U.S. Department of the Navy 2012). Given the available information, the impact on submerged rooted vegetation beds is determined to be minimal and long-term (U.S. Department of the Navy 2012).

3.7.3.2 Physical Disturbance and Strike Stressors

This section analyzes the potential impacts on marine vegetation of the various types of physical disturbance and strike stressors during training and testing activities within the Study Area. Three types of physical stressors are evaluated for their impacts on marine vegetation, including: (1) vessels, in-water devices, and towed in-water devices; (2) military expended materials; and (3) seafloor devices.

The evaluation of the impacts from physical strike and disturbance stressors on marine vegetation focuses on proposed activities that may cause vegetation to be damaged by an object that is moving through the water (e.g., vessels and in-water devices), dropped into the water (e.g., military expended materials), or deployed on the seafloor (e.g., mine shapes and anchors). Not all activities are proposed throughout the Study Area. Wherever appropriate, specific geographic areas of potential impact are identified.

Single-celled algae may overlap with physical disturbance or strike stressors, but the impact would be minimal relative to their total population level; therefore, they will not be discussed further. Seagrasses and macroalgae on the seafloor are the only types of marine vegetation that occur in locations where physical disturbance or strike stressors may be encountered. Therefore, only seagrasses, and macroalgae, are analyzed further for potential impacts from physical disturbance or strike stressors. Since the occurrence of marine algae is an indicator of marine mammal and sea turtle presence, some mitigation measures designed to reduce impacts on these resources may indirectly reduce impacts on marine algae; see Section 5.3.2.2 (Physical Strike and Disturbance).

3.7.3.2.1 Impacts from Vessels and In-Water Devices

Several different types of vessels (ships, submarines, boats, amphibious vehicles) and in-water devices (towed devices, unmanned underwater vehicles) are used during training and testing activities throughout the Study Area, as described in Chapter 2 (Description of Proposed Action and Alternatives). Vessel movements occur intermittently, are variable in duration, ranging from a few hours to a few weeks, and are dispersed throughout the Study Area. Events involving large vessels are widely spread over offshore areas, while smaller vessels are more active in nearshore areas.

The potential impacts from Navy vessels and in-water devices used during training and testing activities on marine vegetation are based on the vertical distribution of the vegetation. Surface vessels include ships, boats, and amphibious vehicles; and seafloor vessels include unmanned underwater vehicles and autonomous underwater vehicles. Vessels may impact vegetation by striking or disturbing vegetation on the sea surface or seafloor (Spalding et al. 2003). In the open ocean, marine algae on the sea surface such as kelp paddies have a patchy distribution. Marine algae could be temporarily disturbed if struck by moving vessels or by the propeller action of transiting vessels. Fragmentation would be on a small spatial scale, and algal mats would be expected to re-form. These strikes could also injure the organisms that inhabit kelp paddies or other marine algal mat, such as sea turtles, seabirds, marine invertebrates, and fish (see Sections 3.5, 3.6, 3.8, and 3.9, respectively). In open-ocean areas, marine algae on the sea surface may be disturbed by vessels and in-water devices. Marine algae could be temporarily disturbed if struck by transiting vessels or by their propellers. It is resilient to winds, waves, and severe weather that could sink the mat or break it into pieces. If an algal mat is struck, broken pieces may grow into new algal mats because marine algae reproduces by vegetative fragmentation (i.e., new plants develop from pieces of the parent plant) (South Atlantic Fishery Management Council 1998). Impacts on marine algae by strikes may collapse the pneumatocysts (air sacs) that keep the mats afloat. Evidence suggests that some floating marine algae will continue to float even when up to 80 percent of the pneumatocysts are removed (Zaitsev 1971).

Vegetation on the seafloor such as seagrasses and macroalgae may be disturbed by amphibious combat vehicles. Seagrasses are resilient to the lower levels of wave action that occur in sheltered estuarine shorelines, but are susceptible to vessel propeller scarring (Sargent et al. 1995). Seagrasses could take up to 10 years to fully regrow and recover from propeller scars (Dawes et al. 1997). Seafloor macroalgae may be present in locations where these vessels and in-water devices occur, but the impacts would be minimal because of their resilience, distribution, and biomass. A literature search of at-risk marine macroalgae species in the Study Area (International Union for Conservation of Nature and Natural Resources 2011) did not indicate that this type of vegetation is more resilient to stressors than other marine vegetation. Because seafloor macroalgae in coastal areas are adapted to natural disturbances, such as storms and wave action that can exceed 33 ft. (10 m) per second (Mach et al. 2007), macroalgae will quickly recover from vessel and in-water device movements. Macroalgae that is floating in the area may be disturbed by amphibious combat vehicle activities, but the impact would not be detectable because of the low number of activities (see Table 2.8-1) and will not be considered further.

Towed in-water devices include towed targets that are used during activities such as missile exercises and gun exercises. These devices are operated at low speeds either on the sea surface or below it. The analysis of in-water devices will focus on towed surface targets because of the potential for impacts on marine algae. Unmanned underwater vehicles and autonomous underwater vehicles are used in training and testing activities in the Study Area. They are typically propeller-driven, and operate within the water column or crawl along the seafloor. The propellers of these devices are encased, eliminating the potential for seagrass propeller scarring. Algae on the seafloor could be disturbed by these devices although, for the same reasons given for vessel disturbance, unmanned underwater vehicles are not expected to compromise the health or condition of algae.

3.7.3.2.1.1 No Action Alternative, Alternative 1, and Alternative 2

Training Activities

Estimates of relative vessel use and location for each alternative are provided in Section 3.0.5.3.3.1 (Vessels). These estimates are based on the number of activities predicted for each alternative. While these estimates provide a prediction of use, actual Navy vessel use depends upon military training

requirements, deployment schedules, annual budgets, and other unpredictable factors. Testing and training concentrations are most dependent upon locations of Navy shore installations and established testing and training areas. Under Alternatives 1 and 2, the Study Area would be expanded, but the concentration of use and the manner in which the Navy tests and trains would remain consistent with the range of variability observed over the last decade. Consequently, the Navy is not changing the rate of vessel use and, therefore, the level of expected strikes would not change either. The difference in events from the No Action Alternative to Alternative 1 and Alternative 2, shown in Table 3.0-30, is not likely to change the probability of a vessel strike in any meaningful way.

Under all alternatives, a variety of vessels, in-water devices, and towed in-water devices would be used throughout the Study Area during training activities, as described in Chapter 2 (Description of Proposed Action and Alternatives). Most activities would involve one vessel, but activities may occasionally use two vessels. Most vessel traffic would occur in SSTC, in and near Pearl Harbor, off portions of Marine Corps Base Camp Pendleton, and on portions of San Clemente Island. Within SSTC, shallow-water vessel movements in defined boat lanes would continue to occur with minimal impacts on marine vegetation because these boat lanes overlie cobble and bare substrates.

Unlike most vessels used in offshore training activities that occur in deep water, amphibious vehicles are designed to move personnel and equipment from ship to shore in shallow water. In San Diego Bay, eelgrass beds are avoided to the maximum practicable extent. Because of the dredging history of San Diego Bay near the Navy ship berths, impacts from vessel movements on marine vegetation are expected to be minimal (U.S. Department of the Navy and San Diego Unified Port District 2011). Because of the quantity of vessel traffic in Hawaiian nearshore waters since the 1940s (especially in waters off Oahu and within Pearl Harbor), the existing vegetation community profile is well-adapted to vessel disturbances. Amphibious vehicles are an exception to this general conclusion because they are designed to come into contact with the seafloor in the surf zone (area of wave action). However, attached macroalgae and seagrass do not overlap with amphibious combat vehicle activities (see Figure 3.3-3). Amphibious vehicles operate within Kaneohe Bay. Macroalgae floating in the area may be disturbed by amphibious combat vehicle activities but the impact would not be detectable given the low number of activities (see Table 2.8-1) and will not be considered further.

On the open ocean, vessel strikes of marine vegetation would be limited to floating marine algae. Vessel movements may disperse or injure algal mats. Because algal distribution is patchy, mats may re-form, and events would be on a small spatial scale, Navy training activities involving vessel movement would not impact the general health of marine algae. Navy mitigation measures would ensure that vessels avoid large algal mats, eelgrass beds, or other sensitive vegetation that other marine life depend on for food or habitat; these measures would safeguard this vegetation type from vessel strikes. In addition, Navy mitigation measures would require helicopter crews that tow in-water devices for mine warfare exercises to monitor the water surface before and during exercises to identify and avoid marine algae.

Under all Alternatives, the impacts from vessel, in-water device, and towed in-water device physical disturbances and strikes during training activities would be minimal disturbances of algal mats and seaweeds. Eelgrass bed damage is not likely but, if it occurs, the impacts would be minor, such as short-term turbidity increases.

The net impact of vessel, in-water device, and towed in-water device physical disturbances and strikes on marine vegetation is expected to be negligible under all alternatives, based on: (1) Navy mitigation measures; (2) the quick recovery of most vegetation types; (3) the short-term nature of most vessel

movements and local disturbances of the surface water, with some temporary increase in suspended sediment in shallow areas; and (4) the deployment of in-water devices at depths where they would not likely come in contact with marine vegetation.

Testing Activities

Under all alternatives, the Navy would test a variety of vessels, vehicles, and in-water devices. Most of the testing activities involving vessel movements and in-water devices occur at sea within the SOCAL Range Complex and HRC, or within the transit corridor between the two range complexes. Some of the testing occurs pierside in San Diego Bay or Pearl Harbor.

On the sea surface, vessel and towed surface target strikes of marine vegetation would be limited to floating marine algal mats. Vessel movements may disperse or injure algal mats. However, algal mats may re-form, and testing events would be on a small spatial scale. Therefore, Navy testing activities involving vessel movement and towed surface targets are not expected to impact the general health of marine algae. No testing activities would occur near seagrasses, such as eelgrass beds in San Diego Bay.

The net impact of vessel, in-water device, and towed in-water device physical disturbances and strikes on marine vegetation during testing activities is expected to be negligible under all alternatives, based on: (1) Navy mitigation measures; (2) the quick recovery of most vegetation types; (3) the short-term nature of most vessel movements and local disturbances of the surface water, with some temporary increase in suspended sediment in shallow areas; and (4) the deployment of in-water devices at depths where they would not likely come in contact with marine vegetation.

3.7.3.2.1.2 Substressor Impact on Marine Vegetation as Essential Fish Habitat (Preferred Alternative)

Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of vessels and in-water devices during training and testing activities would have no impact on attached macroalgae or submerged rooted vegetation that constitutes Essential Fish Habitat or Habitat Areas of Particular Concern. The use of vessels and in-water devices during training and testing activities may have an adverse effect by reducing the quality and quantity of floating macroalgae that constitutes Essential Fish Habitat or Habitat Areas of Particular Concern. The HSTT Essential Fish Habitat Assessment report states that any impacts on marine vegetation incurred by vessel movements and in-water devices would be minimal and short-term (U.S. Department of the Navy 2012).

3.7.3.2.2 Impacts from Military Expended Materials

This section analyzes the strike potential to marine vegetation of the following categories of military expended materials: (1) non-explosive practice munitions, (2) fragments of high-explosive munitions, and (3) expended materials other than ordnance, such as sonobuoys and expendable targets. For a discussion of the types of activities that use military expended materials, where they are used, and how many activities would occur under each Alternative, see Section 3.0.5.3.3.3 (Military Expended Material Strikes).

Military expended materials can impact floating marine algae in the open ocean, and seagrass and other types of algae on the seafloor in coastal areas. Most types of military expended materials are deployed in the open ocean. In coastal water training areas, only projectiles (small and medium), target fragments, and countermeasures could be introduced into areas where shallow water vegetation such as seagrass and seafloor macroalgae may be impacted.

The following are descriptions of the types of military expended materials that could impact marine algae and seagrass. Marine algae could overlap with military expended materials anywhere in the Study Area. SSTC is the only location where these materials could overlap with seagrasses. Potential impacts on marine algae and seagrass are as discussed in Section 3.7.3.2.2. Tables 3.0-65 through 3.0-67 present the numbers and locations of activities that expend military materials during training and testing activities by location and alternative.

Small-, Medium-, and Large-Caliber Projectiles. Small-, medium-, and large-caliber non-explosive practice munitions, or fragments of high-explosive projectiles expended during training and testing activities rapidly sink to the seafloor. The majority of these projectiles would be expended in the open ocean areas of SOCAL and HRC. Because of the small sizes of the projectiles and of their casings, damage to marine vegetation is unlikely. Large-caliber projectiles are primarily used in offshore areas at depths greater than 26 m (85.3 ft.), while small- and medium-caliber projectiles would be expended in both offshore and coastal areas at depths less than 26 m (85.3 ft.). Marine algae could occur where these materials are expended, but seagrasses generally do not because these activities do not normally occur in water that is shallow enough for seagrass to grow.

Bombs, Missiles, and Rockets. Bombs, missiles, and rockets, or their fragments (if high-explosive) are expended offshore (at depths greater than 26 m [83.3 ft.]) during training and testing activities, and rapidly sink to the seafloor. Marine algae could occur where these materials are expended, but seagrass generally does not because of water depth limitations for activities that expend these materials.

Parachutes. Parachutes of varying sizes are used during training and testing activities. The types of activities that use parachutes, the physical characteristics of these expended materials, where they are used, and the number of activities that would occur under each alternative are discussed in Section 3.0.5.3.4.2 (Parachutes). Marine algae could occur in any of the locations where these materials are expended.

Targets. Many training and testing activities use targets. Targets that are hit by munitions could break into fragments. Target fragments vary in size and type, but most fragments are expected to sink. Pieces of targets that are designed to float are recovered when possible. Target fragments would be spread out over large areas. Marine algae and seagrass could occur where these materials are expended.

Countermeasures. Defensive countermeasures such as chaff and flares are used to protect against missile and torpedo attack. Chaff is made of aluminum-coated glass fibers and flares are pyrotechnic devices. Chaff, chaff canisters, and flare end caps are expended materials. Chaff and flares are dispensed from aircraft or fired from ships. Floating marine algal mats could occur in any of the locations that these materials are expended.

3.7.3.2.2.1 No Action Alternative

Training Activities

Tables 3.0-65 through 3.0-67 list the numbers and locations of military expended materials, most of which are small- and medium-caliber projectiles. The numbers and footprints of military expended materials are detailed in Table 3.3-5.

In HRC, projectiles would be expended in shallow-water habitats around Kaula Island during air-to-ground gunnery exercises. Small-caliber projectiles would be expended over the course of 18 events per year, expending about 15,000 small- and medium-caliber projectiles per year. While most of these will

remain on the small island, a small number could be expected to settle in the shallow water around Kaula Island. Common algae found in rocky intertidal habitats include sea lettuce, coralline red algae, red fleshy algae, brown algae, and fleshy green algae (U.S. Department of the Navy 2005). Common plants that inhabit the sandy beach intertidal habitat include the beach morning glory (*Ipomoea* spp.), beach heliotrope (*Tournefortia argentea*), milo (*Thespesia populnea*), and hau (*Hibiscus tiliaceus*), as well as seagrasses found in shallow waters around Kaula Island (Maragos 2000). The footprint of expended projectiles would be very small, and would have no impact on intertidal vegetation. No other activity would introduce projectiles or casings into shallow water in Hawaii.

Floating marine algal mats and other types of algae that occur on the sea surface in the open ocean may be temporarily disturbed if struck by military expended materials. This type of disturbance would not likely be different from conditions created by waves or rough weather. If enough military expended materials land on algal mats, the mats can sink. The likelihood is low that mats would accumulate enough material to cause sinking from military activities, because military expended materials are dispersed widely through an activity area. The few algal mats that would prematurely sink would not have an impact on populations. Strikes would have little impact and would not likely result in the mortality of marine algae or other algae, although these strikes may injure the organisms that inhabit marine algae, such as sea turtles, birds, marine invertebrates, and fish (see Sections 3.5, 3.6, 3.8, and 3.9, respectively).

Military expended materials used for training activities are not expected to pose a risk to marine algae or seagrass because: (1) the relative coverage of marine algae in the Study Area is low, (2) new growth may result from marine algae exposure to military expended materials, (3) the impact area of military expended materials is very small relative to marine algae distribution, and (4) seagrass overlap with areas where the stressor occurs is very limited (see Figure 3.3-2). Based on these factors, potential impacts on marine algae and seagrass from military expended materials are not expected to result in detectable changes in their growth, survival, or propagation, and are not expected to result in population-level impacts.

Testing Activities

Tables 3.0-65 through 3.0-67 list the numbers and locations of military expended materials, most of which are small- and medium-caliber projectiles. The numbers and footprints of military expended materials are detailed in Tables 3.3-5 through 3.3-7. Under the No Action Alternative, testing activities would expend materials in shallow-water habitats. No testing activities would expend materials in shallow-water habitats of SSTC; however, some testing events would expend medium-caliber rounds in SOCAL testing areas as part of Naval Air Systems Command testing of the Airborne Projectile-based mine clearance system.

Under the No Action Alternative, military expended materials used for testing activities are not expected to pose a risk to marine algae or seagrass because: (1) the relative coverage of marine algae in the Study Area is low, (2) new growth may result from marine algae exposure to military expended materials, (3) the impact area of military expended materials is very small relative to marine algae distribution, and (4) seagrass does not overlap with areas where the stressor occurs. Based on these factors, potential impacts on marine algae from military expended materials are not expected to result in detectable changes in its growth, survival, or propagation, and are not expected to result in population-level impacts; and there are no potential impacts on seagrass.

3.7.3.2.2.2 Alternative 1

Training Activities

Tables 3.0-65 through 3.0-67 list the numbers and locations of military expended materials, most of which are small- and medium-caliber projectiles. The numbers and footprints of military expended materials are detailed in Table 3.3-6. As indicated in Section 3.0.5.3.3.3 (Military Expended Materials Strikes), under Alternative 1, the total amount of military expended materials is more than twice the amount expended in the No Action Alternative. The activities and type of military expended materials under Alternative 1 would be expended in the same geographic locations as the No Action Alternative.

Floating marine algal mats and other types of algae that occur on the sea surface in the open ocean may be temporarily disturbed if struck by military expended materials. This type of disturbance would not likely differ from conditions created by waves or rough weather. If enough military expended materials land on algal mats, the mats can sink. Sinking occurs as a natural part of the aging process of marine algae (Schoener and Rowe 1970). The likelihood is low that mats would accumulate enough material to cause sinking from military activities, as military expended materials are dispersed widely through an activity area. The few algal mats that would prematurely sink would not have an impact on populations. Strikes would have little impact, and would not likely result in the mortality of floating algal mats or other algae, although these strikes may injure the organisms that inhabit marine algal mats, such as sea turtles, birds, marine invertebrates, and fish (see Sections 3.5, 3.6, 3.8, and 3.9, respectively).

In comparison to the No Action Alternative, the increase in activities presented in Alternative 1 may increase the risk to marine algae and seagrass of exposure to military expended materials. Despite the increase in the number of military expended materials, the potential impacts on exposed algal mats and seagrass are expected to be the same as under the No Action Alternative because overlap with the resources are limited. For the same reasons as stated in Section 3.7.3.2.2.1 (No Action Alternative), the use of military expended materials is not expected to result in detectable changes in marine algae or seagrass growth, survival, or propagation, and are not expected to result in population-level impacts.

Testing Activities

Tables 3.0-65 through 3.0-67 list the numbers and locations of military expended materials, most of which are small- and medium-caliber projectiles. The numbers and footprints of military expended materials are detailed in Table 3.3-6. As indicated in Section 3.0.5.3.3.3 (Military Expended Materials Strikes), under Alternative 1, the total amount of military expended materials is nearly four times the amount expended in the No Action Alternative. Testing activities under Alternative 1 would be in the same locations as under the No Action Alternative, and military materials would be expended in the same locations as under the No Action Alternative. Military expended materials would typically be of the same type listed under the No Action Alternative.

Under Alternative 1, increased deposition of military expended materials during testing activities would not increase the risk of physical disturbance or strike to seagrass. Under Alternative 1, increased deposition of military expended materials during testing activities could increase the risk of physical disturbance or strike to marine algae. Any damage from deposition of military expended materials would be followed by a recovery period lasting weeks to months. Marine algae could have a detectable response to physical disturbances or strikes by military expended materials, but would recover completely, with no impact on its growth, survival, reproductive success, or lifetime reproductive success.

3.7.3.2.2.3 Alternative 2

Training Activities

The numbers and locations of training activities under Alternative 2 are identical to those of training activities under Alternative 1. Therefore, impacts on and comparisons to the No Action Alternative also are identical, as described in Section 3.7.3.2.2.1 (No Action Alternative).

Testing Activities

Tables 3.0-65 through 3.0-67 list the numbers and locations of military expended materials, most of which are small- and medium-caliber projectiles. The numbers and footprints of military expended materials are detailed in Table 3.3-7. As indicated in Section 3.0.5.3.3.3 (Military Expended Materials Strikes), under Alternative 2, the total amount of military expended materials is nearly five times the amount expended in the No Action Alternative. This represents a 10 percent increase over Alternative 1. The types of activities and military expended materials occurring under Alternative 2 would be the same as those in the No Action Alternative. Furthermore, the activities would occur in the same geographic locations as the No Action Alternative.

In comparison to the No Action Alternative, the overall increase in activities presented in Alternative 2 may increase the risk of marine algae and seagrass exposure to military expended materials. However, the differences in species overlap and potential impacts of surface explosions on marine algae and seagrass during testing activities would not be discernible from those described in Section 3.7.3.2.2.1 (No Action Alternative). For the same reasons as stated in Section 3.7.3.2.2.1 (No Action Alternative) for marine algae and seagrass, the use of military expended materials is not expected to result in detectable changes to marine algae or seagrass growth, survival, or propagation, and is not expected to result in population-level impacts.

3.7.3.2.2.4 Substressor Impact on Marine Vegetation as Essential Fish Habitat (Preferred Alternative)

Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, military expended materials used for training and testing activities may adversely affect Essential Fish Habitat by reducing the quality and quantity of marine vegetation that constitutes Essential Fish Habitat or Habitat Areas of Particular Concern. The HSTT Essential Fish Habitat Assessment states that any impacts of military expended materials on attached macroalgae or submerged rooted vegetation would be minimal and long-term, and any impacts on floating macroalgae would be minimal and short-term (U.S. Department of the Navy 2012).

3.7.3.2.3 Impacts from Seafloor Devices

For a discussion of the types of activities that use seafloor devices, where they are used, and how many activities would occur under each alternative, see Section 3.0.5.3.3.4 (Seafloor Devices). Six training and testing activities require the installation or removal of devices and infrastructure on the seafloor: (1) elevated causeway system and causeway pier insertion and retraction activities; (2) anti-terrorism/force protection underwater surveillance system training; (3) the installation of fixed intelligence, surveillance, and reconnaissance sensor systems; (4) precision anchoring training; (5) offshore petroleum discharge system training; and (6) salvage operations. Marine vegetation on the seafloor may be impacted by seafloor devices, while vegetation on the sea surface such as marine algal mats is not likely to be impacted; therefore, it will not be discussed further. Seagrasses and seafloor macroalgae in the Study Area may be impacted by the use of seafloor devices.

Seafloor device operation, installation, or removal could impact seagrass by physically removing vegetation (e.g., uprooting), crushing, temporarily increasing the turbidity (sediment suspended in the water) of waters nearby, or shading seagrass which may interfere with photosynthesis. If seagrass is not able to photosynthesize, its ability to produce energy is compromised. However, the intersection of seagrasses and seafloor devices is limited, and suspended sediments would settle in a few days. For seafloor devices, in particular, the potential for overlap with seagrass in the Study Area is limited to elevated causeway system and causeway pier insertion and retraction activities and offshore petroleum discharge system training activities. The bayside Bravo training area contains an estimated 1.13 ac. (0.45 ha) of eelgrass habitats; however, the designated Bravo Beach training lane (where the training activity would occur) is a previously disturbed and previously used zone within the Bay (see Figure 3.3-2).

3.7.3.2.3.1 No Action Alternative

Training Activities

Under the No Action Alternative, elevated causeway systems training in Bravo may remove eelgrass within the footprint of the pile. Furthermore, the Navy is participating in mitigation programs for eelgrass restoration if this type of disturbance occurs within eelgrass habitats (U.S. Department of the Navy 2011).

Four anti-terrorism/force protection underwater surveillance training events would occur every year in San Diego Bay. Typical events last five days, and day events may range from 8 to 24 hours per training day. These training activities would involve placing clump anchors around existing piers and ships. These areas are characterized as deep subtidal habitats greater than 20 ft. (6 m) in depth, subject to periodic dredging since the 1940s (U.S. Department of the Navy and San Diego Unified Port District 2011). These areas are too deep to support eelgrass.

Precision anchoring training events would occur 72 times per year within SSTC anchorages. Six offshore petroleum discharge system training events would occur every year. These training events would primarily occur in SSTC boat lanes, but may also occur in the Bravo Beach designated boat lane and waters outside of boat lanes in waters off SSTC.

Marine plant species found within the nearshore waters off San Diego and in waters around San Clemente Island are adapted to natural disturbance, and recover quickly from storms, as well as from wave and surge action. Bayside marine plant species, such as eelgrass, are found in areas where wave action is minimal. Pile driving and installation of seafloor devices may impact vegetation in benthic habitats, but the impacts would be temporary and would be followed by rapid (within a few weeks) recovery, particularly in oceanside boat lanes in nearshore waters off San Diego and in designated training areas adjoining San Clemente Island. However, opportunistic and potentially invasive vegetation could become established in disturbed areas. In bayside areas, recovery of eelgrass from direct disturbance by pile driving would occur over longer timeframes (e.g., over a period of months). Eelgrass beds show signs of recovery after a cessation of physical disturbance; the rate of recovery is a function of the severity of the disturbance (Neckles et al. 2005). The main factors that contribute to eelgrass recovery include improving water quality and cessation of major disturbance activities (e.g., dredging) (Chavez 2009). Pile driving and installation of seafloor devices, in contrast to dredging, have a minor impact limited to the area of the actual pile and footprint of the mooring.

Seafloor device installation in shallow water habitats under the No Action Alternative training activities would pose a negligible risk to marine vegetation. Any damage from seafloor devices would be followed

by a recovery period lasting weeks to months. Although marine vegetation growth near seafloor devices installed during training activities under the No Action Alternative would be inhibited during recovery, population-level impacts are unlikely because of the small, local impact areas, the frequency of training activities, and the wider geographic distribution of seagrasses in and adjacent to training areas.

Testing Activities

Testing activities under the No Action Alternative would install seafloor devices within the Study Area. Space and Naval Warfare Systems Command activities that may impact marine vegetation by installing seafloor devices include fixed system underwater communications testing (nine events in San Diego Bay, nine events at Point Loma and in Imperial Beach, and nine events in San Clemente Island Testing areas), fixed autonomous oceanographic research and meteorology and oceanography testing activities (45 events per year at Point Loma and Imperial Beach locations and 45 events in San Clemente Island Testing areas), and fixed intelligence, surveillance, and reconnaissance sensor system testing activities (9 events per year at Point Loma and Imperial Beach locations and 14 events in San Clemente Island Testing areas).

These testing activities would involve the temporary installation of several arrays on the seafloor, buried 2–6 in. (5–15 cm) in sandy seafloor substrates or suspended in the water column with a mooring structure. Typical tests last 5 days, and day events occur over an 8-hour period. Arrays may stay in the water for several months.

Seafloor devices installed in shallow-water habitats under the No Action Alternative testing activities would pose a negligible risk to marine vegetation. Any damage from deposition of military expended materials would be followed by a recovery period lasting weeks to months. Although marine vegetation growth near seafloor devices installed during testing activities under the No Action Alternative would be inhibited during recovery, population level impacts are unlikely because of the small, local impact areas, the frequency of testing activities, and the wider geographic distribution of seagrasses in and adjacent to testing areas.

3.7.3.2.3.2 Alternative 1

Training Activities

Under Alternative 1, no additional elevated causeway system training events or any other new activity that involves pile driving are proposed. Precision anchoring events within SSTC anchorages would remain the same as under the No Action Alternative, at 72 events per year. Offshore petroleum discharge system training would also remain the same as under the No Action Alternative, at six events per year, as would salvage operations training (remaining steady at three events per year). The number of anti-terrorism/force protection underwater surveillance training events would increase by two events per year (for a total of six events per year) in San Diego Bay over the number of training events for this activity under the No Action Alternative.

Seafloor devices installed in shallow-water habitats under Alternative 1 training activities would pose a negligible risk to marine vegetation. Any damage from deposition of military expended materials would be followed by a recovery period lasting weeks to months. Although marine vegetation growth near seafloor devices installed for training activities under Alternative 1 would be inhibited during recovery, the long-term survival, reproductive success, and lifetime reproductive success would not be impacted.

Testing Activities

Alternative 1 testing events would increase relative to the No Action Alternative. Fixed-system, underwater communications testing would increase by one event per year in each testing area used for this activity (San Diego Bay, Point Loma and Imperial Beach, and San Clemente Island testing areas). Fixed autonomous oceanographic research and meteorology and oceanography testing activities would increase by 10 events per year to account for 50 events in Point Loma and Imperial Beach locations and 50 events in San Clemente Island testing areas. Fixed intelligence, surveillance, and reconnaissance sensor system testing activities would increase by one event per year at Point Loma and Imperial Beach locations, and would increase by two per year at San Clemente Island testing areas. These activities also include bottom-crawling unmanned underwater vehicles (UUVs) and placement of mine shapes (non-explosive).

As noted previously, the Navy uses sandy substrates devoid of marine vegetation to the extent possible. Marine plant species found within San Diego Bay and in waters off San Clemente Island are adapted to natural disturbance, and recover quickly from storms, as well as to high-energy wave action and tidal surges in oceanside areas. As noted previously, eelgrass beds would require longer recovery periods in bayside areas.

Seafloor devices installed in shallow-water habitats during Alternative 1 testing activities would pose a negligible risk to marine vegetation. Any damage from deposition of military expended materials would be followed by a recovery period lasting weeks to months. Although marine vegetation growth in the vicinity of seafloor devices installed during testing activities under Alternative 1 would be inhibited during recovery, the long-term survival, reproductive success, and lifetime reproductive success would not be impacted.

3.7.3.2.3.3 Alternative 2

Training Activities

Under Alternative 2, no additional elevated causeway system training events or other new activities that involve pile driving are proposed. Precision anchoring events within SSTC anchorages would remain the same as under the No Action Alternative, at 72 events per year. Offshore petroleum discharge system training would also remain the same as under the No Action Alternative, at six events per year, as would salvage operations training (remaining at three events per year). Anti-terrorism/force protection underwater surveillance training would increase by two events per year (to six events per year) in San Diego Bay over the No Action Alternative.

Seafloor devices installed in shallow-water habitats during Alternative 2 training activities would pose a negligible risk to marine vegetation. Any damage from deposition of military expended materials would be followed by a recovery period lasting weeks to months. Although marine vegetation growth near seafloor devices installed during training activities under Alternative 2 would be inhibited during recovery, the long-term survival, reproductive success, or lifetime reproductive success would not be impacted.

Testing Activities

Alternative 2 testing events would increase relative to the No Action Alternative. Fixed-system underwater communications testing would increase by two events per year in each testing area used for this testing activity (San Diego Bay, Point Loma and Imperial Beach, and San Clemente Island testing areas). Fixed autonomous oceanographic research and meteorology and oceanography testing activities would increase by 20 events per year to account for 55 events in Point Loma and Imperial Beach

locations and 55 events in San Clemente Island testing areas. Fixed intelligence, surveillance, and reconnaissance sensor system testing activities would increase by two events per year at Point Loma and Imperial Beach locations and increase by four per year at San Clemente Island testing areas. These activities also include bottom-crawling UUVs and placement of mine shapes (non-explosive).

The Navy uses sandy substrates devoid of marine vegetation to the extent possible. Marine plant species found within San Diego Bay and in waters off San Clemente Island are adapted to natural disturbance, and recover quickly from storms, as well as to high-energy wave action and tidal surges in oceanside areas. As noted previously, eelgrass beds in bayside areas would require longer recovery periods.

Seafloor devices installed in shallow-water habitats during Alternative 2 testing activities would pose a negligible risk to marine vegetation. Any damage from deposition of military expended materials would be followed by a recovery period lasting weeks to months. Although marine vegetation growth in the vicinity of seafloor devices installed during testing activities under Alternative 2 would be inhibited during recovery, the long-term survival, reproductive success, or lifetime reproductive success would not be impacted.

3.7.3.2.3.4 Substressor Impact on Marine Vegetation as Essential Fish Habitat (Preferred Alternative)

Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of seafloor devices during training and testing activities would not affect floating macroalgae that constitutes Essential Fish Habitat or Habitat Areas of Particular Concern. The use of seafloor devices during training and testing activities may adversely affect Essential Fish Habitat by reducing the quality or quantity of attached macroalgae and submerged rooted vegetation that constitutes Essential Fish Habitat or Habitat Areas of Particular Concern. The HSTT Essential Fish Habitat Assessment report states that any impacts of seafloor devices on attached macroalgae or submerged rooted vegetation would be minimal and short-term (U.S. Department of the Navy 2012).

3.7.3.3 Secondary Stressors

This section analyzes potential impacts on marine vegetation exposed to stressors indirectly through changes in sediments and water quality. Section 3.1 (Sediments and Water Quality) considered the impacts on marine sediments and water quality from explosives and explosion by-products, metals, chemicals other than explosives, and other materials (marine markers, flares, chaff, targets, and miscellaneous components of other materials). One example of a local impact on water quality could be an increase in cyanobacteria associated with munitions deposits in marine sediments. Cyanobacteria may proliferate when iron is introduced to the marine environment, and this proliferation can negatively affect adjacent habitats by releasing toxins. Introducing iron into the marine environment from munitions or infrastructure is not known to cause toxic red tide events; rather, these harmful events are more associated with natural causes (e.g., upwelling) and the effects of other human activities (e.g., agricultural runoff and other coastal pollution) (Hayes et al. 2007; Whitton and Potts 2008).

The analysis included in Section 3.1 (Sediments and Water Quality) determined that neither state or federal standards or guidelines for sediments nor water quality would be violated by the No Action Alternative, Alternative 1, or Alternative 2. Because of these conditions, population-level impacts on marine vegetation are likely to be inconsequential and not detectable. Therefore, because these standards and guidelines are structured to protect human health and the environment, and the

proposed activities do not violate them, no indirect impacts are anticipated on marine vegetation from the training and testing activities proposed by the No Action Alternative, Alternative 1, or Alternative 2.

3.7.4 Summary of Potential Impacts (Combined Impacts from All Stressors) on Marine Vegetation

3.7.4.1 Combined Impacts of All Stressors

Activities described in this EIS/OEIS that have potential impacts on vegetation are widely dispersed, and not all stressors would occur simultaneously in a given location. The stressors that have potential impacts on marine vegetation include acoustic (underwater and surface explosions) and physical disturbances or strikes (vessels and in-water devices, military expended materials, and seafloor devices). Unlike mobile organisms, vegetation cannot flee from stressors once exposed. Marine algae are the most likely to be exposed to multiple stressors in combination because they occur over large expanses. Discrete locations in the Study Area (mainly within offshore areas with depths greater than 26 m (85 ft.) in portions of range complexes and testing ranges) could experience higher levels of activity involving multiple stressors, which could result in a higher potential risk for impacts on marine algae.

The potential for exposure of seagrasses and attached macroalgae to multiple stressors would be less because activities are not concentrated in coastal distributions (areas with depths less than 26 m [85 ft.]) of these species. The combined impacts of all stressors would not be expected to affect marine vegetation populations because: (1) activities involving more than one stressor are generally short in duration, (2) such activities are dispersed throughout the Study Area, and (3) activities are generally scheduled where previous activities have occurred. The aggregate effect on marine vegetation would not observably differ from existing conditions.

3.7.4.2 Essential Fish Habitat Determinations

Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of metal, chemical, and other material contaminants during training and testing activities would have no adverse impact on marine vegetation that constitutes Essential Fish Habitat or Habitat Areas of Particular Concern. The use of explosives and other impulsive sources, vessel movement, in-water devices, military expended materials, and seafloor devices during training and testing activities may adversely affect Essential Fish Habitat by reducing the quality and quantity of marine vegetation that constitutes Essential Fish Habitat or Habitat Areas of Particular Concern. The HSTT Essential Fish Habitat Assessment report states that individual stressor impacts on marine vegetation were either no effect or minimal, and ranged in duration from temporary to long-term, depending on the habitat impacted (U.S. Department of the Navy 2012).

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REFERENCES

Abbott, I. A. (1999). Marine Red Algae of the Hawaiian Islands. Honolulu, Hawaii: Bishop Museum Press.

Adams, A. J., Locascio, J. V. & Robbins, B. D. (2004). Microhabitat use by a post-settlement stage estuarine fish: Evidence from relative abundance and predation among habitats. *Journal of Experimental Marine Biology and Ecology, 299*, 17-33. doi:10.1016/j.jembe.2003.08.013

Allen, J. A. (1998). Mangroves as alien species: The case of Hawaii. *Global Ecology and Biogeography Letters, 7*(1), 61-71.

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

Bouillon, S. (2009). Mangroves D. d. A. Laffoley and G. Grimsditch (Eds.), *The management of natural coastal carbon sinks*. (pp. 13-20). Prepared by I. U. f. C. o. Nature.

Castro, P. & Huber, M. E. (2000). Marine prokaryotes, protists, fungi, and plants. In *Marine Biology* (3rd ed., pp. 83-103). McGraw-Hill.

Center for Disease Control and Prevention. (2004). Red Tide: Harmful Algal Blooms. Retrieved from http://www.cdc.gov/hab/redtide/pdfs/about.pdf, as accessed on 29 October, 2011.

Chavez, E. (2009). 2008 San Diego Bay Eelgrass Inventory and Bathymetry Update. San Diego Unified Port District Environmental Advisory Committee. Presented by Eric Chavez, National Marine Fisheries Service. September 10, 2009.

Cheroske, A. G., Williams, S. L. & Carpenter, R. C. (2000). Effects of physical and biological disturbances on algal turfs in Kaneohe Bay, Hawaii. *Journal of Experimental Marine Biology and Ecology, 248*, 1-34.

Chmura, G. L. (2009). Tidal Salt Marshes D. d. A. Laffoley and G. Grimsditch (Eds.), *The management of natural coastal carbon sinks*. (pp. 5-11). Prepared by I. U. f. C. o. Nature.

Culbertson, J. B., Valiela, I., Pickart, M., Peacock, E. E. and Reddy, C. M. (2008). Long-term consequences of residual petroleum on salt marsh grass. *Journal of Applied Ecology, 45*(4), 1284-1292. doi: 10.1111/j.1365-2664.2008.01477.x

Dawes, C. J. (1998). *Marine Botany* (2nd ed.). New York, NY: John Wiley and Sons, Inc.

Dawes, C. J., Andorfer, J., Rose, C., Uranowski, C. and Ehringer, N. (1997). Regrowth of the seagrass Thalassia testudinum into propeller scars. *Aquatic Botany, 59*(1-2), 139-155. 10.1016/s0304-3770(97)00021-1 Retrieved from http://www.sciencedirect.com/science/article/pii/S0304377097000211

Dayton, P. K. (1985). Ecology of kelp communities. *Annual Review of Ecology and Systematics, 16*, 215-245. doi:10.1146/annurev.es.16.110185.001243

Dreyer, G. D. and Niering, W. A. (1995). Tidal marshes of Long Island Sound: Ecology, history and restoration. [Electronic]. *Connecticut Aboretum Bulletin, 34*, 2. Retrieved from http://www.conncoll.edu/ccrec/greennet/arbo/publications/34/frame.htm

Feller, I. C., Lovelock, C. E., Berger, U., McKee, K. L., Joye, S. B. and Ball, M. C. (2010). Biocomplexity in mangrove ecosystems. *Annual Review of Marine Science, 2*(1), 395-417. doi:10.1146/annurev.marine.010908.163809

Friedlander, A., Aeby, G., Brown, E., Clark, A., Coles, S., Dollar, S., Wiltse, W. (2005). The state of coral reef ecosystems of the main Hawaiian islands. In J. Waddell (Ed.), *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005*. (NOAA Technical Memorandum NOS NCCOS 11, pp. 222-269). Silver Spring, MD: NOAA/NCCOS Center for Coastal Monitoring and Assessment's Biogeography Team.

Garrison, T. (2004). *Essentials of Oceanography* (3rd ed.). Pacific Grove, CA: Brooks/Cole-Thomas Learning.

Global Invasive Species Database. (2005). *List of invasive marine algae in California*. [Online database] Invasive Species Specialist Group of the IUCN Species Survival Commission. Retrieved from http://www.issg.org/database/species/search.asp?sts=sss&st=sss&fr=1&sn=&rn=California&hci=8&ei=186&lang=EN&Image1.x=22&Image1.y=12, 05 September 2010.

Green, E. P. and Short, F. T. (2003). *World Atlas of Seagrasses* (pp. 298). Berkeley, California: University of California Press.

Harborne, A.R., P.J. Mumby, F. Micheli, C.T. Perry, C.P. Dahlgren, K.E. Holmes, & D.R. Brumbaugh. (2006). The Functional Value of Caribbean Coral Reef, Seagrass and Mangrove Habitats to Ecosystem Processes. *Advances in Marine Biology Volume 50*.

Hayes, M. O., Hoff, R., Michel, J., Scholz, D. and Shigenaka, G. (1992). *An Introduction to Coastal Habitats and Biological Resources for Oil Spill Response*. (Report No. HMRAD 92-4, pp. 401). Seattle, WA: U. S. Department of Commerce, National Oceanic and Atmospheric Administration, Hazardous Materials Response and Assessment Division.

Hayes, P. K., El Semary, N. A. & Sanchez-Baracaldo, P. (2007). The taxonomy of cyanobacteria: Molecular insights into a difficult problem. In J. Brodie and J. Lewis (Eds.), *Unravelling the Algae: The Past, Present, and Future of Algal Systematics* (pp. 93-102). Boca Raton, FL: CRC Press.

Heck, K. L., Jr, Hays, G. & Orth, R. J. (2003). Critical evaluation of the nursery role hypothesis for seagrass meadows. *Marine Ecology Progress Series, 253*, 123-136.

Hemminga, M. and Duarte, C. (2000). Seagrasses in the human environment. In *Seagrass Ecology* (pp. 248-291). Cambridge, UK: Cambridge University Press.

Hoff, R., Hensel, P., Proffitt, E. C., Delgado, P., Shigenaka, G., Yender, R., et al. (Eds.). (2002). *Oil Spills in Mangroves: Planning & Response Considerations*. (pp. 72). Silver Spring, MD: U. S. Department of Commerce, National Oceanic and Atmospheric Administration, Ocean Service, Office of Response and Restoration.

Howard, V. (2008). *Spartina alterniflora*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. Retreived from: http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=1125, on 31 October 2011.

International Union for Conservation of Nature. (2011). IUCN Red List of Threatened Species. Version 2011.2. Retrieved from: www.iucnredlist.org, as accessed on 10 November 2011.

Kenworthy, W. J., Durako, M. J., Fatemy, S. M. R., Valavi, H. and Thayer, G. W. (1993). Ecology of seagrasses in northeastern Saudi Arabia one year after the Gulf War oil spill. *Marine Pollution Bulletin, 27*, 213-222. doi: 10.1016/0025-326x(93)90027-h

Kudela, R., Cochlan, W. & Roberts, A. (2004). Spatial and temporal patterns of *Pseudo-nitzschia* spp. in central California related to regional oceanography. In K. A. Steidinger, J. H. Landsberg, C. R. Tomas and G. A. Vargo (Eds.), *Harmful Algae 2002* (pp. 347-349). St. Petersburg, FL: Florida Fish and Wildlife Conservation Commission, Florida Institute of Oceanography, and Intergovernmental Oceanographic Commission of UNESCO.

Kudela, R. M. & Cochlan, W. P. (2000). Nitrogen and carbon uptake kinetics and the influence of irradiance for a red tide bloom off southern California. *Aquatic Microbial Ecology, 21*, 31-47.

Laffoley, D. d. A. and Grimsditch, G. (2009). Introduction D. d. A. Laffoley and G. Grimsditch (Eds.), *The management of natural coastal carbon sinks*. (pp. 1-3). Prepared by I. U. f. C. o. Nature.

Leet, W. S., Dewees, C. M., Klingbeil, R. & Larson, E. J. (Eds.). (2001). *California's Living Marine Resources: A Status Report*. (pp. 588) California Department of Fish and Game.

Levinton, J. (2009a). Environmental impacts of industrial activities and human populations. In *Marine Biology: Function, Biodiversity, Ecology* (3rd ed., pp. 564-588). New York, NY: Oxford University Press.

Levinton, J. (2009b). Seaweeds, sea grasses, and benthic microorganisms. In *Marine Biology: Function, Biodiversity, Ecology* (3rd ed., pp. 309-320). New York: Oxford University Press.

Levinton, J. (2009c). The water column: Plankton. In *Marine Biology: Function, Biodiversity, Ecology* (3rd ed., pp. 167-186). New York: Oxford University Press.

Mach, K. J., Hale, B. B., Denny, M. W. & Nelson, D. V. (2007, July). Death by small forces: a fracture and fatigue analysis of wave-swept macroalgae. Journal of Experimental Biology, 210(13), 2231-2243. 10.1242/jeb.001578 Retrieved from http://jeb.biologists.org/content/210/13/2231.abstract.

Maragos, J. E. (2000). Hawaiian Islands (U.S.A.). In C. R. C. Sheppard (Ed.), *Seas at the Millenium: An Environmental Evaluation* (Vol. II. Regional Chapters: The Indian Ocean to the Pacific, pp. 791-812). Elsevier Science Ltd.

Miller, K., Engle, J., Uwai, S. & Kawai, H. (2007). First report of the Asian seaweed *Sargassum filicinum* Harvey (Fucales) in California, USA. *Biological Invasions, 9*(5), 609-613. 10.1007/s10530-006-9060-2

Mitsch, W. J., Gosselink, J. G., Anderson, C. J. and Zhang, L. (2009). *Wetland Ecosystems* (pp. 295). Hoboken, NJ: John Wiley & Sons, Inc.

Monterey Bay Aquarium Research Institute. (2009, Last updated 5 February 2009). *Marine Flora of Monterey*. [Web page]. Retrieved from http://www.mbari.org/staff/conn/botany/flora/mflora.htm, 5 September 2010.

National Centers for Coastal Ocean Science. (2010, Last updated April 2010). *Economic Impacts of Harmful Algal Blooms*. [Fact sheet] Center for Sponsored Coastal Ocean Research. Retrieved from http://www.cop.noaa.gov/stressors/extremeevents/hab/current/econimpact_08.pdf

National Marine Fisheries Service. (2002). *Final recovery plan for Johnson's seagrass (Halophia johnsonni)*. (pp. 134). Silver Spring, MD. Prepared by the Johnson's seagrass recovery team. Prepared for [NMFS] National Marine Fisheries Service.

National Oceanic and Atmospheric Administration. (2001). *Seagrasses: An Overview for Coastal Managers*. (pp. 20) NOAA Coastal Services Center.

Neckles, H.A., F.T. Short, S. Barker, & B.S. Kopp. (2005). Disturbance of eelgrass *Zostera marina* by commercial mussel *Mytilus edulis* harvesting in Maine: dragging impacts and habitat recovery.

Parrish, F. A. & Boland, R. C. (2004). Habitat and reef-fish assemblages of banks in the Northwestern Hawaiian Islands. *Marine Biology, 144*, 1065-1073. doi:10.1007/s00227-003-1288-0

Peterson, C. H. (2001). The "Exxon Valdez" oil spill in Alaska: Acute, indirect and chronic effects on the ecosystem. In A. J. Southward, P. A. Tyler, C. M. Young and L. A. Fuiman (Eds.), *Advances in Marine Biology* (Vol. 39, pp. 1-103). San Diego, CA: Academic Press. doi: 10.1016/S0065-2881(01)39008-9

Phillips, R. C. & Meñez, E. G. (1988). Seagrasses. *Smithsonian Contributions to the Marine Sciences, 34*, 104.

Preskitt, L. (2001). *Halophila hawaiiana*. In *Invasive Marine Algae of Hawai'i*. [Web page] University of Hawai'i at Manoa Department of Botany. Retrieved from http://www.hawaii.edu/reefalgae/invasive_algae/seagrasses/halophia_hawaiiana.htm

Preskitt, L. (2002a). *Edible* Limu*: Gifts from the Sea*. [Poster] University of Hawai'i at Manoa Department of Botany. Retrieved from http://www.hawaii.edu/reefalgae/publications/ediblelimu/index.htm, 05 September 2010.

Preskitt, L. (2002b). *Halophila decipiens*. In *Invasive Marine Algae of Hawai'i*. [Web page] University of Hawaiʻi at Manoa Department of Botany. Retrieved from http://www.hawaii.edu/reefalgae/invasive_algae/seagrasses/halophila_decipiens.htm, 16 June 2010.

Preskitt, L. (2010). *Invasive Marine Algae of Hawai'i*. [Web page] University of Hawai'i at Manoa Department of Botany. Retrieved from http://www.hawaii.edu/reefalgae/invasive_algae/INDEX.HTM, 05 September 2010.

Rodriguez, S., Santiago, A. R. T. & Shenker, G. (2001). *A Public-Access GIS-Based Model of Potential Species Habitat Distribution for the Santa Barbara Channel and the Channel Islands National Marine Sanctuary.* (Master's group project). University of California, Santa Barbara.

Ruwa, R. K. (1996). Intertidal wetlands. In T. R. McClanahan and T. P. Young (Eds.), *East African Ecosystems and Their Conservation* (pp. 101-130). New York, New York: Oxford University Press.

Sargent, F. J., Leary, T. J., Crewz, D. W. and Kruer, C. R. (1995). Scarring of Florida's Seagrasses: Assessment and Management Options *Technical Report*. Florida Department of Environmental Protection.

Schnetzer, A., Miller, P. E., Schaffner, R. A., Stauffer, B. A., Jones, B. H., Weisberg, S. B., Caron, D. A. (2007). Blooms of *Pseudo-nitzschia* and domoic acid in the San Pedro Channel and Los Angeles harbor areas of the Southern California Bight, 2003-2004. *Harmful Algae, 6*, 372-387. doi:10.1016/j.hal.2006.11.004

Schoener, A. and Rowe, G. T. (1970). Pelagic Sargassum and its presence among the deep-sea benthos. *Deep-Sea Research, 17*, 923-925.

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

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

Spalding, M., Taylor, M., Ravilious, C., Short, F. & Green, E. (2003). Global overview: The distribution and status of seagrasses. In E. P. Green and F. T. Short (Eds.), *World Atlas of Seagrasses* (pp. 5-26). Berkeley, CA: University of California Press.

Steneck, R. S., Graham, M. H., Bourque, B. J., Corbett, D., Erlandson, J. M., Estes, J. A., et al. (2002). Kelp forest ecosystems: Biodiversity, stability, resilience and future. *Environmental Conservation, 29*(4), 436-459. doi:10.1017/S0376892902000322

Sze, P. (1998). Cyanobacteria. In *A Biology of the Algae* (3rd ed., pp. 21-38). McGraw-Hill.

U.S. Department of the Navy. (1998). *Pacific Missile Range Facility Enhanced Capability Final Environmental Impact Statement*. Volume 1 of 3, December.

U.S. Department of the Navy. (2005). *Marine Resources Assessment for the Hawaiian Islands Operating Area, Final Report*. Prepared for the Department of the Navy, Commander, U.S. Pacific Fleet, December.

U.S. Department of the Navy. (2011). *San Diego Bay Integrated Natural Resources Management Plan*. San Diego, CA. Prepared by Tierra Data Systems, Escondido, CA.

U.S. Department of the Navy. (2012). *Hawaii Training and Testing Essential Fish Habitat Assessment.* Preparend for Commander, Prepared for the Department of the Navy, Commander, U.S. Pacific Fleet.

U.S. Department of the Navy and San Diego Unified Port District. (2011). San Diego Bay Integrated Natural Resources Management Plan, Draft November 2011. San Diego, California. Prepared by Tierra Data Inc., Escondido, California.

U.S. National Response Team. (2010). *What are the Effects of Oil on Seagrass?* [Electronic Pamphlet] U. S. Environmental Protection Agency, Region IV. Retrieved from http://www.nrt.org/production/NRT/RRTHome.nsf/resources/RRTIV-Pamphlets/$File/27_RRT4_Seagrass_Pamphlet.pdf

Veron, J. (2000). Corals of the World. Vol 3. Australia: Australian Institute of Marine Sciences and CRR Qld Pty Ltd.

Waggoner, B. & Speer, B. R. (1998, Last updated August 1998). *Introduction to the Dinoflagellata*. [Web page] University of California Museum of Paleontology. Retrieved from http://www.ucmp.berkeley.edu/protista/dinoflagellata.html, 05 September 2010.

Wilson, C. (2002, Last updated September 2002). *Giant Kelp (*Macrocystis pyrifera*)*. [Web page] California Department of Fish and Game. Retrieved from http://www.dfg.ca.gov/mlpa/response/kelp.pdf.

Whitton, B. A. & Potts, M. (2008). *The Ecology of Cyanobacteria: Their Diversity in Time and Space*. Kluwer Academic Publishers.

Wyllie-Echeverria, S. & Ackerman, J. D. (2003). The seagrasses of the Pacific coast of North America. In E. P. Green and F. T. Short (Eds.), *World Atlas of Seagrasses* (pp. 199-206). Berkeley, CA: University of California Press.

Zaitsev, Y.P. (1971). Marine neustonology. Translation by A. Mercado. Jerusalém: Israel Program for Scientific Translations. 207 p.

3.8 Marine Invertebrates

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3.8 MARINE INVERTEBRATES

MARINE INVERTEBRATES SYNOPSIS

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

- Acoustic (sonar and other active acoustic sources, underwater explosives)
- Energy (electromagnetic devices)
- Physical disturbance and strike (vessels and in-water devices, military expended materials, seafloor devices)
- Entanglement (fiber optic cables and guidance wires, parachutes)
- Ingestion (military expended materials)
- Secondary

Preferred Alternative (Alternative 2)

- Acoustics: Pursuant to the Endangered Species Act (ESA), the use of sonar and other active acoustic sources would have no effect on ESA-listed black abalone (*Haliotis cracherodii*) or white abalone (*Haliotis sorenseni*) species or on ESA-listed coral species. Underwater explosives may affect but are not likely to adversely affect black abalone or white abalone, and would have no effect on ESA-listed coral species. Acoustic stressors would have no effect on designated critical habitat.
- Energy: Pursuant to the ESA, the use of electromagnetic devices would have no effect on ESA-listed black abalone, white abalone or coral species. Energy stressors would have no effect on designated critical habitat.
- Physical Disturbance and Strike: Pursuant to the ESA, the use of vessels and in-water devices, military expended materials, and seafloor devices may affect but is not likely to adversely affect ESA-listed black abalone and white abalone, and would have no effect on coral species proposed for ESA listing. Physical disturbance and strike stressors would have no effect on designated critical habitat.
- Entanglement: Pursuant to the ESA, the use of fiber optic cables and guidance wires, and parachutes would have no effect on ESA-listed black abalone, white abalone or coral species. Entanglement stressors would have no effect on designated critical habitat.
- Ingestion: Pursuant to the ESA, the potential for ingestion of military expended materials would have no effect on ESA-listed black abalone, white abalone or coral species.
- Secondary: Pursuant to the ESA, secondary stressors may affect, but are not likely to adversely affect, ESA-listed black abalone and white abalone, and would not affect coral species proposed for ESA listing. Secondary stressors would have no effect on designated critical habitat.

MARINE INVERTEBRATES SYNOPSIS

Preferred Alternative (Alternative 2, continued)

- Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of sonar and other active acoustic sources; electromagnetic sources; vessel movement; in-water devices; and metal, chemical, or other material contaminants will have no adverse effect on sedentary invertebrate beds or reefs that constitute Essential Fish Habitat or Habitat Areas of Particular Concern. The use of explosives, pile driving, military expended materials, seafloor devices, and explosives and explosive byproduct contaminants may have an adverse effect on Essential Fish Habitat by reducing the quality and quantity of sedentary invertebrate beds or reefs that constitute Essential Fish Habitat or Habitat Areas of Particular Concern.

3.8.1 INTRODUCTION

In this Environmental Impact Statement/Overseas Environmental Impact Statement, marine invertebrates are evaluated based on their distribution and life history relative to the stressor or activity being considered. Activities are evaluated for their potential impact on marine invertebrates in general, and are evaluated by taxonomic and regulatory groupings as appropriate.

Invertebrates are animals without backbones, and marine invertebrates are a large, diverse group of at least 50,000 species (Brusca and Brusca 2003). Many of these species are important to humans ecologically and economically, providing essential ecosystem services (coastal protection) and income from tourism and commercial and recreational fisheries (Spalding et al. 2001). Because marine invertebrates occur in all habitats, activities that affect the water column or the seafloor could impact numerous zooplankton (invertebrates not generally visible to the naked eye), eggs, larvae, larger invertebrates living in the water column, and benthic invertebrates that live on or in the seafloor. The greatest densities of marine invertebrates are usually on the seafloor (Sanders 1968); therefore, activities that contact the seafloor have a greater potential for impact.

The following subsections briefly introduce the Endangered Species Act (ESA)-listed species, federally managed species, habitat types, and major taxonomic groups of marine invertebrates in the Study Area. Federally managed marine invertebrate species regulated under the Magnuson-Stevens Fishery Conservation and Management Act are described in the Hawaii-Southern California Training and Testing (HSTT) Essential Fish Habitat Assessment. The National Oceanic and Atmospheric Administration Fisheries Office of Protected Resources maintains a website that provides additional information on the biology, life history, species distribution (including maps), and conservation of invertebrates.

3.8.1.1 Endangered Species Act-Listed Species

In response to a petition from the Center for Biological Diversity to list under the ESA and designate critical habitat for species of coral, National Marine Fisheries Service (NMFS) reviewed the status of 82 “candidate species” of corals. Candidate species are those petitioned species that are actively being considered for listing as endangered or threatened under the ESA, as well as those species for which

NMFS has initiated an ESA status review that it has announced in the Federal Register. In April 2012, NMFS completed a status review report and draft Management Report of the candidate species of corals. On 7 December 2012, NMFS published a proposed rule with the determination that 66 of these 82 species warrant listing under the ESA as either threatened or endangered. Four of these species occur within the Study Area in waters off the coast of Hawaii and are currently proposed under the ESA as threatened.[1] Of the species determined to not warrant listing as either threatened or endangered, five coral species are found in waters off the coast of Hawaii, and are discussed under Section 3.8.2.11 (Corals, Hydroids, Jellyfish [Phylum Cnidaria]). In waters off the coast of California and within the Study Area, two marine invertebrate species (the black abalone and the white abalone) are endangered under the ESA. NMFS also considers two other marine invertebrate found in waters off of California and within the Study Area as species of concern.

The status and presence of these species in the Study Area are listed in Table 3.8-1. Profiles of the endangered abalone species and a group profile of the four coral species currently proposed as threatened under the ESA are provided in Sections 3.8.2.3 through 3.8.2.9. Emphasis on species-specific information in the following species descriptions will be placed on the two ESA-protected species because any threats to or potential impacts on those species are subject to consultation with regulatory agencies.

Table 3.8-1: Status of Endangered Species Act-Listed and Species Proposed for Endangered Species Act Listing within the Study Area

Species Name and Regulatory Status			Presence in Study Area		
Common Name	**Scientific Name**	**Endangered Species Act Status**	**Open Ocean Area/ Transit Corridor**	**California Current**	**Insular Pacific-Hawaiian**
Black abalone	*Haliotis cracherodii*	Endangered	No	Yes	No
White abalone	*Haliotis sorenseni*	Endangered	No	Yes	No
Fuzzy table coral	*Acropora paniculata*	Proposed Threatened	No	No	Yes
Irregular rice coral (Hawaiian reef coral)	*Montipora dilitata*	Proposed Threatened	No	No	Yes
Blue rice coral	*Montipora flabellate*	Proposed Threatened	No	No	Yes
Sandpaper rice coral	*Montipora patula*	Proposed Threatened	No	No	Yes

3.8.1.2 Federally Managed Species

Federally managed species of marine invertebrates likely to occur within the Study Area are listed in Table 3.8-2. In the context of federally managed species, the term "fishery" applies to any biologically generated object extracted from the ocean (e.g., there is a lobster "fishery" even though the animals are

[1] Proposed species are those candidate species that were found to warrant listing as either threatened or endangered and were officially proposed as such in a Federal Register notice after the completion of a status review and consideration of other protective conservation measures. Public comment is always sought on a proposal to list species under the ESA. NMFS generally has 1 year after a species is proposed for listing under the ESA to make a final determination whether to list a species as threatened or endangered.

not fish). Assessments in Section 3.8.3 (Environmental Consequences) combine federally managed species with the rest of their taxonomic group, unless impacts or differential effects warrant separate treatment. The analysis of impacts on commercial and recreational fisheries is provided in Section 3.11 (Socioeconomics).

Table 3.8-2: Federally Managed Marine Invertebrate Species with Essential Fish Habitat within the Study Area, Covered under Each Fishery Management Plan

Pacific Fishery Management Council	
Pacific Coast Coastal Pelagic Species Fishery Management Plan	
Common Name	**Scientific Name**
Market squid	*Loligo opalescens*
Western Pacific Fishery Management Council	
Fishery Ecosystem Plan for the Hawaii Archipelago	
Common Name	**Scientific Name**
Hawaiian spiny lobster	*Panulirus marginatus*
Spiny lobster	*Panulirus penicillatus*
Ridgeback slipper lobster	*Scyllarides haanii*
Chinese slipper lobster	*Parribacus antarcticus*
Kona crab	*Ranina ranina*
Deepwater shrimp	*Heterocarpus* spp.
Pink coral	*Corallium secundum, Corallium laauense*
Red coral	*Corallium regale*
Midway deepsea coral	*Corallium* sp nov.
Gold coral	*Gerardia* spp., *Callogorgia gilberti, Narella* spp., *Calyptrophora* spp.
Bamboo coral	*Lepidisis olapa, Acanella* spp.
Black coral	*Antipathes dichotoma, Antipathis granids, Antipathes ulex*

3.8.1.3 Taxonomic Groups

All marine invertebrate taxonomic groups are represented in the Study Area. Major invertebrate phyla (taxonomic range)—those with greater than 1,000 species (Appeltans et al. 2010)—and the general zones they inhabit in the Study Area are listed in Table 3.8-3. Throughout the marine invertebrate section, organisms may be referred to by their phylum name or, more generally, as marine invertebrates.

Table 3.8-3: Major Taxonomic Groups of Marine Invertebrates in the Hawaii-Southern California Training and Testing Study Area

Major Invertebrate Groups[1]		Presence in Study Area[2]	
Common Name (Species Group)	**Description**	**Open Ocean**	**Coastal Waters**
Foraminifera, radiolarians, ciliates (Phylum Foraminifera)	Benthic and pelagic single-celled organisms; shells typically made of calcium carbonate or silica.	Water column, seafloor	Water column, seafloor
Sponges (Phylum Porifera)	Benthic animals; large species have calcium carbonate or silica structures embedded in cells to provide structural support.	Seafloor	Seafloor
Corals, hydroids, jellyfish (Phylum Cnidaria)	Benthic and pelagic animals with stinging cells.	Water column, seafloor	Water column, seafloor

Table 3.8-3: Major Taxonomic Groups of Marine Invertebrates in the Hawaii-Southern California Training and Testing Study Area (continued)

Major Invertebrate Groups[1]		Presence in Study Area[2]	
Common Name (Species Group)	**Description**	**Open Ocean**	**Coastal Waters**
Flatworms (Phylum Platyhelminthes)	Mostly benthic; simplest form of marine worm with a flattened body.	Water column, seafloor	Water column, seafloor
Ribbon worms (Phylum Nemertea)	Benthic marine worms with a long extension from the mouth (proboscis) from the mouth that helps capture food.	Water column, seafloor	Seafloor
Round worms (Phylum Nematoda)	Small benthic marine worms; many live in close association with other animals (typically as parasites).	Water column, seafloor	Water column, seafloor
Segmented worms (Phylum Annelida)	Mostly benthic, highly mobile marine worms; many tube-dwelling species.	Seafloor	Seafloor
Bryozoans (Phylum Bryozoa)	Lace-like animals that exist as filter feeding colonies attached to the seafloor and other substrates.	Seafloor	Seafloor
Cephalopods, bivalves, sea snails, chitons (Phylum Molluska)	Mollusks are a diverse group of soft-bodied invertebrates with a specialized layer of tissue called a mantle. Mollusks such as squid are active swimmers and predators, while others such as sea snails are predators or grazers and clams are filter feeders.	Water column, seafloor	Water column, seafloor
Shrimp, crab, lobster, barnacles, copepods (Phylum Arthropoda – Crustacea)	Benthic or pelagic; some are immobile; with an external skeleton; all feeding modes from predator to filter feeder.	Water column, seafloor	Water column, seafloor
Sea stars, sea urchins, sea cucumbers (Phylum Echinodermata)	Benthic predators and filter feeders with tube feet.	Seafloor	Seafloor

[1] Major species groups (those with more than 1,000 species) are based on the World Register of Marine Species (Appeltans et al. 2010) and Catalogue of Life (Bisby et al. 2010).

[2] Presence in the Study Area includes open ocean areas (North Pacific Gyre and North Pacific Transition Zone) and coastal waters of two Large Marine Ecosystems (California Current and Insular-Pacific Hawaiian).

Notes: Benthic = A bottom-dwelling organism; Pelagic = relating to, living, or occurring in the waters of the ocean or the open sea.

3.8.2 AFFECTED ENVIRONMENT

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

Marine invertebrates in the Hawaii Range Complex (HRC) portion of the Study Area inhabit coastal waters and seafloor habitats, including rocky intertidal zones, coral reefs, deep-water slopes, canyons, and seamounts. The intertidal zone is exposed to air at low tide and covered by water at high tide. Inhabitants of the rocky, wave-beaten intertidal zone include species such as helmet urchins

(*Colobocentrotus atratus*) and limpets (Zabin 2003). At least 15 species of intertidal crab live in sandy beaches in the intertidal zone, feeding on algae and detritus (Waikiki Aquarium 2009a).

Corals are the primary living structural components of Hawaii's subtidal zone, with an average of about 20.3 percent coral coverage in the main Hawaiian Islands (Friedlander et al. 2005). Approximately 250 species of corals are found within the main Hawaiian Islands (Maragos et al. 2004). Six species of corals dominate Hawaiian waters: lobe coral (*Porites lobata*), finger coral (*Porites compressa*;), rice coral (*Montipora capitata*), sandpaper rice coral (*Montipora patula*), cauliflower coral (*Pocillopora meandrina*;), and blue rice coral (*Montipora flabellate*) (Friedlander et al. 2005). Blue rice coral is proposed for ESA listing (see Table 3.8-1). The Northwestern Hawaiian Islands have at least 57 species of stony coral, including seven genera of the table coral *Acropora*, which is rare in the main Hawaiian Islands but abundant and widespread in the French Frigate Shoals region (Maragos et al. 2004).

The coral reefs of the Northwestern Hawaiian Islands support diverse communities of bottom-dwelling invertebrates. Over 800 non-coral invertebrate species have been identified from the Northwestern Hawaiian Islands. Mollusks, echinoderms, and crustaceans dominate, representing 80 percent of the invertebrate species (Friedlander et al. 2005). Five species of lobster occur in Hawaii, primarily within the subtidal zone, although their range can extend slightly deeper. Four species occur throughout the tropical oceans of the world (Waikiki Aquarium 2009c), while the Hawaiian spiny lobster (*Panulirus marginatus*) is found only in Hawaii and Johnston Atoll (Polovina et al. 1999). Deepwater corals in the HRC portion of the Study Area include black corals, pink corals, red corals, gold coral, and bamboo coral. These species attach to relatively steep banks with strong currents that provide a steady stream of small algae and animals that drift in the water (plankton) to feed on, as well as minimal sedimentation that would inhibit colonization and growth of these slow-growing species (Grigg 1993).

Marine invertebrates in the Southern California portion of the Study Area inhabit coastal waters and benthic habitats, including salt marshes, kelp forests, soft sediments, canyons, and the continental shelf. Salt marsh invertebrates include oysters (such as the Olympia oyster [*Ostreola conchaphila*]), crabs, and worms that are important prey for birds and small mammals. Mudflats provide habitat for substantial amounts of crustaceans, bivalves, and worms. Representative species include various species of ghost shrimp and marine worms, California jackknife clams (*Ensis myrae*), and California horn snails (*Cerithidea californica*). Sand flats are dominated by bivalves such as heart cockle (*Corculum cardissa*), white-sand clam (*Macoma secta*), and bent-nosed clam (*Macoma nasuta*) (Proctor et al. 1980). The sandy intertidal area is dominated by species that are highly mobile and can burrow. The most common invertebrates are the common sand crab, isopods, talitrid amphipods, polychaetes, Pismo clam (*Tivela stultorum*), bean clam (*Donax gouldii*), and purple olive snail (*Olivella biplicata*) (Dugan et al. 2000).

More than 260 species of sponges, hydroids, sea fans, mollusks, echinoderms, and ascidians (sea squirts) have been identified in the subtidal rocky reefs of central and Southern California (Chess and Hobson 1997). Rock oysters and mussels dominate the tops of rocky reefs. The orange cup coral (*Balanophyllia elegans*) is a common stony coral in hard-bottom habitats of the shallow subtidal zones of the Study Area (Bythell 1986; Kushner et al. 1999). At greater depths, there are calcareous bryozoans, sea fans, stony corals, purple sea urchins, rock scallops, and red abalone (Chess and Hobson 1997).

The Channel Islands, located off the coast of Southern California, are situated in a transitional location between cold and warm water (National Oceanic and Atmospheric Administration 2007). Four of the southern Channel Islands (Santa Barbara, Santa Catalina, San Nicolas, and San Clemente islands) are within the Southern California portion of the Study Area. This area is diverse in invertebrates, supporting

over 5,000 species. The dominant taxa include sea lilies, crabs, lobsters, basket stars, brittle stars, brachiopods, sea urchins, anemones, and salps (Tissot et al. 2006). This diversity is supported by a number of structure-forming invertebrates, including black corals, sea whips, and sponges. Diversity among marine invertebrate species appears greatest for black corals (Tissot et al. 2006). The 17 known species of stony corals include two species that are endemic to the area, flower coral (*Nomlandia californica*) and tree coral (*Dendrophyllia californica*) (Cairns 1994).

The soft-bottom sediments of California's estuarine communities are highly productive, with a high diversity of invertebrates. Representative organisms in the soft-bottom communities of California estuaries, such San Diego Bay, include crustaceans (e.g., caridean or bay shrimps, Pacific razor clams, gaper clams, Washington clams, littleneck clams, and blue mussels) (Emmett et al. 1991; Kalvass 2001). Marine worms, crustaceans, and mollusks are the dominant invertebrates living on and in the soft-bottom sediment and the submerged aquatic vegetation of San Diego Bay (U.S. Department of the Navy 2011).

3.8.2.1 Invertebrate Hearing and Vocalization

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

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

Both behavioral and auditory brainstem response studies suggest that crustaceans may sense sounds up to three kilohertz (kHz), but best sensitivity is likely below 200 Hertz (Hz) (Lovell et al. 2005; Lovell et al. 2006; Goodall et al. 1990). Most cephalopods (e.g., octopus and squid) likely sense low-frequency sound below 1,000 Hz, with best sensitivities at lower frequencies (Budelmann 2010; Mooney et al. 2010; Packard et al. 1990). A few cephalopods may sense higher frequencies up to 1,500 Hz (Hu et al. 2009). Squid did not respond to toothed whale ultrasonic echolocation clicks at sound pressure levels ranging from 199 to 226 decibels (dB) referenced to (re) 1 μ (micro) Pascal (Pa) peak-to-peak, likely because these clicks were outside of squid hearing range (Wilson et al. 2007). However, squid exhibited

alarm responses when exposed to broadband sound from an approaching seismic airgun with received levels exceeding 145 to 150 dB re 1 µPa root mean square (McCauley et al. 2000b).

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

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

3.8.2.2 General Threats

General threats to marine invertebrates include overexploitation and destructive fishing practices (Jackson et al. 2001; Miloslavich et al. 2011; Pandolfi et al. 2003), habitat degradation from pollution and coastal development (Cortes and Risk 1985; Downs et al. 2009), disease, and invasive species (Bryant et al. 1998; Galloway et al. 2009; National Marine Fisheries Service 2010b; Wilkinson 2002). These threats are compounded by global threats to all marine life, including the increasing temperature and decreasing pH of the ocean from pollution linked to global climate change (Cohen et al. 2009; Miloslavich et al. 2011).

In the Study Area, marine invertebrates that are managed to ensure their sustainability have delineated essential fish habitat, which is designated by NMFS and regional fishery management councils. The sustainability and abundance of these organisms are vital to the marine ecosystem and to the sustainability of the world's commercial fisheries (Pauly et al. 2002). Marine invertebrates are harvested for food and for the aquarium trade. Economically important invertebrate groups that are fished, commercially and recreationally, for food in the United States are crustaceans (e.g., shrimps, lobsters, and crabs), bivalves (e.g., scallops, clams, and oysters), and cephalopods (e.g., squid and octopuses) (Morgan and Chuenpagdee 2003; Pauly et al. 2002). These fisheries are a key part of the commercial fisheries industry in the United States (Food and Agriculture Organization of the United Nations 2005). Global threats to crustaceans, bivalves, and cephalopods are largely the result of overfishing, destructive fishing techniques (e.g., trawling) and habitat modification (Morgan and Chuenpagdee 2003; Pauly et al. 2002). A relatively new threat to invertebrates is bioprospecting, the collection of organisms in pursuit of new compounds for pharmaceutical products (National Marine Fisheries Service 2013a).

Additional information on the biology, life history, and conservation of marine invertebrates can be found on the websites maintained by the following organizations:

- NMFS, particularly for ESA-listed species, species currently proposed for ESA listing, species considered as candidate species for ESA listing, and species of concern

- U.S. Coral Reef Task Force
- Marine Bio Conservation Society
- Waikiki Aquarium
- Monterey Bay Aquarium

The discussion above represents general threats to marine invertebrates. Additional threats to individual species within the Study Area are described below in the accounts of those species. The following sections include descriptions of species listed or proposed to be listed as threatened or endangered under the ESA, and descriptions of the major marine invertebrate taxonomic groups in the Study Area. The species-specific information emphasizes the ESA-listed and candidate species because any threats to or potential impacts on those species are subject to consultation with regulatory agencies. These taxonomic group descriptions include descriptions of key habitat-forming invertebrates, including reef-forming sponges, shallow-water corals, two groups of key deep-water corals that form essential fish habitat, corals, and other organisms that define live hardbottom, reef-building worms, and reef-building mollusks (e.g., oysters).

The ESA listing process for 82 species of reef-building corals petitioned by the Center for Biological Diversity (Sakashita and Wolf 2009) is the broadest and most complex listing process undertaken by NMFS (National Oceanic and Atmospheric Administration 2012, Brainard et al. 2011). A threat evaluation was developed for these corals and 19 key threats were selected as the most important factors influencing the potential extinction of candidate coral species before the year 2100 (Table 3.8-4). Because most of these threats are also known to affect marine invertebrate groups, generally, the information is presented here in General Threats rather than within a subsequent subsection.

Table 3.8-4: Summary of Proximate Threats to Coral Species

Proximate Threat[1]	Importance	Used in Coral ESA Determinations
Ocean Warming	High	Yes
Disease	High	Yes
Ocean Acidification	Med-High	Yes
Reef Fishing—Trophic Effects	Medium	Yes
Sedimentation	Low-Medium	Yes
Nutrients	Low-Medium	Yes
Sea-Level Rise	Low-Medium	Yes
Toxins	Low	No
Changing Ocean Circulation	Low	No
Changing Storm Tracks/Intensities	Low	No
Predation	Low	Yes
Reef Fishing—Habitat Impacts/Destructive Fishing Practices	Low	No
Ornamental Trade	Low	Yes
Natural Physical Damage	Low	No

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

Note: ESA = Endangered Species Act

Table 3.8-4: Summary of Proximate Threats to Coral Species (continued)

Proximate Threat[1]	Importance	Used in Coral ESA Determinations
Human-induced Physical Damage	Negligible-Low	No
Aquatic Invasive Species	Negligible-Low	No
Salinity	Negligible	No
African/Asian Dust	Negligible	No
Changes in Insolation	Probably Negligible	No

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

Note: ESA = Endangered Species Act

3.8.2.3 Black Abalone (*Haliotis cracherodii*)

3.8.2.3.1 Status and Management

The black abalone (*Haliotis cracherodii*) was listed as endangered under the ESA on 14 January 2009 (VanBlaricom et al. 2009). A dramatic decline in abundance, likely caused by a disease known as withering syndrome (explained in more detail below), prompted closure of both the commercial and recreational fisheries in California. The State of California imposed a moratorium on black abalone harvesting throughout California in 1993 and on all abalone harvesting in central and Southern California in 1997 (VanBlaricom et al. 2009). A system of California Marine Protected Areas aids in enforcing these regulations. An *Abalone Recovery Management Plan* was adopted by the State of California in 2005.

NMFS has prepared a status review for this species (VanBlaricom et al. 2009). Critical habitat was designated for black abalone by NMFS on 27 October 2011 (76 Federal Register 66806-66844). Most of the designated critical habitat lies along the California coast north of the Study Area. Designated critical habitat includes rocky intertidal and subtidal habitats from the mean higher high water line to a depth of approximately 20 ft. (6 m), as well as the waters encompassed by these areas. Designated critical habitat extends from Del Mar Landing Ecological Reserve to the Palos Verdes Peninsula. Within the Study Area, critical habitat occurs in waters surrounding Santa Catalina and Santa Barbara Islands. No training or testing activities occur in waters surrounding these islands (the training activities occur in open ocean portions). The specific areas proposed for designation off San Nicolas and San Clemente Islands were determined to be ineligible for designation because the U.S. Department of the Navy's (Navy's) Integrated Natural Resources Management Plans provide benefits to black abalone in those areas. The critical habitat designation also identifies primary constituent elements, which are habitat elements essential for the conservation of the species. The primary constituent elements for black abalone are rocky substrate, food resources, juvenile settlement habitat, suitable water quality, and suitable nearshore circulation patterns.

Various projects are in place to monitor the status of the species, to understand and address withering disease, to improve reproduction, and to minimize illegal harvest. For instance, the Navy monitors black abalone populations on San Clemente and San Nicolas Islands, and the species is managed under both the *San Clemente Island Integrated Natural Resources Management Plan* and *San Nicolas Island Integrated Natural Resources Management Plan*.

3.8.2.3.2 Habitat and Geographic Range

The distribution of the black abalone ranges approximately from Point Arena in northern California to Bahia Tortugas and Isla Guadalupe, Mexico (VanBlaricom et al. 2009). Although the geographic range of

black abalone extends to northern California, the most abundant populations historically have occurred in the Channel Islands (VanBlaricom et al. 2009). A map of the black abalone range can be accessed at http://www.nmfs.noaa.gov/pr/species/invertebrates/blackabalone.htm.

Black abalone live on rocky substrates in the high to low intertidal zone (with most animals found in the middle and lower intertidal) within the Southern California portion of the Study Area. They occur among other invertebrate species, including California mussels (*Mytilus californianus*), gooseneck barnacles (*Pollicipes polymerus*), and anemones. Of the eight species of abalone in the waters of California, the black abalone inhabits the shallowest areas. It is rarely found deeper than 20 ft. (6.1 m), and smaller individuals generally inhabit the higher intertidal zones. Complex surfaces with cracks and crevices may be crucial habitat for juveniles, and appear to be important for adult survival as well (VanBlaricom et al. 2009).

3.8.2.3.3 Population and Abundance

Black abalones were abundant before 1985 in the coastal waters from Point Arena in northern California to Bahia Tortugas and Isla Guadalupe, Mexico. Substantial populations also occurred in the coastal waters of the Channel Islands of Southern California. In the early 1970s, the black abalone constituted the largest abalone fishery in California (Smith et al. 2003). Because of withering syndrome, black abalone populations south of Monterey County, California have experienced 95 percent or greater declines in abundance since the mid-1980s (Neuman et al. 2010). Withering syndrome is caused by the bacteria species *Candidatus Xenohaliotis californiensis*, which attacks the lining of the abalone's digestive tract, inhibiting the production of digestive enzymes. To prevent starvation, the abalone consumes its own body mass, causing its characteristic muscular "foot" to wither and atrophy. This impairs the abalone's ability to adhere to rocks, making it far more vulnerable to predation or starvation (VanBlaricom et al. 2009).

Major declines in abundance in the Channel Islands, the primary fishing grounds for this species before closure of the abalone fishery, have severely reduced the population as a whole (VanBlaricom et al. 2009). The Black Abalone Status Review Team estimates that, unless effective measures are put in place to counter the population decline caused by withering syndrome and overfishing, the species will likely be extinct within 30 years (VanBlaricom et al. 2009). San Nicolas Island is one of the only locations in Southern California where black abalone have been increasing and where multiple recruitment events have occurred since 2005 (VanBlaricom et al. 2009).

3.8.2.3.4 Predator-Prey Interactions

The black abalone diet varies with life history stage. As larvae, black abalones receive nourishment from an egg yolk and do not actively feed. Settled abalone clamp tightly to rocky substrates and feed on algal matter that they scrape from the rocks. Juveniles feed on bottom-dwelling diatoms, bacterial films, and algae. As they increase in size and become less vulnerable to predation, abalones move into more open locations (though still cryptic) and gain access to both attached and drift algae. Adult abalone feed primarily on fragments of drift kelp (Smith et al. 2003) and red algae (VanBlaricom et al. 2009). The primary predators of abalone are humans, fish, otters (Smith et al. 2003), sea stars, and striped crabs (National Oceanic and Atmospheric Administration 2010a).

3.8.2.3.5 Species-Specific Threats

The black abalone population is declining because of withering syndrome and overharvesting. An additional factor in the population decline is the black abalone’s reproductive process and low

population density in areas affected by the disease. The black abalone is a broadcast spawner and a relatively sedentary marine mollusk that requires a critical population size and the proximity of other spawning abalone to successfully reproduce. The reduction in black abalone populations has isolated many individuals, preventing them from reproducing successfully (VanBlaricom et al. 2009).

3.8.2.4 White Abalone (*Haliotis sorenseni*)

3.8.2.4.1 Status and Management

The white abalone (*Haliotis sorenseni*) was listed as endangered under the ESA in May 2001 (National Marine Fisheries Service 2001), and is recognized as one stock (Hobday and Tegner 2000). Overfishing in the 1970s reduced the population to such low densities that successful reproduction was severely restricted. White abalone survival and recovery continue to be negatively affected by reproductive failure (Hobday et al. 2001), as well as by rising sea surface temperatures (Vilchis et al. 2005) and diseases, such as withering syndrome (Friedman et al. 2003).

The State of California suspended all forms of harvesting of the white abalone in 1996 and, in 1997, imposed an indefinite moratorium on the harvesting of all abalone in central and Southern California (National Marine Fisheries Service 2008). Critical habitat is not designated for white abalone. NMFS determined that informing the public of the locations of critical habitat, which includes areas where white abalone still exist, would increase the risk of illegal harvesting of white abalone (National Marine Fisheries Service 2001, 2008). Potential habitat may exist between Point Conception, California, and the California/Mexico border, with much of it occurring in the isolated, deep waters off the Channel Islands. In reaction to concerns over the status of white abalone, the White Abalone Restoration Consortium was formed to propagate a captive-reared stock to enhance the depleted wild stock (National Marine Fisheries Service 2008). There is now a captive breeding program at the Bodega Bay Marine Laboratory, UC Davis, in partnership with several facilities throughout California.

3.8.2.4.2 Habitat and Geographic Range

The white abalone is a well-concealed, attached, bottom-dwelling species that prefers reefs and rock piles with low relief areas surrounded by sandy areas (Hobday and Tegner 2000). White abalone in the Southern California Bight typically inhabit depths ranging from 60 to 195 ft. (18 to 59 m), with the highest densities occurring between 130 and 165 ft. (40 and 50 m) (Butler et al. 2006). White abalones are found in waters deeper than other west coast abalone species. Overall, habitat associations of white abalone depend on its main food source, attached or drifting brown algae (National Marine Fisheries Service 2001). Thus, depth distribution is limited by water clarity and light penetration as well as by the availability of hard substrate or anchoring points on seafloor (Butler et al. 2006). Evidence suggests that white abalone prefer the sand and rock interface at the reef's edge, rather than the middle sections of reefs (National Marine Fisheries Service 2008).

White abalone were historically found between Point Conception, California, and Punta Abreojos, Baja California, Mexico, at depths as shallow as 16 ft. (5 m) (National Marine Fisheries Service 2008). White abalone was once abundant throughout its range, but was more common and abundant along the coast in the northern and southern extents of its range. This area includes the Channel Islands of San Clemente (Navy owned) and Santa Catalina islands in the northeastern corner of the Southern California portion of the California Current Large Marine Ecosystem (Figure 3.8-1) (Butler et al. 2006; National Marine Fisheries Service 2008). On the southern end of the range, the species was also common around a number of islands, including Isla Cedros and Isla Natividad, Mexico (Hobday and Tegner 2000).

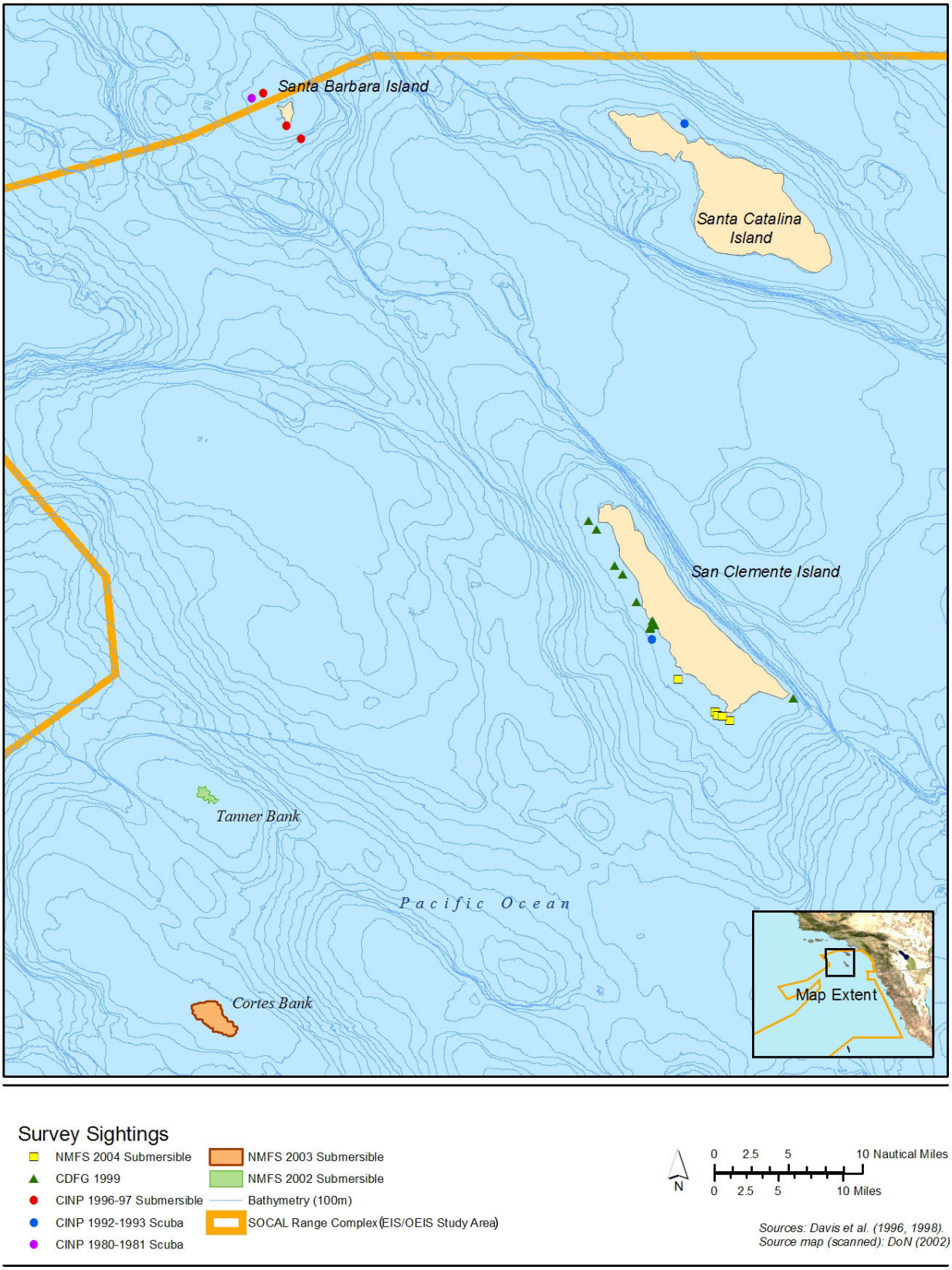

Figure 3.8-1: Locations of White Abalone in the Hawaii-Southern California Training and Testing Study Area

Although it occurs in extremely low numbers, its current range appears similar to that of its historical range (National Marine Fisheries Service 2008).

Except for some isolated survivors, the species is distributed only around the Channel Islands and along various banks within the Study Area (Hobday and Tegner 2000; Rogers-Bennett et al. 2002). Since 1996, various researchers (Butler et al. 2006; Davis et al. 1996, 1998; Hobday and Tegner 2000) have conducted submersible surveys off Tanner and Cortes Banks (approximately 50 miles [80 kilometers {km}] southwest of San Clemente Island) to map abalone habitat structure, examine distributions, and estimate the population size. They recorded 258 animals, with 168 recorded on Tanner Bank in 2002, at depths ranging from 105 to 180 ft. (32 to 55 m). In 2004, 35 individuals were recorded at Tanner Bank, 12 at Cortez Bank, and five off San Clemente Island. One study (Butler et al. 2006) documented 5 square miles (mi.^{2}) (1,359 hectares [ha]) of available white abalone habitat at Tanner Bank, 4 mi.^{2} (1,139 ha) at Cortez Bank, and 3 mi.^{2} (889 ha) on the western side of San Clemente Island. Both of these banks are underwater mountains that occur off the coast of Southern California.

3.8.2.4.3 Population and Abundance

Since the 1970s, the white abalone population has experienced a 99 percent reduction in density (National Marine Fisheries Service 2008). Between 2002 and 2010, decreases in abundance (approximately 78 percent) and density (33 to 100 percent depending on depth and survey year) have been reported at Tanner Bank, an area of historically high abundance (>1 per square meter [m^2]) (Butler et al. 2006, Stierhoff et al. 2012). An increase in the size distribution over this same time period suggests individuals in the white abalone population are growing larger (and aging) with little or no indication of adequate recruitment success. With a dispersed population of aging individuals, prospects for recruitment remain low without management intervention, such as outplanting of healthy, captive-bred white abalone in suitable habitats where populations are approaching or have reached local extinction (Stierhoff et al. 2012).

3.8.2.4.4 Predator-Prey Interactions

Similar to black abalone, the white abalone diet varies with life history stage. As larvae, white abalones do not actively feed. Settled abalone clamp tightly to rocky substrates and feed on algal matter scraped from the rocks or trapped under their shells. Juveniles feed on bottom-dwelling diatoms, bacterial films, and algae. As they increase in size and become less vulnerable to predation, abalones leave their sheltered habitat to search for food. Adult white abalone feed primarily on fragments of attached or drifting brown algae (National Oceanic and Atmospheric Administration 2010c). Predators of white abalone include sea otters, fish, sea stars, crabs, and octopuses, as well as humans through illegal harvesting (Hobday and Tegner 2000).

3.8.2.4.5 Species Specific Threats

White abalone faces similar threats (overharvesting, low population densities, and withering syndrome) to those of black abalone. Because of the small population of white abalone, impacts on the remaining population are magnified.

3.8.2.5 Fuzzy Table Coral (*Acropora paniculata*)

3.8.2.5.1 Status and Management

In February 2010, NMFS issued *Notice of 90-Day Finding on a Petition to List 83 Species of Corals as Threatened or Endangered Under the ESA*, which included fuzzy table coral (*Acropora paniculata*) (National Marine Fisheries Service 2010). In December 2012, NMFS published a proposed rule to list this

species as threatened under the ESA. NMFS has not proposed a critical habitat designation for this species.

3.8.2.5.2 Habitat and Geographic Range

Fuzzy table coral has been reported to occupy upper reef slopes, subtidal, reef edges, and sheltered lagoons in water depths ranging from 33 to 115 ft. (10 to 35 m) (Carpenter et al. 2008). This coral species has a wide geographic range, stretching from the Red Sea, across the Indo-Pacific, western and central Pacific Ocean to the Papahanaumokuakea Marine National Monument at French Frigate Shoals (Brainard et al. 2011). Within the Study Area, this species exists only in the Hawaiian archipelago at French Frigate Shoals.

3.8.2.5.3 Population and Abundance

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

Abundance of fuzzy table coral has been reported as uncommon to rare on most reefs (Veron 2000); however, it is common in Papua New Guinea (Wallace 1999). Apparently isolated to the French Frigate Shoals, this species is not common in the Study Area.

3.8.2.5.4 Predator-Prey Interactions

Like other Acroporidae corals, fuzzy table coral feed on zooplankton or other materials suspended in the water column, the majority of which are small marine organisms. Corals use stinging cells on tentacles surrounding their mouths to capture prey (Brusca and Brusca 2003). In addition to actively capturing prey, reef-building corals including fuzzy table coral have another method of acquiring nutrients through their symbiotic relationship with zooxanthellae. The waste products of the fuzzy table coral host provide nitrogen to the zooxanthellae, and the zooxanthellae provide organic compounds (e.g., carbohydrates) produced by photosynthesis to its host (Brusca and Brusca 2003, Schuhmacher and Zibrowius 1985). The photosynthetic pigments in zooxanthellae also provide corals with their characteristic color. Predators of corals include sea stars, snails, and fish (e.g., parrotfish and butterfly fish). See Section 3.8.2.11 (Corals, Hydroids, Jellyfish [Phylum Cnidaria]) for an overview of coral predator-prey relationships.

The specific effects of predation are poorly known for fuzzy table coral. Most members of the genus *Acropora* are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) and by corallivorous snails, both of which occur in the Study Area.

3.8.2.5.5 Species Specific Threats

There are no species-specific threats associated with fuzzy table coral. It is susceptible to the same suite of stressors that generally threaten corals (Section 3.8.2.2, General Threats). As stated previously, the distribution of fuzzy table coral is limited to the French Frigate Shoals within the Papahanaumokuakea Marine National Monument. This species is protected by three regulatory agencies, including the NOAA

National Ocean Service, the U.S. Fish and Wildlife Service, and the State of Hawaii. The harvest of any coral is prohibited within the Papahanaumokuakea Marine National Monument. There is no human habitation within the monument and, therefore, no anthropogenic effects. Fishing, sedimentation, and pollution are not factors that could contribute to decline. While fuzzy table coral is not common in Hawaii, it is fully protected from human-caused impacts (due to state and federal regulations restricting activities within protected waters).

3.8.2.6 Irregular Rice Coral (*Montipora dilatata*)

3.8.2.6.1 Status and Management

In December 2012, NFMS published a proposed rule to list irregular rice coral (*Montipora dilatata*) as threatened under the ESA. NMFS has not proposed a critical habitat designation for irregular rice coral. Previously, this species was considered a species of concern by NMFS because of the rarity of this species and small geographic distribution, limited to a few Hawaiian reef locations.

There have been recent disagreements regarding taxomony of this species. NMFS prefers to group *Montipora flabellata, Montipora turgescens*, and *Montipora dilitata* for evaluation purposes for extinction risk. In November 2012, the State of Hawaii submitted comments on this strategy, stating that grouping these three species is not warranted. For instance, *Montipora turgescens* has a wide distribution in the Pacific, which contrasts with the narrower endemic distributions of the other two species.

3.8.2.6.2 Habitat and Geographic Range

Irregular rice coral is endemic to Hawaii and has a highly restricted distribution. According to the State of Hawaii, the only reliable location of irregular rice coral is Kaneohe Bay, on the island of Oahu, Hawaii, and reports of its occurrence elsewhere have been discredited or determined to be a misidentification of similar *Montipora* species (National Oceanic and Atmospheric Administration 2012 and Brainard et al. 2011).

3.8.2.6.3 Population and Abundance

Irregular rice coral is extremely rare. As stated previously, the distribution of this coral species is restricted to Kaneohe Bay, where there are only 10 colonies. Irregular rice coral colonies break easily in storms or through bioerosion, and the resulting fragments can form new colonies (National Marine Fisheries Service 2007). This species is sensitive to thermal stress, as are all *Montipora* species, and recovers slowly after a bleaching event (Brainard et al. 2011).

3.8.2.6.4 Predator-Prey Interactions

There is no species-specific information regarding predator-prey interactions for irregular rice corals. Members of genus *Montipora*, however, are a preferred prey species of crown-of-thorns sea star and subject to snail predation. (Brainard et al. 2011)

3.8.2.6.5 Species Specific Threats

Irregular rice coral is subject to the same suite of threats as other corals (Brainard et al. 2011). Irregular rice coral was originally considered a species of concern based on the following factors: (1) vulnerability to coral bleaching; (2) fresh water kills and exposure at extreme low tide; (3) habitat degradation and modification as a result of sedimentation, pollution, and alien alga invasion; and (4) damage by anchors, fish pots, swimmers, and divers (National Marine Fisheries Service 2010).

3.8.2.7 Blue Rice Coral (*Montipora flabellate*)

3.8.2.7.1 Status and Management

In February 2010, NMFS issued *Notice of 90-Day Finding on a Petition to List 83 Species of Corals as Threatened or Endangered Under the ESA*, which included blue rice coral (*Montipora flabellate*) (National Marine Fisheries Service 2010). In December 2012, NFMS published a proposed rule to list this species as threatened under the ESA. NMFS has not proposed a critical habitat designation for this species.

3.8.2.7.2 Habitat and Geographic Range

Blue rice coral, like irregular rice coral, is endemic to Hawaiian reef systems, although with a wider distribution in Hawaii. Veron (2000) reports this species as occupying most reef flats and slopes, and Carpenter et al. (2008) report this species to depths of 33 to 115 ft. (10 to 35 m).

3.8.2.7.3 Population and Abundance

Blue rice coral is the fifth-most common coral in Hawaii and is generally thought to be in decline. Declines in irregular rice coral are suspected to be greater than in blue rice corals (National Oceanic and Atmospheric Administration 2012, Brainard et al. 2011).

3.8.2.7.4 Predator-Prey Interactions

There is no species-specific information regarding predator-prey interactions for blue rice corals. Members of genus *Montipora,* however, are a preferred prey species of crown-of-thorns and subject to snail predation.

3.8.2.7.5 Species Specific Threats

There are no species-specific threats associated with blue rice coral. It is susceptible to the same suite of stressors that generally threaten corals (Section 3.8.2.2, General Threats).

3.8.2.8 Sandpaper Rice Coral (*Montipora patula*)

3.8.2.8.1 Status and Management

In February 2010, NMFS issued *Notice of 90-Day Finding on a Petition to List 83 Species of Corals as Threatened or Endangered Under the ESA*, which included sandpaper rice coral (*Montipora patula*) (National Marine Fisheries Service 2010). In December 2012, NFMS published a proposed rule to list this species as threatened under the ESA. NMFS has not proposed a critical habitat designation for this species.

3.8.2.8.2 Habitat and Geographic Range

Sandpaper rice coral is also a shallow reef (depth of 33 ft. [10 m]) (Brown and Wolf 2009), but it may occur in deeper habitats (National Oceanic and Atmospheric Administration 2012). Sandpaper rice coral is common in wave-swept environments but less tolerant of sediment-impacted areas (Jokiel et al. 2007). The geographic range of sandpaper rice coral is restricted to the Hawaiian Islands, Johnston Atoll, and the Mariana Islands (Veron 2000). Within the Study Area, records are reported from islands within the Papahanaumokuakea Marine National Monument, Johnston Atoll, waters off Molokai, and the western coast of Hawaii Island.

3.8.2.8.3 Population and Abundance

Sandpaper rice coral has been reported as the fourth-most abundant coral in Hawaii (National Oceanic and Atmospheric Administration 2012, Brainard et al. 2011). Declines of sandpaper rice coral have been reported on a subset of transects over 12 years, but other transects within sites show high variability between surveys and/or similar cover between the beginning and end of the study (Dollar and Grigg 2004).

3.8.2.8.4 Predator-Prey Interactions

There is no species-specific information regarding predator-prey interactions for sandpaper rice corals. Members of genus *Montipora,* however, are a preferred prey species of crown-of-thorns and subject to snail predation (Brainard et al. 2011).

3.8.2.8.5 Species Specific Threats

There are no species-specific threats associated with sandpaper rice coral. It is susceptible to the same suite of stressors that generally threaten corals (Section 3.8.2.2, General Threats). It should be noted that sandpaper rice coral is among the most bleaching-susceptible species in the Northwestern Hawaiian Islands (Kenyon and Brainard 2006).

3.8.2.9 Forminiferans, Radiolarians, Ciliates (Phylum Protozoa)

Foraminiferans, radiolarians, and ciliates are minute singled-celled organisms, sometimes forming colonies of cells, belonging to the Phylum Protozoa (Castro and Huber 2000). They are found in the water column and seafloor of the world's oceans. Foraminifera in the genus *Globergerina* occur in the waters around the California Current and Insular Pacific-Hawaiian Large Marine Ecosystems (Field et al. 2006). Forminifera form diverse and intricate shells out of calcium carbonate (Wetmore 2006). The shells of formanifera that live in the water column eventually sink to the deep seafloor, forming sediments known as formaminiferan ooze (Wetmore 2006). Formaninfera feed on diatoms and other small organisms. Their predators include copepods and other zooplankton. Radiolarians are microscopic organisms that form glass-like shells made of silica. Radiolarian ooze covers large areas of the ocean floor (Castro and Huber 2000; Wetmore 2006). Ciliates are protozoans with small hairs (cilia) that are used to feed and move around.

3.8.2.10 Sponges (Phylum Porifera)

Sponges include over 8,000 marine species worldwide, and are classified in the Phylum Porifera (Appeltans et al. 2010). Sponges are bottom-dwelling, multi-cellular animals that can be best described as an aggregation of cells that perform different functions. Sponges are largely sessile (not mobile), except for their larval stages, and are common throughout the Study Area at all depths. Sponges reproduce both sexually and asexually. Water flowing through the sponge provides food and oxygen and removes wastes (Castro and Huber 2000; Collins and Waggoner 2006). Many sponges form calcium carbonate or silica spicules or bodies embedded in cells to provide structural support (Castro and Huber 2000). Sponges provide homes for a variety of animals, including shrimp, crabs, barnacles, worms, brittle stars, sea cucumbers, and other sponges (Colin and Arneson 1995d). Sponges in the genera *Grantiidae* and *Clathria* occur in the waters around the California Current Large Marine Ecosystems. Common species in the Insular Pacific-Hawaiian Large Marine Ecosystem include grey encrusting sponge (*Gelliodes fibrosa*) and *blue Caribbean sponge* (*Haliclona caerulea*) (Quanzi and Wang 2009).

3.8.2.11 Corals, Hydroids, Jellyfish (Phylum Cnidaria)

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

Corals are in a class of animals that also includes anemones and soft corals. The individual unit is referred to as a polyp, and most species occur as colonies of polyps. Reef-building corals in the photic zone, shallower than approximately 650 ft. (200 m), usually host zooxanthellae that provide extra energy to the corals (Castro and Huber 2000). All corals feed on small planktonic organisms or dissolved organic matter, although some shallow-water corals derive most of their energy from their symbiotic algae (Dubinsky and Berman-Frank 2001). Most hard corals and some soft corals are habitat-forming (i.e., they form coral reefs) (Freiwald et al. 2004; Spalding et al. 2001), and some soft corals define particular habitat types (e.g., hard bottom is typically characterized by sponges and soft corals) (South Atlantic Fishery Management Council 1998).

Apart from a few exceptions in the Pacific Ocean, coral reefs are confined to the warm tropical and subtropical waters between 30 degrees (°) North (N) and 30° South (S). The dominant species of corals in the Insular Pacific-Hawaiian Large Marine Ecosystem are in the genera Porites, Montipora, and Pavona (National Marine Fisheries Service 2007, 2009). Deep-sea coral communities are prevalent throughout the Hawaiian archipelago, and often form offshore reefs that surround all of the Main Hawaiian Islands at depths between 27 and 109 fathoms (50 to 200 m) (Maragos 1998). Much like shallow-water corals, deep-sea corals are fragile, slow growing, and can survive for hundreds of years (Roberts and Hirshfield, 2003). In the Hawaiian Islands, gorgonians are the most common group of deep-sea corals. Of the gorgonians, primnoids are the most abundant group in the Hawaiian archipelago and are dominant off Molokai (Chave and Malahoff, 1998).

While there are no coral reefs in the eastern Pacific Ocean, there are cold-water coral species that would occur within the California Current Large Marine Ecosystem. Corals of the in the California portion of the Study Area include anthozoans and hydrozoans (or hydrocorals); anthozoans include hexacorals and octocorals. Hexacorals are represented by scleractinians (stony corals), antipatharians (black corals), and corallimorpharians (coral-like organisms lacking a calcium carbonate skeleton); octocorals include soft corals and gorgonians (e.g., sea fans). Most of the habitat-forming deep-sea corals are anthozoans and hydrozoans (Etnoyer and Morgan 2003, 2005). The majorities of stony corals within the California Current Large Marine Ecosystem are, however, azooxanthellate and obtain energy from detritus, zooplankton, and nekton they capture from the surrounding water (Cairns 1994; Roberts and Hirshfield 2003). Since azooxanthellate corals do not depend on sunlight or a symbiotic existence with zooxanthellae, they can be found in water depths exceeding 20,000 ft. (6,000 m) (Etnoyer and Morgan 2005).

Not all of the 82 species included in the 2010 status review by NMFS were proposed for threatened or endangered status in the December 2012 proposed rule. Of the 16 species that were not proposed for listing, five of these occur within the Study Area. These species include swelling coral (*Leptoseris*

incrustans), Puko's coral (*Porites pukoensis*), stellar coral (*Psammocora stellata*), Agassiz's coral (*Cyphastrea agassizi*), and ocellated coral (*Cyphastrea ocellina*). The December 2012 proposed rule obviated the status of these five species as ESA candidate species.

The coral species that were originally included in the status review, but not proposed for ESA listing, occur throughout the coastal areas of the Insular Pacific-Hawaiian Large Marine Ecosystem in the Hawaii portion of the Study Area. Swelling coral is a widespread species, occurring throughout the Red Sea and the East Indian Ocean as far as Hawaii and French Polynesia (Brown and Wolf 2009) in shallow reef flats (Veron 2000), although this species may occur at much deeper depths between 50 and 80 m on reef slopes (Rooney et al. 2010). Within the Study Area, reports of this species include Papahanaumokuakea Marine National Monument, Pacific Remote Islands Marine National Monument, and shallow waters off of Molokai and Hawaii Island. Puko's coral is endemic to Hawaii and is believed to occupy shallow protected reef environments, especially lagoons (Veron 2000). The current distribution is believed to be found at Puako, on the south side of Molokai, although this species has not been found there during recent searches (National Oceanic and Atmospheric Administration 2012). The depth range for this species is unknown, but is generally associated with shallow reef environments (Sheppard et al. 2008). Stellar coral is widely distributed across the Indo-Pacific region, from the Seychelles in the western Indian Ocean to areas on the Pacific coasts of North, Central, and South America (outside of the Southern California portion of the Study Area) (Cortes et al. 2008). Stellar coral has been reported to occupy shallow wave-washed rock (Veron 2000) and has been reported at depths ranging from 0 m to 20 m (Carpenter et al. 2008). Agassiz's coral and ocellated coral are uncommon in the Hawaiian archipelago (Fenner 2005). They are also found on Johnston Atoll, south of the Hawaiian Islands, as well as waters off the western coast of Hawaii Island and northern coast of Molokai. Agassiz's coral has been reported from shallow reef environments (Veron 2000) in depths ranging from 3 m to 20 m (Carpenter et al. 2008). Ocellated coral has been reported from shallow upper reef slopes (Veron 2000) in waters ranging from 5 m to 20 m (Carpenter et al. 2008).

Estimates of population or abundance for candidate corals in the Study Area are not available or speculative. Swelling coral is found throughout the Hawaiian archipelago and is believed to be decreasing (Brown and Wolf 2009). Stellar corals grow slowly but are also among the most opportunistic of corals because they can rapidly recolonize areas left vacant by disturbances (Brown and Wolf 2009). Sexual reproduction is important, but asexual reproduction and fragmentation are more effective strategies for colonizing free areas within the reef. The population trend for Puko's coral is unknown (Sheppard et al. 2008). This species is very rare, with likely fewer than 50 colonies occurring at a single site on Molokai (Sheppard et al. 2008). Stellar coral is abundant in the eastern Pacific portion of its range, although in the Hawaii portion of the Study Area, the species is reported as uncommon (Veron 2000). Both Agassiz's coral and ocellated coral are reported as rare or uncommon (Veron 2000, Carpenter 2008).

Predation information for swelling coral, Agassiz's coral, and ocellate coral is not available (Brainard et al. 2011). Puko's coral and other members of genus *Porites* are susceptible to crown-of-thorns seastar and snail predation. Butterfly fish are also known to predate on massive forms of Puko's coral (Brainard et al. 2011). Stellar coral is also susceptible to predation by crown-of-thorns seastar but is not a preferred prey species (Brainard et al. 2011).

3.8.2.12 Flatworms (Phylum Platyhelminthes)

Flatworms include between 8,000 and 20,000 marine species worldwide (Appeltans et al. 2010; Castro and Huber 2000), and are the simplest form of marine worm (Castro and Huber 2000). The largest single

group of flatworms is parasites commonly found in fishes, seabirds, and whales (Castro and Huber 2000; University of California Berkeley 2010b). The life history of parasitic flatworms plays a role in the regulation of populations for the marine vertebrates they inhabit. Ingestion by the host organism is the primary dispersal method for parasitic flatworms. As parasites, they are not typically found in the water column, outside of a host organism. The remaining groups are non-parasitic carnivores, living without a host. Flatworms are found throughout the Study Area living on rocks in tide pools and reefs, or within the top layer of sandy areas. Flatworms in the genera *Waminoa* and *Freemania* occur in the waters around the California Current Large Marine Ecosystems. Dominant genera of flatworms in the Insular Pacific-Hawaiian Large Marine Ecosystem include *Pseudobiceros* and *Pseudoceros* (Appeltans et al. 2010; Castro and Huber 2000).

3.8.2.13 Ribbon Worms (Phylum Nemertea)

Ribbon worms include approximately 1,000 marine species worldwide (Appeltans et al. 2010). Ribbon worms, with their distinct gut and mouth parts, are more complex than flatworms (Castro and Huber 2000). Organisms in this phylum are bottom-dwelling, predatory marine worms that are equipped with a long extension from the mouth (proboscis) that helps them capture food (Castro and Huber 2000). Some species are also equipped with a sharp needle-like structure that delivers poison to kill prey. Ribbon worms occupy an important place in the marine food web as prey for a variety of fish and invertebrates and as a predator of other bottom-dwelling organisms, such as worms and crustaceans (Castro and Huber 2000). Some ribbon worms are parasitic and occupy the inside of the mantle of mollusks, where they feed on the waste products of their host (Castro and Huber 2000). Ribbon worms are found throughout the Study Area in soft-bottom habitat. *Emplectonema gracile* is a common species of ribbon worm that occurs in the waters around the California Current Large Marine Ecosystems. Several species of ribbon worms in the genus *Baseodiscus* are endemic to the Insular Pacific-Hawaiian Large Marine Ecosystem (Castro and Huber 2000).

3.8.2.14 Round Worms (Phylum Nematoda)

Round worms include over 5,000 marine species, though this number may be a gross underestimate (Appeltans et al. 2010). Common genera include *Anisakis* and *Thynnascaris* (Castro and Huber 2000). Round worms are small and cylindrical, and are abundant in sediments and in host organisms as parasites (Castro and Huber 2000). Round worms are one of the most widespread marine invertebrates, with population densities of one million organisms per 11 square feet (ft.^{2}) (1 m^2) of mud (Levinton 2009). This group has a variety of food preferences, including algae, small invertebrates, annelid worms, and organic material from sediment. Like free-living flatworms, parasitic nematodes provide important ecosystem services by regulating populations of other marine organisms by causing illness or mortality in less viable organisms. Round worms are found throughout the Study Area. Species in the family Anisakidae infect marine fish, and may cause illness in humans if fish are consumed raw without proper precautions (Castro and Huber 2000).

3.8.2.15 Segmented Worms (Phylum Annelida)

Segmented worms include approximately 12,000 marine species worldwide in the phylum Annelida, although most marine forms are in the class Polychaeta (Appeltans et al. 2010). Segmented worms are the most complex group of marine worms, with a well-developed respiratory and gastrointestinal system (Castro and Huber 2000). Different species of segmented worms may be highly mobile or burrow in the seafloor (Castro and Huber 2000). Most segmented worms are predators; others are scavengers, deposit feeders, filter feeders, or suspension feeders of sand, sediment, and water (Hoover 1998c). The variety of feeding strategies and close connection to the seafloor make Annelids an integral part of the

marine food web (Levinton 2009). Burrowing in the seafloor and agitating the sediment increases the oxygen content of the seafloor and makes important buried nutrients available to other organisms. This ecosystem service allows bacteria and other organisms, which are also an important part of the food web, to flourish on the seafloor. Segmented worms are found throughout the Study Area inhabiting rocky, sandy, and muddy areas of the seafloor. Common genera of segmented worms in the California Current Large Marine Ecosystem are *Nereis* and *Phragmatapoma*. Common species in the Insular Pacific-Hawaiian Large Marine Ecosystem are *Loimia medusa* and *Spirobranchus giganteus*. These worms also colonize corals, vessel hulls, docks, and floating debris (Castro and Huber 2000). Some species of worms build rigid tubes, and aggregations of these tubes form reefs. Giant tube worms (*Riftia pachyptila*) are chemosynthetic (a primary production process without sunlight) reef-forming worms living on hydrothermal vents of the abyssal oceans. Their distribution is poorly known in the Study Area.

3.8.2.16 Bryozoans (Phylum Bryozoa)

Bryozoans are small lace-like, colony-forming animals. Classified in the Phylum Bryozoa, there are approximately 5,000 marine species worldwide (Appeltans et al. 2010). Bryozoans attach to a variety of surfaces, including rocks, shells, wood, and algae, and feed on particles suspended in the water (Hoover 1998a). Bryozoans are found throughout the Study Area. Genera that occur in the California Current Large Marine Ecosystem are *Bugula* and *Schizporella*. Common species in the Insular Pacific-Hawaiian Large Marine Ecosystem are *Disporella violacea* and *Reteporellina denticulate*. Bryozoans are of economic importance for bioprospecting (the search for organisms for potential commercial use in pharmaceuticals). As a biofouling organism, bryozoans also interfere with boat operations and clog industrial water intakes and conduits (Hoover 1998a).

3.8.2.17 Squid, Bivalves, Sea Snails, Chitons (Phylum Molluska)

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

Important commercial, ecological, and recreational species of Molluska in the California Current Large Marine Ecosystem include all abalone species (black abalone, white abalone, green abalone, red abalone, pink abalone, threaded abalone, and flat abalone) found within the Study Area and the California market squid (*Loligo opalescens*) (Clark et al. 2005). Important commercial, ecological, and recreational species of Molluska in the Insular Pacific-Hawaiian Large Marine Ecosystem include various species of squid, the endemic cuttlefish (*Euprymna scolopes*), bivalves (clams and mussels), and limpets (*Cellana exarata* and *Cellana sandwicensis*), also called opihi (Western Pacific Regional Fishery Management Council 2001).

3.8.2.18 Shrimp, Crab, Lobster, Barnacles, Copepods (Phylum Arthropoda)

Shrimp, crab, lobster, barnacles, and copepods are animals with skeletons on the outside of their body (Castro and Huber 2000). Classified in the Phylum Arthropoda, over 50,000 species belong to the subphylum Crustacea within Phylum Arthropoda (Appeltans et al. 2010). Shrimp, crabs, and lobsters are typically carnivorous or omnivorous predators or scavengers, preying on mollusks (primarily gastropods, such as limpets, sea snails and slugs), other crustaceans, echinoderms (such as starfish, urchins, and sea cucumbers), small fish, algae, and sea grass (Waikiki Aquarium 2009a, b, c; Western Pacific Regional Fishery Management Council 2009). Barnacles and copepods feed by filtering algae and small organisms from the water (Levinton 2009).

Important commercial, ecological, and recreational species of Crustacea in the California Current Large Marine Ecosystem include the spot shrimp (*Pandalus platyceros*), ridgeback rock shrimp (*Sicyonia ingentis*), rock crab (*Cancer* species), sheep crab (*Loxorhynchus grandis*) and California spiny lobster (*Panulirus interruptus*) (Clark et al. 2005). The Hawaiian spiny lobster is an important commercial, ecological, and recreational species of Crustacea in the Insular Pacific-Hawaiian Large Marine Ecosystem.

3.8.2.19 Sea Stars, Sea Urchins, Sea Cucumbers (Phylum Echinodermata)

Phylum Echinodermata has over 6,000 marine species, such as sea stars, sea urchins, and sea cucumbers (Appeltans et al. 2010). Sea stars (asteroids), sea urchins (echinoids), sea cucumbers (holothuriods), brittle stars and basket stars (ophuiroids), and feather stars and sea lilies (crinoids) are symmetrical around the center axis of the body (Castro and Huber 2000). Most echinoderms have separate sexes, but unisexual forms occur among the sea stars, sea cucumbers, and brittle stars. Many species have external fertilization, producing planktonic larvae, but some brood their eggs, never releasing free-swimming larvae (Colin and Arneson 1995b). Many echinoderms are either scavengers or predators on organisms that do not move, such as algae, stony corals, sponges, clams, and oysters (Hoover 1998b). Some species filter food particles from sand, mud, or water.

Important commercial, ecological, and recreational species of echinoderms in the California Current Large Marine Ecosystem include California sea cucumbers (*Parastichopus californicus*), sea stars (*Pisaster* species), red sea urchin (*Strongylocentrotus franciscanus*), and purple sea urchin (*Strongylocentrotus purpuratus*) (Clark et al. 2005). Important commercial, ecological, and recreational species of echinoderm in the Insular Pacific-Hawaiian Large Marine Ecosystem include helmet urchins, the burrowing sea urchin (*Echinometra mathaei*), sea cucumbers, and sea stars. The crown-of-thorns sea star (*Acanthaster planci*) is a carnivorous predator that feeds on coal polyps and can devastate coral reefs because of its voracious appetite (Pawson 1995). In 1969, crown-of-thorns sea stars infested reefs off southern Molokai but did not cause extensive damage to living coral polyps of cauliflower coral (Gulko 1998; Hoover 1998b).

3.8.3 Environmental Consequences

This section analyzes the potential impacts on marine invertebrates from implementing the project alternatives, including the No Action Alternative, Alternative 1, and Alternative 2. Navy training and testing activities are evaluated for their potential impact on marine invertebrates in general, by taxonomic groups, and in detail for species listed under the ESA, species proposed for listing, and federally managed species or groups such as coral Habitat Areas of Particular Concern (Section 3.8.2, Affected Environment).

General characteristics of all Navy stressors were introduced in Section 3.0.5.3 (Identification of Stressors for Analysis) and living resources' general susceptibilities to stressors were introduced in Section 3.0.5.7 (Biological Resource Methods). Stressors vary in intensity, frequency, duration, and location within the Study Area. Based on the general threats to marine invertebrates discussed in Section 3.8.2 (Affected Environment), stressors applicable to marine invertebrates in the Study Area and analyzed below include the following:

- Acoustic (sonar, other active acoustic sources, underwater explosives)
- Energy (electromagnetic devices)
- Physical disturbance and strikes (vessels and in-water devices, military expended materials, seafloor devices)
- Entanglement (fiber optic cables, guidance wires, parachutes)
- Ingestion (military expended materials)
- Secondary

These components are analyzed for potential impacts on marine invertebrates within the stressor categories contained in this section. The specific analyses of the training and testing activities consider these components, within the context of geographic location and overlap of marine invertebrates. In addition to the analysis here, the details of all training and testing activities, stressors, and geographic occurrence within the Study Area are summarized in Section 3.0.5.3 (Identification of Stressors for Analysis) and detailed in Appendix A (Navy Activities Descriptions).

3.8.3.1 Acoustic Stressors

Assessing whether sounds may disturb or injure an animal involves understanding the characteristics of the acoustic sources, the animals that may be near the sound, and the effects that sound may have on the physiology and behavior of those animals. The methods used to predict acoustic effects on invertebrates build upon the Conceptual Framework for Assessing Effects from Sound-Producing Activities (Section 3.0.5.7.1). Categories of potential impacts are direct trauma, hearing loss, auditory masking, behavioral reactions, and physiological stress. Little information is available on the potential impacts on marine invertebrates of exposure to sonar, explosions, and other sound-producing activities. Most studies focused on squid or crustaceans, and the consequences of exposures to broadband impulsive air guns typically used for seismic exploration, rather than on sonar or explosions.

Direct trauma and mortality may occur due to the rapid pressure changes associated with an explosion. Most marine invertebrates lack air cavities that could make them vulnerable to trauma due to rapid pressure changes. Marine invertebrates could also be displaced by a shock wave, which could cause injury.

To experience hearing impacts, masking, behavioral reactions, or physiological stress, a marine invertebrate must be able to sense sound. Marine invertebrates are likely only sensitive to water particle motion caused by nearby low-frequency sources, and likely do not sense distant or mid- and high-frequency sounds (Section 3.8.2.1, Invertebrate Hearing and Vocalization). Andre et al. (2011) found progressive damage to statocyst hair cells in squid after exposure to two hours of 50 to 100 Hz sweeps at sound pressure levels of 157 to 175 dB re 1 µPa; however, it is impossible to determine whether damage was because of the sound exposure or some other aspect of capture or captivity because inappropriate and incorrect controls were used. No damage to statocysts and no impacts on crustacean balance (another function of the statocyst) were observed in crustaceans repeatedly exposed to high-intensity airgun firings (Christian et al. 2003; Payne et al. 2007). This limited information

suggests that marine invertebrate statocysts may be resistant to impulsive sound (such as explosives) impacts, but that the impact of long-term or non-impulsive (such as sonar or other active acoustic sources) sound exposures is undetermined.

Masking occurs when a sound interferes with an animal's ability to detect other biologically relevant sounds in its environment. Little is known about how marine invertebrates use sound in their environment. Some studies have shown that crab and coral larvae and post-larvae may use nearby reef sounds when in their settlement phase (Jeffs et al. 2003; Radford et al. 2007; Stanley et al. 2010; Vermeij et al. 2010), although it is unknown what component of reef noise is used. Larvae likely sense particle motion of nearby sounds, limiting their reef noise detection range (less than 328 ft. [100 m]) (Vermeij et al. 2010). Anthropogenic sounds could mask important acoustic cues, affecting detection of settlement cues or predators, potentially affecting larval settlement patterns or survivability in highly modified acoustic environments (Simpson et al. 2011). Low-frequency sounds could interfere with perception of low-frequency rasps or rumbles among crustaceans, although these are often already obscured by ambient noise (Patek et al. 2009). Sonar is not used in areas where corals proposed for ESA listing are known to occur.

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

There is some evidence of possible stress effects on invertebrates from long-term or intense sound exposure. Captive sand shrimp exposed to low-frequency noise (30 to 40 dB above ambient) continuously for 3 months demonstrated decreases in both growth rate and reproductive rate (Lagardère 1982). Sand shrimp showed lower rates of metabolism when kept in quiet, soundproofed tanks than when kept in tanks with typical ambient noise (Lagardère and Régnault 1980). Repeated intense airgun exposures caused no changes in biochemical stress markers in snow crabs (Christian et al. 2003), but some biochemical stress markers were observed in lobsters (Payne et al. 2007). The study indicated that this may have been because of captivity rather than noise exposure. The effect of long-term (multiple years), intermittent sound exposure was examined in a statistical analysis of recorded catch rate of rock lobster and seismic airgun activity (Parry and Gason 2006). No correlation was found between catch rate and seismic airgun activity, implying no long-term population impacts from intermittent anthropogenic sound exposure over long periods.

Because research on the consequences of exposing marine invertebrates to anthropogenic sounds is limited, qualitative analyses were conducted to determine the effects of the following acoustic stressors on marine invertebrates within the Study Area: non-impulsive sources (including sonar, vessel noise,

aircraft overflights, and other active acoustic sources) and impulsive acoustic sources (including explosives, pile driving, swimmer defense airguns, and weapons firing).

3.8.3.1.1 Impacts from Sonar and Other Active Acoustic Sources

Sources of non-impulsive underwater sound during testing and training events include broadband vessel noise (including surface ships, boats, and submarines), aircraft overflight noise (fixed-wing and rotary-wing aircraft), sonar, and other active non-impulsive sources. Non-impulsive sounds associated with testing and training are described in Section 3.0.5.3.1 (Acoustic Stressors).

Surface combatant ships and submarines are designed to be quiet to evade enemy detection, whereas other Navy ships and small craft have higher source levels, similar to equivalently sized commercial ships and private vessels (see Section 3.0.5.3.1.6, Vessel Noise). Ship noise tends to be low-frequency and broadband. Broadband noise from aircraft would depend on the platform, speed, and altitude (see Section 3.0.5.3.1.7, Aircraft Overflight Noise). Any sound transmitted through the air-water interface. Underwater sounds from aircraft are strongest just below the surface and directly under the aircraft. Sonar and other active acoustic sound sources emit sound waves into the water to detect objects, safely navigate, and communicate. These sources may emit low-, mid-, high-, or very-high-frequency sounds at various sound pressure levels.

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

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

3.8.3.1.1.1 No Action Alternative

Training Activities

Under the No Action Alternative, training activities using sonar and other active acoustic sources could occur throughout the Study Area, but would typically occur in the Southern California (SOCAL) Range Complex and HRC. Certain portions of the Study Area, such as areas near Navy ports, airfields, and range complexes are used more heavily by vessels and aircraft than other portions of the Study Area. Navy vessel noise and aircraft overflight noise associated with training could occur in all of the range complexes and throughout the Study Area while in transit. The locations and number of activities proposed for training under the No Action Alternative are shown in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). Sounds produced during training are described in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources), Section 3.0.5.3.1.6 (Vessel Noise), and Section 3.0.5.3.1.7 (Aircraft Overflight Noise).

As discussed above, most marine invertebrates would not sense mid- or high-frequency sounds, distant sounds, or aircraft noise transmitted through the air-water interface (see Section 3.8.2.1, Invertebrate Hearing and Vocalization). Most marine invertebrates would not be close enough to intense sound sources, such as some sonars, to potentially experience impacts to sensory structures. Any marine

invertebrate capable of sensing sound may alter its behavior if exposed to non-impulsive sound, although it is unknown if responses to non-impulsive sounds occur. Continuous noise, such as from vessels, may contribute to masking of relevant environmental sounds, such as reef noise. Because the distance over which most marine invertebrates are expected to detect any sounds is limited and vessels would be in transit, any sound exposures with the potential to cause masking or behavioral responses would be brief. Without prolonged proximate exposures, long-term impacts are not expected. Although non-impulsive underwater sounds produced during training activities may briefly impact individuals, intermittent exposures to non-impulsive sounds are not expected to impact survival, growth, recruitment, or reproduction of widespread marine invertebrate populations.

Under the No Action Alternative, ESA-listed black and white abalone and coral species proposed for ESA listing would not be able to hear sonar or other active acoustic sources. Training activities using sonar or other active acoustic sources are not proposed in designated black abalone or white abalone critical habitat in shallow waters within SOCAL, nor does this activity occur in waters known to support corals that are proposed for ESA listing. No critical habitat was designated for the coral species proposed for listing. Noise produced by transiting vessels would not result in the destruction or impairment of any hard substrate that could be habitat for black or white abalone, or habitat for corals proposed for ESA listing.

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities as described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Under the No Action Alternative, testing activities using sonar and other active acoustic sources could occur throughout the Study Area, but would typically occur in SOCAL and HRC. Certain portions of the Study Area, such as areas near Navy ports and airfields, installations, and training ranges and testing areas are used more heavily by vessels and aircraft than other portions of the Study Area. Underwater noise from vessels and aircraft overflights associated with testing could occur in all the range complexes, the training ranges, and throughout the Study Area while in transit. The locations and number of activities proposed for testing under the No Action Alternative are shown in Table 2.8-2 through 2.8-5 of Chapter 2 (Description of Proposed Action and Alternatives). Sounds produced during testing are described in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources), Section 3.0.5.3.1.6 (Vessel Noise), and Section 3.0.5.3.1.7 (Aircraft Overflight Noise).

As discussed above, most marine invertebrates would not sense mid- or high-frequency sounds, distant sounds, or aircraft noise transmitted through the air-water interface (see Section 3.8.2.1, Invertebrate Hearing and Vocalization). Most marine invertebrates would not be close enough to intense sound sources, such as some sonars, to potentially experience impacts to sensory structures. Any marine invertebrate capable of sensing sound may alter its behavior if exposed to non-impulsive sound, although it is unknown if responses to non-impulsive sounds occur. Continuous noise, such as from vessels, may contribute to masking of relevant environmental sounds, such as reef noise. Because the distance over which most marine invertebrates are expected to detect any sounds is limited and vessels would be in transit, any sound exposures with the potential to cause masking or behavioral responses would be brief. Without prolonged proximate exposures, long-term impacts are not expected. Although

non-impulsive underwater sounds produced during testing activities may briefly impact individuals, intermittent exposures to non-impulsive sounds are not expected to impact survival, growth, recruitment, or reproduction of widespread marine invertebrate populations.

Under the No Action Alternative, ESA-listed black and white abalone and coral species proposed for ESA listing would not be able to hear sonar or other active acoustic sources. Testing activities using sonar or other active acoustic sources are not proposed in designated black abalone or white abalone critical habitat in shallow waters within SOCAL, nor does this activity occur in waters known to support corals that are proposed for ESA listing. No critical habitat was designated for the coral species proposed for listing. Noise produced by transiting vessels would not result in the destruction or impairment of any hard substrate that could be habitat for black or white abalone habitat, or habitat for corals proposed for ESA listing. The stressors discussed in this section do not co-occur with ESA-listed species or coral species proposed for ESA listing.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities as described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.1.1.2 Alternative 1

Training Activities

Under Alternative 1, marine invertebrates would be exposed to increased amounts of non-impulsive sound compared to the No Action alternative due to increased use of sonars and other active acoustic sources, vessels, and aircraft overflights. Non-impulsive sound sources used during training would be similar to those under the No Action Alternative, with the addition of new active acoustic sources associated with the introduction of the Littoral Combat Ship. The locations of training using vessels, aircraft, and sonars would be similar to those under the No Action Alternative. The locations and number of activities proposed for training under Alternative 1 are shown in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). Sounds produced during training are described in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources), Section 3.0.5.3.1.6 (Vessel Noise), and Section 3.0.5.3.1.7 (Aircraft Overflight Noise).

In comparison to the No Action Alternative, the increased use under Alternative 1 of sonars, vessels, and aircraft associated with training would increase the likelihood of exposure of marine invertebrates to non-impulsive underwater sounds. The expected impacts on individual marine invertebrates capable of detecting the sound, however, would remain the same. For the same reasons as stated in Section 3.8.3.1.1.1 (No Action Alternative), non-impulsive sounds associated with training are not expected to impact most marine invertebrates or cause more than a short-term behavioral disturbance to some marine invertebrates capable of detecting nearby sound. No long-term impacts on the survival, growth, recruitment, or reproduction of marine invertebrate populations are expected. Similarly, non-impulsive underwater sound during training would not impact ESA-listed black or white abalone, coral species proposed for ESA listing, or their critical habitat. The stressors discussed in this section do not co-occur with ESA-listed species or coral species proposed for ESA listing.

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities as described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Under Alternative 1, marine invertebrates would be exposed to increased amounts of sonars and active acoustic sources (including sources not analyzed under the No Action Alternative), vessel noise, and aircraft overflight noise during testing activities compared to the No Action Alternative. The locations of testing activities using vessels, aircraft, and sonars and other active acoustic sources would be similar to those under the No Action Alternative. The locations and number of activities proposed for testing under Alternative 1 are shown in Tables 2.8-2 through 2.8-5 of Chapter 2 (Description of Proposed Action and Alternatives). Sounds produced during testing are described in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources), Section 3.0.5.3.1.6 (Vessel Noise), and Section 3.0.5.3.1.7 (Aircraft Overflight Noise).

In comparison to the No Action Alternative, the increased use under Alternative 1 of sonars, vessels, and aircraft associated with testing would increase the likelihood of exposure of marine invertebrates to non-impulsive underwater sounds. The expected impacts on individual marine invertebrates capable of detecting the sound, however, would remain the same. For the same reasons as stated in Section 3.8.3.1.1.1 (No Action Alternative), non-impulsive sounds associated with testing are not expected to impact most marine invertebrates or cause more than a short-term behavioral disturbance to some marine invertebrates capable of detecting nearby sound. No long-term impacts on the survival, growth, recruitment, or reproduction of marine invertebrate populations are expected. Similarly, non-impulsive underwater sound during training would not impact ESA-listed black or white abalone, coral species proposed for ESA listing, or their critical habitat. The stressors discussed in this section do not co-occur with ESA-listed species or coral species proposed for ESA listing.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities as described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.1.1.3 Alternative 2

Training Activities

Under Alternative 2, the number of training activities with non-impulsive sound would be the same as under Alternative 1. Therefore, Alternative 2 would have the same effects as under Alternative 1.

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities as described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Under Alternative 2, marine invertebrates would be exposed to increased amounts of sonars and active acoustic sources, vessel noise, and aircraft overflight noise during testing activities compared to the No Action Alternative. The locations of testing activities using vessels, aircraft, and sonars and other active acoustic sources would be similar to those under the No Action Alternative. The locations and number of activities proposed for testing under Alternative 2 are shown in Tables 2.8-2 through 2.8-5 of Chapter 2 (Description of Proposed Action and Alternatives). Sounds produced during testing are described in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources), Section 3.0.5.3.1.6 (Vessel Noise), and Section 3.0.5.3.1.7 (Aircraft Overflight Noise).

In comparison to the No Action Alternative, the increased use under Alternative 2 of sonars, vessels, and aircraft associated with testing would increase the likelihood of exposure of marine invertebrates to non-impulsive underwater sounds. The expected impacts on individual marine invertebrates capable of detecting the sound, however, would remain the same. For the same reasons as stated in Section 3.8.3.1.1.2 (Alternative 1), non-impulsive sounds associated with testing are not expected to impact most marine invertebrates or cause more than a short-term behavioral disturbance to some marine invertebrates capable of detecting nearby sound. No long-term impacts on the survival, growth, recruitment, or reproduction of marine invertebrate populations are expected. Similar to Alternative 2, non-impulsive underwater sound during training would not affect ESA-listed black or white abalone, coral species proposed for ESA listing, or their critical habitats. The stressors discussed in this section do not co-occur with ESA-listed species or coral species proposed for ESA listing.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities as described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.1.1.4 Substressor Impact on Sedentary Invertebrate Beds and Reefs as Essential Fish Habitat

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

3.8.3.1.2 Impacts from Explosives and Other Impulsive Sources

Explosives impact pile driving; weapons firing, launch, and impact of ordnance on the water surface; and swimmer defense airguns introduce loud, impulsive, broadband sounds into the marine environment.

Impulsive sources are characterized by rapid pressure rise times and high peak pressures. Explosions produce high-pressure shock waves that could cause injury or physical disturbance due to rapid pressure changes. Some other impulsive sources, such as swimmer defense airguns and impact pile driving, also produce shock waves, but of lower intensity. Impulsive sounds are usually brief, but the associated rapid pressure changes can injure or startle marine invertebrates.

Limited studies of crustaceans have examined mortality rates at various distances from detonations in shallow water (Aplin 1947; Chesapeake Biological Laboratory 1948; Gaspin et al. 1976). Similar studies of mollusks have shown them to be more resistant than crustaceans to explosive impacts (Chesapeake Biological Laboratory 1948; Gaspin et al. 1976). Other invertebrates found in association with mollusks, such as sea anemones, polychaete worms, isopods, and amphipods, were observed to be undamaged in areas near detonations (Gaspin et al. 1976). Using data from these experiments, Young (1991) developed curves that estimate the distance from an explosion beyond which at least 90 percent of certain marine invertebrates would survive, depending on the weight of the explosive (Figure 3.8-2).

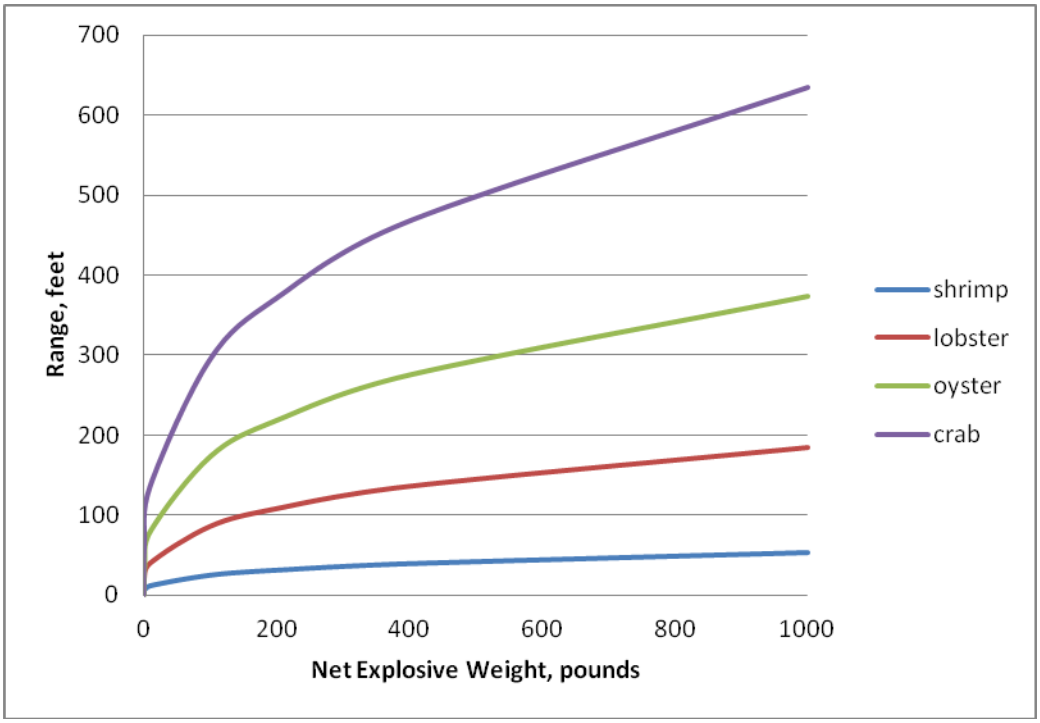

Figure 3.8-2: Prediction of Distance to 90 Percent Survivability of Marine Invertebrates Exposed to an Underwater Explosion (Young 1991)

In deeper waters where most detonations would occur near the water surface, most benthic marine invertebrates would be beyond the 90 percent survivability ranges shown above, even for larger quantities of explosives. In addition, most detonations would occur near the water surface, releasing a portion of the explosive energy into the air rather than the water and reducing impacts to marine invertebrates throughout the water column. The number of organisms affected would depend on the size of the explosive, the distance from the explosion, and the presence of groups of pelagic invertebrates. In addition to trauma caused by a shock wave, organisms could be killed in an area of cavitation that forms near the surface above large underwater detonations. Cavitation is where the

reflected shock wave creates a region of negative pressure followed by a collapse, or water hammer (see Section 3.0.4, Acoustic and Explosives Primer).

Some charges are detonated in shallow water or near the seafloor, including explosive ordnance demolition charges and some explosions associated with mine warfare. In addition to injuring nearby organisms, a blast near the bottom could potentially disturb hard substrate suitable for colonization (see Section 3.3.3.1, Acoustic Stressors). An explosion in the near vicinity of hard corals could cause fragmentation and siltation of the corals. Shallow coral reefs are avoided during all activities involving explosives. Hardbottom substrates are protected during mine warfare exercises and precision anchoring exercises. Hardbottom areas are used for some explosives training, but these occur in the same designated locations within Silver Strand Training Complex (SSTC) (see Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring). It should be noted that coral species proposed for ESA listing do not occur in areas that are used for shallow water explosives training.

Impulses from pile driving and removal are broadband and carry most of their energy in the lower frequencies (see Section 3.0.5.3.1.3, Pile Driving, for a discussion of sounds produced during impact pile driving and vibratory pile removal). Impact pile driving can produce a shock wave that is transmitted to the sediment and water column (Reinhall and Dahl 2011). Nearby marine invertebrates could be killed or injured by the physical placement of the pile or by the impulses. Marine invertebrates in the area around a pile driving and vibratory removal site would be exposed to multiple impulsive sounds over an estimated 13 days. Repeated exposures to impulsive noise, such as pile driving, could damage structures used by some marine invertebrates to sense water motion, although studies have shown crustaceans may withstand repeated impulsive exposures without sensory damage.

Air guns have slower rise times and lower peak pressures than many explosives. Studies of airgun impacts on marine invertebrates have used seismic airguns, which are more powerful than any swimmer defense airguns proposed for use during Navy testing. Studies of crustaceans have shown that adult crustaceans were not noticeably physically affected by exposures to intense seismic airgun use (Christian et al. 2003; Payne et al. 2007). Snow crab eggs repeatedly exposed to airgun firings had slightly increased mortality and apparent delayed development (Christian et al. 2003), but Dungeness crab (*Metacarcinus magister*) zoeae were not affected by repeated exposures (Pearson et al. 1993). Some squid showed strong startle responses, including inking, when exposed to the first shot of broadband sound from a nearby seismic airgun (sound exposure level of 163 dB re 1 μPa^2-s), but strong startle responses were not seen when sounds were gradually increased (McCauley et al. 2000a; McCauley et al. 2000b). Seismic airguns were implicated in giant squid strandings in unpublished reports (Guerra and Gonzales 2006; Guerra et al. 2004). Although analyses of the damage to the stranded squid were inconclusive and proximity to the airguns was unknown, the report hypothesized that the squid may have become disoriented due to statolith damage or may have been close enough to experience shock wave impacts. Airguns used during testing of swimmer defense systems are intended to be nonlethal swimmer deterrents, and are substantially less powerful than those used in seismic studies. It is unlikely that they would injure marine invertebrates. Some pelagic invertebrates such as squid within a short distance may startle and swim away from these swimmer defense airguns.

Firing weapons on a ship generates sound by firing the gun (muzzle blast), the shell flying through the air, and vibration from the blast propagating through the ship's hull (see Section 3.0.5.3.1.5, Weapons Firing, Launch, and Impact Noise). In addition, larger non-explosive munitions and targets could produce loud impulsive noise when hitting the water, depending on the size, weight, and speed of the object at

impact (McLennan 1997). Small- and medium-caliber munitions are not expected to produce substantial impact noise.

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

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

3.8.3.1.2.1 No Action Alternative

Training Activities

Under the No Action Alternative, marine invertebrates would be exposed to explosions at or beneath the water surface and underwater impulsive noise from weapons firing, launches, impacts of non-explosive munitions, and pile driving during training activities. Noise could be produced by explosions, weapons firing, launches, and impacts of non-explosive munitions throughout the Study Area, including HRC, SOCAL, and SSTC. The number of training events using explosives, weapons firing, launches, and non-explosive munitions and their proposed locations are presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). A discussion of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosions). The largest source class proposed for training under the No Action Alternative is E13 (greater than 1,000 pounds [lb.] net explosive weight), used during bombing exercises (air-to-surface) and sinking exercises. Under the No Action Alternative, up to nine detonations of this size may occur. The types of noise produced during weapons firing, launches, and non-explosive munitions impact are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise). Pile driving noise is discussed in Section 3.0.5.3.1.3 (Pile Driving).

In general, explosive events would consist of a single explosion or a few smaller explosions over a short period. Some marine invertebrates close to a detonation would likely be killed, injured, broken, or displaced. Most detonations would occur greater than 3 nautical miles (nm) from shore. As water depth increases away from shore, benthic and pelagic invertebrates would be less likely to be impacted by detonations at or near the surface. In addition, detonations near the surface would release a portion of their explosive energy into the air, reducing the explosive impacts in the water.

Many corals and hardbottom invertebrates are sessile, fragile, and particularly vulnerable to shock wave impacts. Many of these organisms are slow-growing and could require decades to recover (Precht et al. 2001). Explosive impacts on benthic invertebrates are more likely when an explosive is large compared to the water depth or when an explosive is detonated at or near the bottom; however, most explosions would occur at or near the water surface, reducing the likelihood of bottom impacts.

Black abalone and, to an even lesser extent, white abalone, could be exposed to underwater detonations associated with training exercises; however, because the number of underwater detonations is very small (no more than 18 per year; see Table 2.8-1), and because of the Navy's avoidance of rocky habitat and the very low population densities of black abalone, the probability of black abalone being exposed to these activities is sufficiently small to be discountable. Similarly, the Navy has committed to restrict activities such as amphibious assaults, insertion and extraction, and Naval Fire Support to areas that would not support black abalone, so black abalone or white abalone are not likely to be exposed to stressors associated with these activities. As a result, black abalone and white abalone may be affected by the training exercises and testing activities the Navy proposes to conduct in the SOCAL Range Complex portion of the Study Area, but is not likely to be adversely affected by those activities. There is no designated critical habitat for ESA-listed black or white abalone on San Clemente Island, and other underwater explosions would not overlap with critical habitat.

The four species of coral currently proposed for ESA listing are not known to be located where underwater explosives trainings occur. As described in Section 3.8.2.5 and Section 3.8.2.8, fuzzy table coral and sandpaper rice coral are found within Papahanaumokuakea Marine National Monument around French Frigate Shoals. As described in Section 3.8.2.6, irregular rice coral is only known to occur in Kaneohe Bay. Blue rice coral has a wider distribution in the Hawaiian Islands (see Section 3.8.2.7). However, these nearshore locations do not coincide with training activities that use underwater explosions. Therefore, the four coral species currently proposed for listing under the ESA would not be affected by training activities that use explosives. NMFS has not designated critical habitat for these coral species.

Pile driving could cause additional injury, mortality, displacement, or disturbance of marine invertebrates in the vicinity of the construction area; however, impacts at the proposed sandy beach and San Diego Bay locations would be recoverable. Because impulsive exposures are brief, limited in number, spread over a large area, no long-term impacts due to startle reactions or short-term behavioral changes would be expected.

Noise produced by weapons firing, launches, and impacts of non-explosive munitions would consist of a single or several impulses over a short period and would likely not be injurious.

Some marine invertebrates may be sensitive to the low-frequency component of impulsive sound, and they may exhibit startle reactions or temporary changes in swim speed in response to an impulsive exposure. Because exposures are brief, limited in number, and spread over a large area, no long-term impacts due to startle reactions or short-term behavioral changes are expected. Although individual marine invertebrates may be injured or killed during an explosion, no long-term impacts on the survival, growth, recruitment, or reproduction of marine invertebrate populations are expected.

Pursuant to the ESA, the use of explosives and other impulsive sources during training activities as described under the No Action Alternative:

- *may affect, but is not likely to adversely affect, ESA-listed abalone species,*
- *would have no effect on any of the four coral species currently proposed for ESA listing, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Under the No Action Alternative, marine invertebrates would be exposed to explosions at or beneath the water surface and underwater impulsive sounds from swimmer defense airguns, weapons firing, launches, and impacts of non-explosive munitions during testing activities. Testing activities under the No Action Alternative would not include pile driving. Noise could be produced by explosions, weapons firing, launches, and impacts of non-explosive munitions throughout the Study Area, including HRC, SOCAL, and SSTC. The number of testing events using explosives, swimmer defense airguns, weapons firing, launches, and non-explosive munitions and their proposed locations are presented in Tables 2.8-2 through 2.8-5 of Chapter 2 (Description of Proposed Action and Alternatives). A discussion of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosions). The types of noise produced during weapons firing, launches, and non-explosive munitions impact are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise). Noise produced by the firing of swimmer defense airguns is discussed in Section 3.0.5.3.1.4 (Swimmer Defense Airguns). The largest source class proposed for testing under the No Action Alternative is E11 (651–1,000 lb. net explosive weight).

Many corals and hardbottom invertebrates are sessile, fragile, and particularly vulnerable to shock wave impacts. Many of these organisms are slow-growing and could require decades to recover (Precht et al. 2001). Explosive impacts on benthic invertebrates and pelagic invertebrates (e.g., squid) are more likely when an explosive is large compared to the water depth or when an explosive is detonated at or near the bottom; however, most explosions would occur at or near the water surface, reducing the likelihood of bottom impacts.

Explosions from underwater detonations during mine warfare activities could create shock waves that may affect ESA-listed black and white abalone. Underwater detonations, however, would typically occur over soft-bottom substrate and not near abalone habitat areas, which is not considered black or white abalone habitat. There is no designated critical habitat for ESA-listed black or white abalone on San Clemente Island, and other underwater explosions would not overlap with critical habitat.

The four species of coral currently proposed for ESA listing are not known to be located where underwater explosives testing activities occur. As described in Section 3.8.2.5 and Section 3.8.2.8, fuzzy table coral and sandpaper rice coral are found within Papahanaumokuakea Marine National Monument around French Frigate Shoals. As described in Section 3.8.2.6, irregular rice coral is only known to occur in Kaneohe Bay. Blue rice coral has a wider distribution in the Hawaiian Islands (see Section 3.8.2.7). However, these nearshore locations do not coincide with testing activities that use underwater explosions. Therefore, the four coral species currently proposed for listing under the ESA would not be affected by testing activities that use explosives. NMFS has not designated critical habitat for these coral species.

Noise produced by swimmer defense airguns, weapons firing, launches, and impacts of non-explosive munitions would consist of a single or several impulses over a short period and would likely not be injurious.

Some marine invertebrates may be sensitive to the low-frequency component of impulsive sound, and they may exhibit startle reactions or temporary changes in swim speed in response to an impulsive exposure. Because impulsive exposures are brief, limited in number, and spread over a large area, no long-term impacts due to startle reactions or short-term behavioral changes are expected. Although

individual marine invertebrates may be injured or killed during an explosion, no long-term impacts on the survival, growth, recruitment, or reproduction of marine invertebrate populations are expected.

Pursuant to the ESA, the use of explosives and other impulsive sources during testing activities as described under the No Action Alternative:

- *may affect, but is not likely to adversely affect, ESA-listed abalone species;*
- *would have no effect on any of the four coral species currently proposed for ESA listing; and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.1.2.2 Alternative 1

Training Activities

Under Alternative 1, marine invertebrates would be exposed to explosions at or beneath the water surface and underwater impulsive noise from weapons firing, launches, impacts of non-explosive munitions, and pile driving during training activities. Although training would increase, it would generally occur in the same areas as under the No Action Alternative, with the addition of explosives used during mine neutralization-explosive ordnance demolition. The largest source class proposed for training under Alternative 1 is E13, used during bombing exercises (air-to-surface) and sinking exercises. The number of training events using explosives, weapons firing, launches, and non-explosive munitions and their proposed locations are presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). A discussion of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosions). The types of noise produced during weapons firing, launches, and non-explosive munitions impact are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise). Pile driving noise is discussed in Section 3.0.5.3.1.3 (Pile Driving).

Although more marine invertebrates could be exposed to explosions at or near the water surface and underwater impulsive noise due to weapons firing, launches, and non-explosive munitions impacts, the type of impacts to individual marine invertebrates are expected to remain the same as those described under the No Action Alternative (Section 3.8.3.1.2.1, No Action Alternative). Although individual marine invertebrates may be injured or killed during an explosion or during pile driving, no long-term impacts on the survival, growth, recruitment, or reproduction of marine invertebrate populations are expected.

Explosions from underwater detonations during mine warfare activities could create shock waves that may affect ESA-listed black and white abalone. Underwater detonations, however, would typically occur over soft-bottom substrate, which is not considered black or white abalone habitat. These explosions would not occur near abalone habitats, so the likelihood of shock waves from explosions affecting abalone is sufficiently small to be discountable. There is no designated critical habitat for ESA-listed black or white abalone on San Clemente Island, and other underwater explosions would not overlap with critical habitat.

The four species of coral currently proposed for ESA listing are not known to be located where underwater explosives training activities occur under Alternative 1. As described in Section 3.8.2.5 and Section 3.8.2.8, fuzzy table coral and sandpaper rice coral are found within Papahanaumokuakea Marine National Monument around French Frigate Shoals. As described in Section 3.8.2.6, irregular rice coral is only known to occur in Kaneohe Bay. Blue rice coral has a wider distribution in the Hawaiian Islands (see Section 3.8.2.7). However, these nearshore locations do not coincide with testing activities that use underwater explosions. Therefore, the four coral species currently proposed for listing under the ESA

would not be affected by training activities that use explosives. NMFS has not designated critical habitat for these coral species.

Pursuant to the ESA, the use of explosives and other impulsive sources during training activities as described under Alternative 1:

- *may affect, but is not likely to adversely affect, ESA-listed abalone species;*
- *would have no effect on any of the four coral species currently proposed for ESA listing; and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Under Alternative 1, marine invertebrates would be exposed to additional explosions at or beneath the water surface and increased amounts of underwater impulsive sounds due to swimmer defense airguns, weapons firing, launch, and impacts of non-explosive munitions during testing activities. It should be noted that the number of activities using swimmer defense airguns as part of testing activities would decrease from five events under the No Action Alternative to four events under Alternative 1. Testing activities under Alternative 1 would not include pile driving. The description, number, and proposed locations of testing activities are presented in Tables 2.8-2 through 2.8-5 of Chapter 2 (Description of Proposed Action and Alternatives).

Testing activities under Alternative 1 that produce in-water noise from weapons firing, launch, and impacts of non-explosive munitions with the water's surface would increase compared to the No Action Alternative. The types of noise produced during weapons firing, launches, and non-explosive munitions impact are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise).

Although more marine invertebrates could be exposed to explosions and impulsive noise due to swimmer defense airguns, weapons firing, launches, and non-explosive munitions impacts, the type of impacts to individual marine invertebrates are expected to remain the same as those described under the No Action Alternative (Section 3.8.3.1.2.1, No Action Alternative). Because impulsive exposures are brief, limited in number, and spread over a large area, no long-term impacts due to startle reactions or short-term behavioral changes are expected. Although individual marine invertebrates may be injured or killed during an explosion, no long-term impacts on the survival, growth, recruitment, or reproduction of marine invertebrate populations are expected.

Explosions from underwater detonations during mine warfare activities could create shock waves that may affect ESA-listed black and white abalone. Underwater detonations, however, would typically occur over soft-bottom substrate, which is not considered black or white abalone habitat. These explosions would not occur near abalone habitats, so the likelihood of shock waves from explosions affecting abalone is sufficiently small to be discountable. There is no designated critical habitat for ESA-listed black or white abalone on San Clemente Island, and other underwater explosions would not overlap with critical habitat.

The four species of coral currently proposed for ESA listing are not known to be located where underwater explosives testing activities occur under Alternative 1. As described in Section 3.8.2.5 and Section 3.8.2.8, fuzzy table coral and sandpaper rice coral are found within Papahanaumokuakea Marine National Monument around French Frigate Shoals. As described in Section 3.8.2.6, irregular rice coral is only known to occur in Kaneohe Bay. Blue rice coral has a wider distribution in the Hawaiian Islands (see Section 3.8.2.7). However, these nearshore locations do not coincide with testing activities that use

underwater explosions. Therefore, the four coral species currently proposed for listing under the ESA would not be affected by testing activities that use explosives under Alternative 1.

Pursuant to the ESA, the use of explosives and other impulsive sources during testing activities as described under Alternative 1:

- *may affect, but is not likely to adversely affect, ESA-listed abalone species;*
- *would have no effect on any of the four coral species currently proposed for ESA listing; and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.1.2.3 Alternative 2

Training Activities

Under Alternative 2, the number of training activities and number of underwater explosions would be the same as under Alternative 1 (see Table 3.0-9). The locations of explosions would be the same as under Alternative 1. Therefore, Alternative 2 would have the same effects as under Alternative 1.

Pursuant to the ESA, the use of explosives and other impulsive sources during training activities as described under Alternative 2:

- *may affect, but is not likely to adversely affect, ESA-listed abalone species;*
- *would have no effect on any of the four coral species currently proposed for ESA listing; and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Under Alternative 2, marine invertebrates would be exposed to additional explosions at or beneath the water surface and increased amounts of underwater impulsive sounds due to weapons firing, launch, and impacts of non-explosive munitions during testing activities. The number of testing activities that use swimmer defense airguns would not change relative to the No Action Alternative. Testing activities under Alternative 2 would not include pile driving. The description, number, and proposed locations of testing activities are presented in Tables 2.8-2 through 2.8-5 of Chapter 2 (Description of Proposed Action and Alternatives).

Testing activities under Alternative 2 that produce in-water noise from weapons firing, launch, and impacts of non-explosive munitions with the water's surface would increase compared to the No Action Alternative. The types of noise produced during weapons firing, launches, and non-explosive munitions impact are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise).

Although more marine invertebrates could be exposed to explosions and impulsive noise due to swimmer defense airguns, weapons firing, launches, and non-explosive munitions impacts, the type of impacts to individual marine invertebrates are expected to remain the same as those described under the No Action Alternative (Section 3.8.3.1.2.1, No Action Alternative). Because impulsive exposures are brief, limited in number, and spread over a large area, no long-term impacts due to startle reactions or short-term behavioral changes are expected. Although individual marine invertebrates may be injured or killed during an explosion, no long-term impacts on the survival, growth, recruitment, or reproduction of marine invertebrate populations are expected.

Explosions from underwater detonations during mine warfare activities could create shock waves that may affect ESA-listed black and white abalone. Underwater detonations, however, would typically occur

over soft-bottom substrate, which is not considered black or white abalone habitat. These explosions would not occur near abalone habitats, so the likelihood of shock waves from explosions affecting abalone is sufficiently small to be discountable. There is no designated critical habitat for ESA-listed black or white abalone on San Clemente Island, and other underwater explosions would not overlap with critical habitat.

The four species of coral currently proposed for ESA listing are not known to be located where underwater explosives testing activities occur under Alternative 2. As described in Section 3.8.2.5 and Section 3.8.2.8, fuzzy table coral and sandpaper rice coral are found within Papahanaumokuakea Marine National Monument around French Frigate Shoals. As described in Section 3.8.2.6, irregular rice coral is only known to occur in Kaneohe Bay. Blue rice coral has a wider distribution in the Hawaiian Islands (see Section 3.8.2.7). However, these nearshore locations do not coincide with testing activities that use underwater explosions. Therefore, the four coral species currently proposed for listing under the ESA would not be affected by testing activities that use explosives under Alternative 2.

Pursuant to the ESA, the use of explosives and other impulsive sources during testing activities as described under Alternative 2:

- *may affect, but is not likely to adversely affect, ESA-listed abalone species;*
- *would have no effect on any of the four coral species currently proposed for ESA listing; and*
- *would have no effect on ESA-listed black abalone critical habitat.*

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

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

3.8.3.2 Energy Stressors

This section analyzes the potential impacts of the various types of energy stressors that can occur during training and testing activities within the Study Area. This section includes analysis of the potential impacts from electromagnetic devices.

3.8.3.2.1 Impacts from Electromagnetic Devices

Several different types of electromagnetic devices are used during training and testing activities. For a discussion of the types of activities that use electromagnetic devices, where they are used, and how many activities would occur under each alternative, please see Section 3.0.5.3.2.1 (Electromagnetic Devices). Aspects of electromagnetic stressors that are applicable to marine organisms in general are presented in Section 3.0.5.7.2 (Conceptual Framework for Assessing Effects from Energy-Producing Activities).

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

Important physical and biological characteristics of habitat for ESA-listed black and white abalone are defined in Sections 3.8.2.3.2 and 3.8.2.4.2 (Habitat and Geographic Range), respectively. There is no established mechanism for energy stressors to affect important characteristics of this critical habitat. Therefore; it is not probable that energy stressors could degrade the quality or quantity of black and white abalone habitat.

3.8.3.2.1.1 No Action Alternative

Training Activities

Table 3.0-18 lists the number and location of training activities that use electromagnetic devices. As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under the No Action Alternative, training activities involving electromagnetic devices occur during magnetic influence mine sweeping activities as part of mine warfare. No training activities involving electromagnetic devices would occur in HRC under the No Action Alternative.

Species that do not occur within these specific areas—including ESA-listed black and white abalone and coral species currently proposed for ESA listing—would not be exposed to electromagnetic fields associated with Navy training activities. Species that do occur within the areas listed above could be exposed to electromagnetic fields. Electromagnetic devices associated with training activities would not be used in habitat for black and white abalone. Therefore, electromagnetic devices would not affect black abalone or white abalone habitats or black abalone critical habitat. Critical habitat has not been designated for the four species of coral currently proposed for ESA listing.

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

Pursuant to the ESA, the use of electromagnetic devices during training activities as described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed white abalone or black abalone critical habitats.*

Testing Activities

Table 3.0-18 lists the number and location of testing activities that use electromagnetic devices. As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under the No Action Alternative, testing activities involving electromagnetic devices occur during airborne towed minesweeping systems testing activities in SOCAL; no testing activities involving electromagnetic devices would occur in HRC under the No Action Alternative.

Species that do not occur within these specified areas—including ESA-listed black and white abalone and the four species of coral currently proposed for ESA listing—would not be exposed to electromagnetic fields. Species that do occur within the areas listed above could be exposed to electromagnetic fields. Electromagnetic devices associated with training activities would not be used in black or white abalone habitat areas. Therefore, electromagnetic devices would not affect black abalone or white abalone habitats or black abalone critical habitat. Critical habitat has not been designated for the four species of coral currently proposed for ESA listing.

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

Pursuant to the ESA, the use of electromagnetic devices during testing activities as described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.2.1.2 Alternative 1

Training Activities

Table 3.0-18 lists the number and location of training activities that use electromagnetic devices. As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 1, training activities involving electromagnetic devices occur during magnetic influence mine sweeping activities as part of mine warfare. The number of mine countermeasures activities in SOCAL would remain the same. No training activities involving electromagnetic devices would occur in HRC under Alternative 1.

Species that do not occur within these specified areas—including ESA-listed black and white abalone and the four species of coral currently proposed for ESA listing—would not be exposed to electromagnetic fields. Species that do occur within the areas listed above could be exposed to electromagnetic fields. Electromagnetic devices associated with training activities would not be used in black or white abalone

habitat areas or designated black abalone habitat. Critical habitat has not been designated for the four species of coral currently proposed for ESA listing.

As with the No Action Alternative, these training events would occur in open waters where the depth to the seafloor allows for the dissipation of electromagnetic waves. Therefore, since electromagnetic devices would be used less often under Alternative 1, individual impacts would be the same, but the likelihood of exposure would be reduced.

Pursuant to the ESA, the use of electromagnetic devices during training activities as described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Table 3.0-18 lists the number and location of testing activities that use electromagnetic devices. As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 1, testing activities involving electromagnetic devices occur during airborne towed minesweeping systems testing activities in the open ocean portions of SOCAL; no testing activities involving electromagnetic devices would occur in HRC or within SSTC under Alternative 1. The number of testing activities that use electromagnetic devices would increase under from 15 under the No Action Alternative to 27 events under Alternative 1.

Species that do not occur within these specified areas—including ESA-listed black and white abalone and the four species of coral currently proposed for ESA listing—would not be exposed to electromagnetic fields. Species that do occur within the areas listed above could be exposed to electromagnetic fields. Electromagnetic devices associated with testing activities would not be used in black abalone or white habitat or designated black abalone critical habitat. Therefore, electromagnetic devices would not affect black abalone critical habitat. Critical habitat has not been proposed for the four species of coral currently proposed for ESA listing.

As with the No Action Alternative, testing activities under Alternative 1 would occur in open waters, where depth to the seafloor allows for the dissipation of electromagnetic waves. Therefore, since electromagnetic devices would used in the same number of testing activities, effects of electromagnetic stressors under Alternative 1 would have no impact, as under the No Action Alternative.

Pursuant to the ESA, the use of electromagnetic devices during testing activities as described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.2.1.3 Alternative 2

Training Activities

Under Alternative 2, training activities would be consistent with Alternative 1. Therefore, Alternative 2 would have the same effects as under Alternative 1.

Pursuant to the ESA, the use of electromagnetic devices during training activities as described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Table 3.0-18 lists the number and location of testing activities that use electromagnetic devices. As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 2, testing activities involving electromagnetic devices occur during airborne towed minesweeping systems testing activities in the open ocean portions of SOCAL; no testing activities involving electromagnetic devices would occur in HRC or within SSTC under Alternative 2. The number of testing activities that use electromagnetic devices would increase under from 15 under the No Action Alternative to 31 events under Alternative 2. This represents a slight increase relative to Alternative 1 (two additional events).

Pursuant to the ESA, the use of electromagnetic devices during testing activities as described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

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

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

3.8.3.3 Physical Disturbance and Strike Stressors

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

Most marine invertebrate populations extend across wide areas containing hundreds or thousands of discrete patches of suitable habitat. Sessile (attached to the seafloor) invertebrate populations may be maintained by complex currents that carry adults and young from place to place. Such widespread populations are difficult to evaluate in terms of Navy training and testing activities that occur in relatively small areas of the Study Area. In this context, a physical strike or disturbance would impact individual organisms directly or indirectly, but not to the extent that the viability of populations or species would be impacted.

With few exceptions, activities involving vessels and in-water devices are not intended to contact the seafloor. Except for amphibious activities and bottom-crawling unmanned underwater vehicles, there is no potential strike impact and limited potential disturbance impact on benthic or habitat-forming marine invertebrates.

With the exception of corals and other sessile benthic invertebrates, most invertebrate populations recover quickly from disturbance. Many large invertebrates, such as crabs, shrimps, and clams, undergo massive disturbance during commercial and recreational harvests or during disturbances within the surf zone. Other invertebrates, such as the small soft-bodied organisms that live in the bottom sediment, are thought to be well-adapted to natural physical disturbances, although recovery from human-induced disturbance is delayed by decades or more (Lindholm et al. 2011). These populations would recover from a strike or other disturbance on scales of weeks to years. Biotic habitats, such as coral reefs, deep-sea coral, and sponge communities, may take decades to re-grow following a strike or disturbance (Precht et al. 2001).

3.8.3.3.1 Impacts from Vessels and In-Water Devices

The majority of the training and testing activities under all the alternatives involve vessels, and a few of the activities involve the use of in-water devices. For a discussion of the types of activities that use vessels and in-water devices, where they are used, and how many events would occur under each alternative, see Tables 3.0-30 and 3.0-38. See Table 3.0-19 for a representative list of Navy vessel sizes and speeds and Table 3.0-31 for the types, sizes, and speeds of Navy in-water devices used in the Study Area.

Vessels and in-water devices could impact marine invertebrates by disturbing the water column or sediments, or directly striking organisms (Bishop 2008). The propeller wash (water displaced by propellers used for propulsion) from vessel movement and water displaced from vessel hulls could disturb marine invertebrates in the water column, and is a likely cause of zooplankton mortality (Bickel et al. 2011). This local and short-term exposure to vessel and propeller movements could displace, injure, or kill zooplankton, invertebrate eggs or larvae, and macro-invertebrates in the upper portions of the water column. It should be noted that the Navy avoids known abalone beds (as well as critical habitat designations) in waters off California and coral reefs that are known to support corals proposed for ESA listing within waters off Hawaii.

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

Vessels and towed in-water devices do not normally collide with invertebrates that inhabit the seafloor because Navy vessels are operated in relatively deep waters and have navigational capabilities to avoid contact with these habitats. A consequence of vessel operation in shallow water is increased turbidity from stirring-up bottom sediments. Turbidity can impact corals and invertebrate communities on hardbottom areas by reducing the amount of light that reaches these organisms and by clogging siphons for filter feeding organisms. Reef-building corals are sensitive to water clarity because they host symbiotic algae that require sunlight to live. Encrusting organisms residing on hardbottom can be

impacted by persistent silting from increased turbidity. In addition, propeller wash and physical contact with coral and hardbottom areas can cause structural damage to the substrate as well as mortality to encrusting organisms. While information on the frequency of vessel operations in shallow water is not adequate to support a specific risk assessment, typical navigational procedures minimize the likelihood of contacting the seafloor, and most Navy vessel movements in nearshore waters are confined to established channels and ports, or predictable transit lanes within the Hawaiian Islands or between San Diego Bay and San Clemente Island.

Amphibious vessels would contact the seafloor in the surf zone during Amphibious Assault and Amphibious Raid operations. Benthic invertebrates within the disturbed area, such as crabs, clams, and polychaete worms, could be displaced, injured, or killed during amphibious operations. Benthic invertebrates inhabiting these areas are adapted to a highly variable environment and are expected to rapidly re-colonize disturbed areas by immigration and larval recruitment. Studies indicate that benthic communities of high energy, sandy beaches recover relatively quickly (typically within 2 to 7 months) following beach nourishment (U.S. Army Corps of Engineers 2001). Schoeman et al. (2000) found that the macrobenthic (visible organisms on the seafloor) community required between 7 and 16 days to recover, following excavation and removal of sand from a 2,150 ft.^{2} (200 m^2) quadrant in the mid-intertidal zone of a sandy beach. The impacts of amphibious vehicle operations on benthic communities would be relatively minor, short-term, and local.

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

3.8.3.3.1.1 No Action Alternative

Training Activities

As indicated in Sections 3.0.5.3.3.1 (Vessels) and 3.0.5.3.3.2 (In-Water Devices), the majority of the training activities include vessels, and a few of the activities involve the use of in-water devices. These activities could be widely dispersed throughout the Study Area, but would be more concentrated near naval ports, piers and ranges. Amphibious landings could occur in SSTC, SOCAL, and HRC. Amphibious landings in HRC would be restricted to designated beaches. Hydrographic surveys have supported the mapping of precise transit routes through sandy bottom areas to avoid potential vessel strikes of coral reefs. In addition, during landings, crews follow procedures to identify obstructions to navigation, which would include coral reefs.

Species that do not occur near the surface within the Study Area—including ESA-listed black and white abalone—would not be exposed to vessel strikes. In addition, these species would not be affected by amphibious landings since ESA-listed black and white abalone inhabit rocky shores and hardbottom, which are not used for amphibious landings. There is no designated critical habitat on San Clemente Island, where the majority of amphibious landings would occur, and the majority of vessel movements would occur in the open ocean. Coral species that are currently proposed for ESA listings are located in discrete areas where vessel movements and amphibious landings do not occur. Therefore, these corals will not be affected by vessel movements or in-water devices.

Species that do occur near the surface within the Study Area would have the potential to be exposed to vessel strikes. Large, slow vessels would pose little risk to marine invertebrates in the open ocean although, in coastal waters, currents from large vessels may cause resuspension and settlement of

sediment onto sensitive invertebrate communities. Vessels travelling at high speeds would generally pose more of a risk through propeller action in shallow waters. Under the No Action Alternative, these shallow-water vessels would continue to operate in defined boat lanes with sufficient depths to avoid propeller or hull strikes of benthic invertebrates.

There would be a higher likelihood of vessel strikes over the continental shelf portions of the Study Area because of the concentration of vessel movements in those areas. Exposure of marine invertebrates to vessel disturbance and strikes is limited to organisms in the uppermost portions of the water column. Pelagic marine invertebrates are generally disturbed, rather than struck, as the water flows around the vessel or in-water device. Invertebrates that occur on the seafloor, including shallow-water corals, hardbottom, and deep-water corals, are not likely to be exposed to this stressor because they typically occur at depths greater than that potentially impacted by vessels.

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

Pursuant to the ESA, the use of vessels or in-water devices during training activities as described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

As indicated in Sections 3.0.5.3.3.1 (Vessels) and 3.0.5.3.3.2 (In-Water Devices), Navy vessel movements and in-water devices would occur throughout the Study Area during testing activities. Vessel movements and in-water devices during testing activities would be similar to those described previously under training activities for the No Action Alternative.

Species that do not occur near the surface within the Study Area—including ESA-listed black and white abalone—would not be exposed to vessel strikes. In addition, these species would not be affected by amphibious landings since ESA-listed black and white abalones inhabit rocky shores and hardbottom, which are not used for amphibious landings. There is no designated critical habitat on San Clemente Island, where the majority of amphibious landings would occur, and the majority of vessel movements would occur in the open ocean. Coral species that are currently proposed for ESA listings are located in discrete areas where vessel movements and amphibious landings do not occur. Therefore, these corals will not be affected by vessel movements or in-water devices.

The impact of vessels and in-water devices on marine invertebrates would be inconsequential because: (1) the area exposed to the stressor amounts to a small portion of each vessel's and in-water device's footprint, and is extremely small relative to most marine invertebrates' ranges; (2) the frequency of activities involving the stressor is low such that few individuals could be exposed to more than one

event; and (3) exposures would be localized, temporary, and would cease with the conclusion of the activity. Activities involving vessels and in-water devices are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at the population level.

Pursuant to the ESA, the use of vessels or in-water devices during testing activities as described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.3.1.2 Alternative 1

Training Activities

As indicated in Sections 3.0.5.3.3.1 (Vessels) and 3.0.5.3.3.2 (In-Water Devices), the majority of the training activities include vessels, and a few of the activities involve the use of in-water devices. These activities could be widely dispersed throughout the Study Area, but would be more concentrated near naval ports, piers and ranges. Amphibious landings could occur in SSTC, SOCAL, and HRC. Amphibious landings in HRC would be restricted to designated beaches. Hydrographic surveys have supported the mapping of precise transit routes through sandy bottom areas to avoid potential vessel strikes of coral reefs. In addition, during landings, crews follow procedures to identify obstructions to navigation, which would include coral reefs.

The vessels and in-water devices used during training activities under Alternative 1 would be similar to those described under the No Action Alternative. Therefore, effects under Alternative 1 from vessel strikes and in-water devices would be similar to No Action Alternative.

Pursuant to the ESA, the use of vessels or in-water devices during training activities as described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

As indicated in Sections 3.0.5.3.3.1 (Vessels) and 3.0.5.3.3.2 (In-Water Devices), the majority of the testing activities include vessels, and a few of the activities involve the use of in-water devices. These activities could be widely dispersed throughout the Study Area, but would be more concentrated near naval ports, piers and ranges. Amphibious landings could occur in SSTC, SOCAL, and HRC.

The vessels and in-water devices used during testing activities under Alternative 1 would be similar to those described under the No Action Alternative. Therefore, effects under Alternative 1 from vessel strikes and in-water devices would be similar to No Action Alternative.

Pursuant to the ESA, the use of vessels or in-water devices during testing activities as described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.3.1.3 Alternative 2

Training

Under Alternative 2, training activities would be consistent with Alternative 1. Therefore, Alternative 2 would have the same effects as under Alternative 1.

Pursuant to the ESA, the use of vessels or in-water devices during training activities as described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing

As indicated in Sections 3.0.5.3.3.1 (Vessels) and 3.0.5.3.3.2 (In-Water Devices), the majority of the testing activities include vessels, and a few of the activities involve the use of in-water devices. These activities could be widely dispersed throughout the Study Area, but would be more concentrated near naval ports, piers and ranges. Amphibious landings could occur in SSTC, SOCAL, and HRC.

The vessels and in-water devices used during testing activities under Alternative 2 would be similar to those described under the No Action Alternative. Therefore, effects under Alternative 2 from vessel strikes and in-water devices would be similar to No Action Alternative.

Pursuant to the ESA, the use of vessels or in-water devices during testing activities as described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed white abalone or black abalone critical habitats.*

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

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

3.8.3.3.2 Impacts from Military Expended Materials

This section analyzes the strike potential to invertebrates from the following categories of military expended materials: (1) non-explosive practice munitions, (2) fragments from high-explosive munitions, and (3) expended materials other than ordnance, such as sonobuoys, vessel hulks, and expendable

targets. For a discussion of the types of activities that use military expended materials, where they are used, and how many activities would occur under each alternative, see Section 3.0.5.3.3.3 (Military Expended Materials).

Military expended materials are deposited throughout the Study Area. However, the majority of military expended materials are deposited within the confines of established gunnery ranges and weapons testing areas. These areas of higher military expended materials deposition are generally away from the coastline but on the continental shelf and slope.

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

Physical disturbances or strikes by military expended materials on marine invertebrates are possible at the water's surface, through the water column, and on the seafloor. Disturbance or strike impacts on marine invertebrates by military expended materials falling through the water column are possible, but not very likely because military expended materials do not generally sink rapidly enough to cause strike injury (i.e., as opposed to fragments propelled by high explosives); and exposed invertebrates would likely experience only temporary displacement as the object passes by. Therefore, the discussion of military expended materials disturbance and strikes will focus on military expended materials at the water's surface and on the seafloor. While marine invertebrates on the seafloor may be impacted by military expended materials propelled by high explosives, this event is not very likely except for mine warfare detonations, which typically occur at or near the seafloor.

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

3.8.3.3.2.1 Munitions

Small-, Medium-, and Large-Caliber Projectiles

Various types of projectiles could cause a temporary local impact when they strike the surface of the water. Navy training and testing in the Study Area, such as gunnery exercises, include firing a variety of weapons and using a variety of non-explosive training and testing rounds, including small-, medium-, and large-caliber projectiles. Large-caliber projectiles are primarily used in the open ocean beyond 20 nm.

Direct ordnance strikes from firing weapons are potential strike stressors to marine invertebrates. Military expended materials could impact the water with great force and produce a large impulse. Physical disruption of the water column is a local, temporary impact, and would be limited to a small area (within a radius of tens of meters) around the impact point, persisting for a few minutes. Physical and chemical properties of the surrounding water would be temporarily altered (e.g., slight heating or cooling and increased oxygen concentrations due to turbulent mixing with the atmosphere), but there would be no lasting change resulting in long-term impacts on marine invertebrates. Although the sea surface is rich with invertebrates, most are zooplankton and relatively few are large pelagic invertebrates (e.g., some jellyfish and some swimming crabs). Zooplankton, eggs and larvae, and larger

pelagic organisms in the upper portions of the water column could be displaced, injured, or killed by military expended materials impacting the sea surface. Individual organisms would be impacted directly or indirectly, but not to the extent that the viability of populations or species would be impacted, primarily because the number of organisms exposed to these devices is extremely small relative to population sizes.

Marine invertebrates on the seafloor could be displaced, injured, or killed by military expended materials contacting the seafloor. While all marine invertebrates living on or in the seafloor are susceptible to disturbance, strikes, and burial by military expended materials, only sessile (attached to the seafloor) marine invertebrates are susceptible to impact by abrasion. Parachutes are the principal source of abrasion stressors to marine invertebrates, and these are addressed separately because the nature of their potential impacts is materially different than other military expended materials.

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

Bombs, Missiles, and Rockets

Bombs, missiles, and rockets are potential strike stressors to marine invertebrates. The nature of their potential impacts is the same as projectiles. However, they are addressed separately because they are larger than most projectiles, and because high-explosive bombs, missiles, and rockets are likely to produce a greater number of small fragments than projectiles. Propelled fragments are produced by high explosives. Close to the explosion, invertebrates could be injured by propelled fragments. However, studies of underwater bomb blasts have shown that fragments are larger than those produced during air blasts and decelerate much more rapidly (O'Keefe and Young 1984; Swisdak Jr. and Montaro 1992), reducing the risk to marine organisms. Bombs, missiles, and rockets are designed to explode within 3 ft. (1 m) of the sea surface where marine invertebrates are relatively infrequent. The fitness of individual organisms would be impacted directly or indirectly, but not to the extent that the viability of populations or species would be impacted, primarily because the number of organisms exposed to these devices would be extremely small relative to population sizes.

3.8.3.3.2.2 Military Expended Materials other than Munitions

Vessel Hulk

During a sinking exercise, aircraft, ship, and submarine crews deliver ordnance on a surface target, which is a clean (Section 3.1, Sediments and Water Quality), deactivated ship deliberately sunk using multiple weapon systems. Sinking exercises occur in specific open ocean areas, outside of the coastal range complexes. Ordnance strikes by the various weapons used in these exercises are a potential source of impacts. However, these impacts are discussed for each of those weapons categories in this section and are not repeated here. Therefore, the analysis of sinking exercises as a strike potential for benthic invertebrates is discussed in terms of the vessel hulk landing on the seafloor. The primary difference between a vessel hulk and other military expended materials as a strike potential for marine invertebrates is a difference in scale. As the vessel hulk settles on the seafloor, all marine invertebrates within the footprint of the hulk would be impacted by strike or burial, and invertebrates a short distance beyond the footprint of the hulk would be disturbed. A vessel hulk may also change ocean flow patterns, sediment transport, and benthic communities. Habitat-forming invertebrates (i.e., corals) are likely

absent where sinking exercises are planned because this activity occurs in depths greater than the range of reef forming corals and most other habitat-forming invertebrates (approximately 10,000 ft. [3,050 m]) and away from hydrothermal vent communities. It is possible that deep-sea corals may be impacted by a sinking vessel hulk or fragments of a hulk, but the size of the impact on the seafloor relative to the relatively broad distribution of deep sea corals suggests that these impacts would seldom occur.

Parachutes

Parachutes of varying sizes are used during training and testing activities. For a discussion of the types of activities that use parachutes, physical characteristics of these expended materials, where they are used, and how many activities would occur under each alternative, see Section 3.0.5.3.4.2 (Parachutes). See Table 3.0-84 for information regarding the number and location of activities involving parachutes. Activities that expend sonobuoy and air-launched torpedo parachutes generally occur in water deeper than 183 m. Because they are in the air and water column for a time span of minutes (see Section 3.0.5.3.4.2, Parachutes), it is improbable that such a parachute deployed over water deeper than 183 m could travel far enough to affect shallow-water corals. Parachutes may impact marine invertebrates by disturbance, strikes, burial, smothering, or abrasion. Movement of parachutes in the water may break more fragile invertebrates such as deep-water corals.

3.8.3.3.2.3 No Action Alternative

Training Activities

The number of military expended materials and their impact footprints are detailed in Table 3.3-5. As indicated in Section 3.0.5.3.3.3 (Military Expended Materials), under the No Action Alternative, nearly all military expended materials would be expected in HRC and SOCAL.

The majority of military expended materials would be used in the open ocean. Some military expended materials may be expended in the nearshore waters of San Clemente Island during use of impact areas. The majority of fired ordnance would impact on land and would not be expected to affect ESA-listed black and white abalone. Military expended materials would not be expected to affect black and white abalone because of the limited amount of military expended materials in nearshore waters. There is no designated critical habitat on San Clemente Island. As for known offshore habitats known to support white abalone (such as the Tanner Banks), it is conceivable for military expended materials to fall in waters occupied by the white abalone; however, due to the low population density and the wide spread use of chaff and flares, the potential for strike is sufficiently small to discount adverse effects. The majority of military expended material in nearshore and offshore waters surrounding the Tanner Banks is chaff and flares, which are expended in waters away from critical habitat designations in waters off Santa Barbara and Santa Catalina islands (the Navy does not train in these nearshore areas off of these islands). Military expended materials are not deposited in areas that are known to support coral species proposed for ESA listing.

Military expended materials that are ordnance (e.g., bombs, missiles, rockets, projectiles, and associated fragments may strike marine invertebrates at the sea surface or on the seafloor. Consequences of strike or disturbance may include injury or mortality, particularly within the footprint of the object as it contacts the seafloor. Secondary impacts are possible if military expended materials are mobilized by currents or waves, and would cease when the military expended materials are incorporated into the seafloor by natural encrustation or burial processes. The fitness of individual organisms would be impacted directly or indirectly, but not to the extent that the viability of populations or species would be impacted primarily because the number of organisms exposed to these devices would be extremely small relative to population sizes.

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

Activities occurring at depths less than 2,600 ft. (800 m) may impact deep-water corals and other marine invertebrate assemblages. Consequences from impacts of military expended materials on marine invertebrate assemblages may include breakage, injury, or mortality. Parachutes and fiber optic cables may cause abrasion injury or mortality, or breakage. The fitness of individual organisms would be impacted directly or indirectly, to the extent that the viability of populations or species would be impacted.

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

Pursuant to the ESA, the use of military expended materials during training activities as described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing;*
- *may affect, but is not likely to adversely affect, ESA-listed white abalone or black abalone species; and*
- *would have no effect on ESA-listed white abalone or black abalone critical habitats.*

Testing Activities

The number of military expended materials and their impact footprints are detailed in Table 3.3-5. As indicated in Section 3.0.5.3.3.3 (Military Expended Materials), under the No Action Alternative, nearly all of the military expended materials are expected in HRC and SOCAL.

The majority of military expended materials would be used in the open ocean. Some military expended materials may be expended in the nearshore waters of San Clemente Island during use of impact areas. Military expended materials deposited in this area may sink to the seafloor and have localized impacts on corals surrounding San Clemente Island. Military expended materials would not be expected to affect black and white abalone because of the limited amount of military expended materials in nearshore waters. There is no designated critical habitat on San Clemente Island. As for known offshore habitats known to support white abalone (such as the Tanner Banks), it is conceivable for military expended materials to fall in waters occupied by the white abalone during testing activities; however, due to the

low population density and the wide spread use of chaff and flares, the potential for strike is sufficiently small to discount adverse effects. The majority of military expended material in nearshore and offshore waters surrounding the Tanner Banks is chaff and flares, which pose a negligible risk to critical habitat. It should be noted that chaff and flares are generally not deposited near shorelines, as to not interfere with regional commercial and private aviation.

Bombs, missiles, rockets, projectiles, and associated fragments may strike marine invertebrates at the sea surface or on the seafloor. Consequences of strikes or disturbances may include injury or mortality, particularly within the footprint of the object as it contacts the seafloor. Individual organisms would be impacted directly or indirectly, but not to the extent that the viability of populations or species would be impacted primarily, because the number of organisms exposed to these devices would be extremely small relative to population sizes.

Activities occurring at depths less than 2,600 ft. (800 m) may impact deep-water corals and other marine invertebrate assemblages. Consequences may include breakage, injury, or mortality for each projectile or munitions (see Section 3.3, Marine Habitats). Parachutes and cables may cause abrasion injury or mortality and breakage. The fitness of individual organisms would be impacted directly or indirectly to the extent that the viability of populations or species would be impacted.

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

Pursuant to the ESA, the use of military expended materials during testing activities as described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing;*
- *may affect, but is not likely to adversely affect, ESA-listed white abalone or black abalone species; and*
- *would have no effect on ESA-listed white abalone or black abalone critical habitats.*

3.8.3.3.2.4 Alternative 1

Training Activities

The number of military expended materials and their impact footprints are detailed in Table 3.3-6. As indicated in Section 3.0.5.3.3.3 (Military Expended Materials), under Alternative 1, nearly all of the military expended materials are expected in HRC and SOCAL. Alternative 1 would include substantial increases in the use of small- and medium-caliber projectiles. The use of bombs, missiles, rockets, projectiles, and associated fragments would also increase incrementally.

The majority of military expended materials would be used in the open ocean. Some military expended materials may be expended in the nearshore waters of San Clemente Island during use of impact areas. The majority of fired ordnance would impact on land and would not be expected to affect ESA-listed black and white abalone. Military expended materials would not be expected to affect black and white

abalone because of the limited amount of military expended materials in nearshore waters. There is no designated critical habitat on San Clemente Island. As for known offshore habitats known to support white abalone (such as the Tanner Banks), it is conceivable for military expended materials to fall in waters occupied by the white abalone; however, due to the low population density and the wide spread use of chaff and flares, the potential for strike is sufficiently small to discount adverse effects. The majority of military expended material in nearshore waters is chaff and flares, which pose a negligible risk to benthic organisms. Use of military expended materials will not affect critical habitat. None of the expended materials are expected to be deposited in areas known to support corals proposed for ESA listing.

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

Pursuant to the ESA, the use of military expended materials during training activities as described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing;*
- *may affect, but is not likely to adversely affect, ESA-listed white abalone or black abalone species; and*
- *would have no effect on ESA-listed white abalone or black abalone critical habitats.*

Testing Activities

The number of military expended materials and their impact footprints are detailed in Table 3.3-6 (in Section 3.3, Marine Habitats). As indicated in Section 3.0.5.3.3.3 (Military Expended Materials), under Alternative 1, nearly all of the military expended materials are expected in HRC and SOCAL. Alternative 1 would include substantial increases in the use of small- and medium-caliber projectiles, bombs, missiles, rockets, projectiles, and associated fragments because of the introduction of new testing activities.

The majority of military expended materials would be used in the open ocean. Some military expended materials may be expended in the nearshore waters of San Clemente Island during use of impact areas. Military expended materials would not be expected to affect black and white abalone because of the limited amount of military expended materials in nearshore waters. There is no designated critical habitat on San Clemente Island. As for known offshore habitats known to support white abalone (such as the Tanner Banks), it is conceivable for military expended materials to fall in waters occupied by the white abalone; however, due to the low population density and the wide spread use of chaff and flares, the potential for strike is sufficiently small to discount adverse effects. The majority of military expended material in nearshore waters is chaff and flares, which pose a negligible risk to benthic organisms. Use of military expended materials will not affect critical habitat.

Although the number of military expended materials would increase under Alternative 1 compared to the No Action Alternative, the types of impacts would be similar to those described under the No Action Alternative. The probability of military expended material strikes on marine invertebrates, however, would increase because of the increase in the number of military expended materials. Activities involving military expended materials are not expected to yield any behavioral changes or lasting effects

on the survival, growth, recruitment, or reproduction of invertebrate species at the population level. However, the combined consequences of all military expended materials could degrade habitat quality.

Pursuant to the ESA, the use of military expended materials during testing activities as described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing;*
- *may affect, but is not likely to adversely affect, ESA-listed white abalone or black abalone species; and*
- *would have no effect on ESA-listed white abalone or black abalone critical habitats.*

3.8.3.3.2.5 Alternative 2

Training Activities

Under Alternative 2, the Navy proposes the same numbers and types of military expended materials as described in Alternative 1. Therefore, the impacts of Alternative 2 training activities on marine invertebrates would be the same as for Alternative 1.

Pursuant to the ESA, the use of military expended materials during training activities as described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing;*
- *may affect, but is not likely to adversely affect, ESA-listed white abalone or black abalone species; and*
- *would have no effect on ESA-listed white abalone or black abalone critical habitats.*

Testing Activities

The number of military expended materials and their impact footprints are detailed in Table 3.3-7. As indicated in Section 3.0.5.3.3.3 (Military Expended Materials), under Alternative 2, nearly all of the military expended materials are expected in HRC and SOCAL. Alternative 2 would include substantial increases in the use of small- and medium-caliber projectiles, bombs, missiles, rockets, projectiles, and associated fragments because of the introduction of new testing activities.

The majority of military expended materials would be used in the open ocean. Some military expended materials may be expended in the nearshore waters of San Clemente Island during use of impact areas. Military expended materials would not be expected to affect black and white abalone because of the limited amount of military expended materials in nearshore waters. There is no designated critical habitat on San Clemente Island. As for known offshore habitats known to support white abalone (such as the Tanner Banks), it is conceivable for military expended materials to fall in waters occupied by the white abalone; however, due to the low population density and the wide spread use of chaff and flares, the potential for strike is sufficiently small to discount adverse effects. The majority of military expended material in nearshore waters is chaff and flares, which pose a negligible risk to critical habitat.

Although the number of military expended materials would increase under Alternative 2 compared to the No Action Alternative, the types of impacts would be similar to those described under the No Action Alternative. The probability of military expended material strikes on marine invertebrates, however, would increase because of the increase in the number of military expended materials. Activities involving military expended materials are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at the population level. However, the combined consequences of all military expended materials could degrade habitat quality.

Pursuant to the ESA, the use of military expended materials during testing activities as described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing;*
- *may affect, but is not likely to adversely affect, ESA-listed white abalone or black abalone species; and*
- *would have no effect on ESA-listed white abalone or black abalone critical habitats.*

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

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

3.8.3.3.3 Impacts from Seafloor Devices

For a discussion of the types of activities that use seafloor devices, where they are used, and how many activities would occur under each alternative, see Section 3.0.5.3.3.4 (Seafloor Devices). Seafloor devices include items that are placed on, dropped on, or moved along the seafloor, such as mine shapes, anchor blocks, surface vessel anchors, bottom-placed instruments, bottom-crawling unmanned underwater vehicles, and bottom-placed targets that are recovered (not expended).

Deployment of seafloor devices would cause disturbance, injury, or mortality within the footprint of the device, may disturb marine invertebrates outside the footprint of the device, and would cause temporary local increases in turbidity near the ocean bottom. Objects placed on the seafloor may attract invertebrates, or provide temporary attachment points for invertebrates. Some invertebrates attached to the devices would be removed from the habitat when the devices are recovered. A shallow depression may remain in the soft bottom sediment where an anchor was dropped. This analysis assumes a 1:1 relationship between high-explosive mines and their moorings; and a 1:1 relationship between high-explosive mine neutralizers and moorings for their targets.

3.8.3.3.3.1 No Action Alternative

Training Activities

Table 3.0-70 lists the number and location where seafloor devices are used. As indicated in Section 3.0.5.3.3.4 (Seafloor Devices), under the No Action Alternative, seafloor devices used during training activities would occur in HRC, SOCAL, and SSTC.

Seafloor devices could occur within potential ESA-listed black and white abalone habitat off San Clemente Island, but would not be expected to affect either species because seafloor devices are typically placed in soft-bottom areas. There is no designated critical habitat for ESA-listed black and white abalone off San Clemente Island and seafloor devices would not occur in areas of designated critical habitat within the Study Area.

Under the No Action Alternative, four elevated causeway systems training events would occur every year, primarily in SSTC oceanside Boat Lanes 1 through 10, but also periodically in the bayside Bravo training area (see Figure 2.1-10). Boat Lanes 1 through 10 have sand (5,300 acres [ac.] [22 square kilometers {km^2}]) or cobble (510 ac. [2.5 km^2]) substrates, with a small amount of understory algae (3.26 ac. [0.013 km^2]) (U.S. Department of the Navy 2011). The bayside Bravo training area contains an estimated 1.13 ac. (0.5 ha) of sandy substrates that support benthic invertebrate communities. Elevated causeway systems training in Bravo would remove surface substrate within the footprint of the pile, but the effects are expected to be short in duration.

Potential impacts of precision anchoring are qualitatively different than other seafloor devices because the activity involves repeated disturbance to the same area of seafloor. Precision anchoring occurs in long-established soft-bottom areas that have a history of disturbance by anchors, and continued exposure is likely to be inconsequential and not detectable.

Salvage operations under the No Action Alternative would occur three times per year in Puuloa Underwater Range, Naval Defensive Sea Area, Keehi Lagoon, or training areas in Pearl Harbor. These locations do not support coral species currently proposed for ESA listing found in waters off Hawaii. Training activities would consist of lowering and raising a vessel from the seafloor. The infrastructure to keep the vessel in place was implemented after in 2009. Potential impacts to marine invertebrates would be limited to area directly below the vessel, but this area would experience repeated impacts from raising and lowering the vessel during each training activity.

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

Pursuant to the ESA, the use of seafloor devices during training activities as described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing;*
- *may affect, but is not likely to adversely affect, ESA-listed white abalone or black abalone species; and*
- *would have no effect on ESA-listed white abalone or black abalone critical habitats.*

Testing Activities

Table 3.0-70 lists the number and location where seafloor devices are used. As indicated in Section 3.0.5.3.3.4 (Seafloor Devices), under the No Action Alternative, seafloor devices used during testing activities would occur in SOCAL. Testing activities under the No Action Alternative include anti-terrorism/force protection underwater surveillance testing events and fixed intelligence, surveillance, and reconnaissance sensor system testing events. Anti-terrorism/force protection underwater surveillance testing events typically last 5 days, and day activities could range from 8 to 24 hours per testing day. These testing activities would involve placing clump anchors around existing piers and ships. These areas are characterized as deep subtidal habitats greater than 20 ft. (6 m) in depth,

subject to periodic dredging since the 1940s (U.S. Department of the Navy 2011). These areas may support various hard-shelled marine invertebrates.

Fixed intelligence, surveillance, and reconnaissance sensor system testing events would occur in waters off Point Loma and San Clemente Island. Fixed intelligence, surveillance, and reconnaissance sensor system testing involves the temporary installation of several arrays on the seafloor in sandy seafloor substrates or suspended in the water column with a mooring structure. Arrays may stay in the water for several months.

Seafloor devices could occur within potential ESA-listed black and white abalone habitat off San Clemente Island, but would not be expected to affect either species because seafloor devices are typically placed in soft-bottom areas. There is no designated critical habitat for ESA-listed black and white abalone off San Clemente Island and seafloor devices would not occur in areas of designated critical habitat within the Study Area. There are no testing activities that would occur under the No Action Alternative in the HRC; therefore, coral species proposed for ESA listing would not be affected by seafloor device testing.

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

Pursuant to the ESA, the use of seafloor devices during testing activities as described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing;*
- *may affect, but is not likely to adversely affect, ESA-listed white abalone and black abalone species; and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.3.3.2 Alternative 1

Training Activities

Table 3.0-70 lists the number and location where seafloor devices are used. As indicated in Section 3.0.5.3.3.4 (Seafloor Devices), under Alternative 1, seafloor devices used during training activities would occur in HRC, SOCAL, and SSTC. Under Alternative 1, the number of training activities that use seafloor devices would remain the same as under the No Action Alternative. Because there would be no changes in the seafloor devices used for training activities under Alternative 1 relative to the No Action Alternative, the effects of Alternative 1 training activities would be the same as for the No Action Alternative.

Pursuant to the ESA, the use of seafloor devices during training activities as described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing;*
- *may affect, but is not likely to adversely affect ESA-listed white abalone or black abalone species; and*
- *would have no effect on ESA-listed white abalone or black abalone critical habitats.*

Testing Activities

Table 3.0-70 lists the number and location where seafloor devices are used. As indicated in Section 3.0.5.3.3.4 (Seafloor Devices), under Alternative 1, seafloor devices used during testing activities would increase within SOCAL (from 35 to 59) and new testing activities would be introduced within the open ocean portions of the HRC (15 new events).

The increase in fixed intelligence, surveillance, and reconnaissance sensor testing activities in waters off Point Loma and San Clemente Island would increase the number of installed devices on the seafloor, and therefore could directly impact benthic invertebrates or remove portions of the seafloor from available habitat for benthic invertebrate species. Although the Navy would increase the number of testing activities involving the installation or removal of seafloor devices, the Navy would continue to minimize impacts on the marine invertebrate community by using previously disturbed areas whenever operationally feasible. The types of impacts from seafloor devices under Alternative 1 would be similar to those described under the No Action Alternative because the same seafloor devices would be used. There would be an increased likelihood of strikes from seafloor devices, however, because of the increased number of testing activities. The testing activities that occur within the HRC occur in open ocean locations and do not overlap with areas known to support corals proposed for ESA listing.

Pursuant to the ESA, the use of seafloor devices during testing activities as described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing;*
- *may affect, but is not likely to adversely affect, ESA-listed white abalone or black abalone species; and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.3.3.3 Alternative 2

Training Activities

Under Alternative 2, training activities would be consistent with Alternative 1. Therefore, Alternative 2 would have the same effects as under Alternative 1.

Pursuant to the ESA, the use of seafloor devices during training activities as described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing;*
- *may affect, but is not likely to adversely affect, ESA-listed white abalone or black abalone species; and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Table 3.0-70 lists the number and location where seafloor devices are used. As indicated in Section 3.0.5.3.3.4 (Seafloor Devices), under Alternative 2, seafloor devices used during testing activities would increase within SOCAL (from 35 to 65) and new testing activities would be introduced within the open ocean portions of the HRC (17 new events).

The increase in fixed intelligence, surveillance, and reconnaissance sensor testing activities in waters off Point Loma and San Clemente Island would increase the number of installed devices on the seafloor, and therefore could directly impact benthic invertebrates or remove portions of the seafloor from available habitat for benthic invertebrate species. Although the Navy would increase the number of testing activities involving the installation or removal of seafloor devices, the Navy would continue to minimize impacts on the marine invertebrate community by using previously disturbed areas whenever operationally feasible. The types of impacts from seafloor devices under Alternative 2 would be similar to those described under the No Action Alternative because the same seafloor devices would be used. There would be an increased likelihood of strikes from seafloor devices, however, because of the increased number of testing activities. The testing activities proposed within the HRC under Alternative 2 would occur in open ocean locations and do not overlap with areas known to support corals proposed for ESA listing.

Pursuant to the ESA, the use of seafloor devices during testing activities as described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing;*
- *may affect, but is not likely to adversely affect, ESA-listed white abalone or black abalone species; and*
- *would have no effect on ESA-listed black abalone critical habitat.*

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

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

3.8.3.4 Entanglement Stressors

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

Most marine invertebrates are less susceptible to entanglement than fishes, sea turtles, and marine mammals due to their size, behavior, and morphology. Because even fishing nets which are designed to take marine invertebrates operate by enclosing rather than entangling, marine invertebrates seem to be somewhat less susceptible than vertebrates to entanglement (Chuenpagdee et al. 2003). A survey of marine debris entanglements found that marine invertebrates composed 16 percent of all animal entanglements (Ocean Conservancy 2010). The same survey cites potential entanglement in military

items only in the context of waste-handling aboard ships, and not for military expended materials. Nevertheless, it is conceivable that marine invertebrates, particularly arthropods and echinoderms with rigid appendages, might become entangled in fiber optic cables and guidance wires, and in parachutes.

3.8.3.4.1 Impacts from Fiber Optic Cables and Guidance Wires

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

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

3.8.3.4.1.1 No Action Alternative

Training Activities

Table 3.0-80 and Table 3.0-83 list the number and locations of activities that expend fiber optic cables and guidance wires under the No Action Alternative. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under the No Action Alternative, airborne mine neutralization activities, with HE neutralizers, that expend fiber optic cables could occur in the SOCAL Range Complex. Torpedoes expending guidance wire would occur in HRC and SOCAL Range Complex.

ESA-listed black and white abalone do not occur in areas offshore where torpedo launches would occur, and would not be exposed to fiber optic cables and guidance wires. Airborne mine neutralization activities and fiber optic cables expended during training activities could occur in the nearshore areas of SOCAL, where ESA-listed abalone species are present. ESA-listed abalone species, however, would not be affected by fiber optic cables because fiber optic cables would not be expected to entangle ESA-listed abalone species since they are relatively sessile marine invertebrates. No effect would be expected on critical habitat from entanglement; potential physical disturbance on critical habitat by fiber optic cables and guidance wires are discussed as a physical impact in Section 3.8.3.3.2 (Impacts from Military Expended Materials). In the HRC, locations where expended materials are deposited do not support coral species currently proposed for ESA listing.

Given the low numbers used, most marine invertebrates would never be exposed to a fiber optic cable or guidance wire. The impact of cables and guidance wires on marine invertebrates is not likely to cause injury or mortality to individuals, and impacts would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges; (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one event; (3) exposures would be localized; and (4) marine invertebrates are not particularly susceptible to entanglement

stressors, most would avoid entanglement and simply be temporarily disturbed. Activities involving fiber optic cables and guidance wires are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at individual or population levels.

Pursuant to the ESA, the use of fiber optic cables and guidance wires expended during training activities described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Table 3.0-80 and Table 3.0-83 list the number and locations of activities that expend fiber optic cables and guidance wires under the No Action Alternative. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), 240 guidance wires and 15 fiber optic cables would be expended within SOCAL Range Complex under the No Action Alternative. Within HRC, 160 guidance wires would be expended under the No Action Alternative testing activities (no fiber optic cables would be expended as part of testing activities under the No Action Alternative).

ESA-listed black and white abalone do not occur in areas offshore where torpedo launches would occur, and would not be exposed to guidance wires. Airborne mine neutralization activities and fiber optic cables expended during testing activities could occur in the nearshore areas of SOCAL, where ESA-listed abalone species are present. ESA-listed abalone species, however, would not be affected by fiber optic cables because fiber optic cables would not be expected to entangle ESA-listed abalone species since they are relatively sessile marine invertebrates. No effect would be expected on critical habitat from entanglement; potential physical disturbance on critical habitat by fiber optic cables and guidance wires are discussed as a physical impact in Section 3.8.3.3.2 (Impacts from Military Expended Materials). In the HRC, locations where expended materials are deposited do not support coral species currently proposed for ESA listing.

Fiber optic cables and guidance wires expended during testing activities would be the same or similar types to those expended during training activities. Therefore, fiber optic cables and guidance wires expended during testing activities would have the same effects on marine invertebrates as those described for training activities under the No Action Alternative.

Pursuant to the ESA, the use of fiber optic cables and guidance wires expended during testing activities described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.4.1.2 Alternative 1

Training Activities

Table 3.0-80 and Table 3.0-83 list the number and locations of activities that expend fiber optic cables and guidance wires under Alternative 1. The activities using fiber optic cables under Alternative 1 would occur in the same geographic locations as the No Action Alternative. As indicated in Section 3.0.5.3.4.1

(Fiber Optic Cables and Guidance Wires), under Alternative 1, the number of training activities that expend fiber optic cables would be greater than that of the No Action Alternative. Under Alternative 1, the number of training activities that expend guidance wire is expected to increase 15 percent compared to the No Action Alternative. The torpedo activities using guidance wire under Alternative 1 would occur in the same geographic locations as the No Action Alternative.

As stated in Section 3.8.3.4.1.1 (No Action Alternative), cables and guidance wires would not be expected to cause injury or mortality to marine invertebrate individuals. Cables and guidance wires would not have an effect on ESA-listed species or species currently proposed for listing, and use of cables and guidance wires would not reduce the conservation value of critical habitat because overlap between the stressor and resource would not be anticipated. In comparison to the No Action Alternative, the increase in activities would not substantially increase the risk of exposure to cables and guidance wires.

Pursuant to the ESA, the use of fiber optic cables and guidance wires expended during training activities described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Table 3.0-80 and Table 3.0-83 list the number and locations of testing activities that expend fiber optic cables and guidance wires under Alternative 1. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), 248 guidance wires and 16 fiber optic cables would be expended within SOCAL Range Complex under Alternative 1. Within HRC, 232 guidance wires would be expended under Alternative 1 testing activities (no fiber optic cables would be expended as part of testing activities under the No Action Alternative). The testing activities using guidance wire under Alternative 1 would occur in the same geographic locations as the No Action Alternative.

As stated in Section 3.8.3.4.1.1 (No Action Alternative), fiber optic cables and guidance wires would not be expected to cause injury to or mortality of marine invertebrate individuals. Fiber optic cables and guidance wires would not affect ESA-listed species or species currently considered for ESA listing because the activities that expend fiber optic cables and guidance wires do not co-occur within areas known to support these species. The use of fiber optic cables and guidance wires would not reduce the conservation value of critical habitat because overlap between the stressor and resource is not anticipated. In comparison to the No Action Alternative, the increase in activities would not substantially increase the risk of exposure to fiber optic cables and guidance wires.

Pursuant to the ESA, the use of fiber optic cables and guidance wires expended during testing activities described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.4.1.3 Alternative 2

Training Activities

Under Alternative 2, the Navy proposes the same numbers and types of military expended materials as described in Alternative 1. Therefore, the impacts of Alternative 2 training activities on marine invertebrates would be the same as for Alternative 1.

Pursuant to the ESA, the use of fiber optic cables and guidance wires expended during training activities described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Table 3.0-80 and Table 3.0-83 list the number and locations of activities that expend fiber optic cables and guidance wires under Alternative 2. The activities that expend fiber optic cables and guidance wires under Alternative 2 would occur in the same geographic locations as the No Action Alternative. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under Alternative 2, the number of airborne mine neutralization activities (with high explosive neutralizers) would increase to 17 testing activities per year, compared to 15 testing activities under the No Action Alternative. The number of torpedo activities that expend guidance wire under Alternative 2 would increase to nearly twice that of the No Action Alternative. The torpedo activities using guidance wire under Alternative 2 would occur in the same geographic locations as the No Action Alternative.

As stated in Section 3.8.3.4.1.1 (No Action Alternative), fiber optic cables and guidance wires would not be expected to cause injury or mortality marine invertebrate individuals. Fiber optic cables and guidance wires would not affect ESA-listed species or species currently considered for ESA listing, and use of cables and guidance wires would not reduce the conservation value of critical habitat because overlap between the stressor and resource is not anticipated. In comparison to the No Action Alternative, the increase in activities would not substantially increase the risk of exposure to fiber optic cables and guidance wires.

Pursuant to the ESA, the use of fiber optic cables and guidance wires expended during testing activities described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.4.2 Impacts from Parachutes

Parachutes of varying sizes are used during training and testing activities. For a discussion of the types of activities that use parachutes, physical characteristics of these expended materials, where they are used, and how many activities would occur under each alternative, please see Section 3.0.5.3.4.2 (Parachutes). Parachutes pose a potential, though unlikely, entanglement risk to susceptible marine invertebrates. The most likely method of entanglement would be a marine invertebrate crawling through the fabric or cord that would then tighten around it.

Abrasion and shading-related impacts on sessile benthic (attached to the seafloor) marine invertebrates that may result from entanglement stressors are discussed with physical impacts in Section 3.8.3.3 (Physical Disturbance and Strike Stressors). Potential indirect effects of the parachute being transported laterally along the seafloor are discussed in Section 3.8.3.5.3.3 (Secondary Stressors).

A marine invertebrate that might become entangled could be temporarily confused and escape unharmed, held tightly enough that it could be injured during its struggle to escape, preyed upon while entangled, or starved while entangled. The likelihood of these outcomes cannot be predicted with any certainty because interactions between invertebrate species and entanglement hazards are not well known. The potential entanglement scenarios are based on observations of how marine invertebrates are entangled in marine debris (Environmental Sciences Group 2005; Ocean Conservancy 2010). The number of parachutes expended across the Study Area is extremely small relative to the number of marine invertebrates, resulting in a low rate of potential encounter for marine invertebrates.

3.8.3.4.2.1 No Action Alternative

Training Activities

Table 3.0-84 lists the number and locations of expended parachutes. As indicated in Section 3.0.5.3.4.2 (Parachutes), under the No Action Alternative, activities involving parachute use would occur in HRC and SOCAL.

ESA-listed abalone species and coral species currently proposed for ESA listing are not susceptible to entanglement in parachutes since they are relatively sessile marine invertebrates. Similarly, entanglement cannot affect critical habitat; potential consequences of physical disturbance and strike stressors associated with these objects, however, is addressed in Section 3.8.3.3.2 (Impacts from Military Expended Materials).

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

Pursuant to the ESA, the use of parachutes expended during training activities described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Table 3.0-84 lists the number and locations of expended parachutes. As indicated in Section 3.0.5.3.4.2 (Parachutes), under the No Action Alternative, activities involving parachute use would occur in HRC and SOCAL.

ESA-listed abalone species and coral species currently proposed for ESA listing are not susceptible to entanglement in parachutes since they are relatively sessile marine invertebrates. Similarly entanglement cannot affect critical habitat; potential consequences of physical disturbance and strike stressors associated with these objects, however, is addressed in Section 3.8.3.3.2 (Impacts from Military Expended Materials).

Most marine invertebrates would never encounter a parachute. Some individual marine invertebrates could be injured or killed in the unlikely event of exposure and entanglement, but most mobile marine invertebrates would avoid entanglement and simply be temporarily disturbed and would recover completely soon after exposure. The growth, survival, annual reproductive success, or lifetime reproductive success of populations would not be impacted directly or indirectly.

Pursuant to the ESA, the use of parachutes expended during testing activities described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.4.2.2 Alternative 1

Training Activities

Table 3.0-84 lists the number and locations of expended parachutes. As indicated in Section 3.0.5.3.4.2 (Parachutes), under Alternative 1, activities involving parachute use would occur in HRC and SOCAL. ESA-listed abalone species and coral species currently proposed for ESA listing are not susceptible to entanglement in parachutes since they are relatively sessile marine invertebrates. Despite the increase in number of expended parachutes, parachutes used under Alternative 1 would be the same as those used under the No Action Alternative, and would have the same effects as described under the No Action Alternative.

Most marine invertebrates would never encounter a parachute. Some individual marine invertebrates could be injured or killed in the unlikely event of exposure and entanglement, but most mobile marine invertebrates would avoid entanglement and simply be temporarily disturbed and would recover completely soon after exposure. The growth, survival, annual reproductive success, or lifetime reproductive success of populations would not be impacted directly or indirectly.

Pursuant to the ESA, the use of parachutes expended during training activities described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Table 3.0-84 lists the number and locations of expended parachutes. As indicated in Section 3.0.5.3.4.2 (Parachutes), under Alternative 1, activities involving parachute use would occur in HRC and SOCAL. ESA-listed abalone species and coral species currently proposed for ESA listing are not susceptible to entanglement in parachutes since they are relatively sessile marine invertebrates. Despite the increase in number of expended parachutes, parachutes used under Alternative 1 would be the same as those

used under the No Action Alternative, and would have the same effects as described under the No Action Alternative.

Pursuant to the ESA, the use of parachutes expended during testing activities described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.4.2.3 Alternative 2

Training Activities

Under Alternative 2, the Navy proposes the same numbers and types of parachutes as described in Alternative 1. Therefore, the impacts of Alternative 2 training activities on marine invertebrates would be the same as for Alternative 1.

Pursuant to the ESA, the use of parachutes expended during training activities described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

Testing Activities

Table 3.0-84 lists the number and locations of expended parachutes. As indicated in Section 3.0.5.3.4.2 (Parachutes), under Alternative 2, activities involving parachute use would occur in HRC and SOCAL. ESA-listed abalone species and coral species currently proposed for ESA listing are not susceptible to entanglement in parachutes since they are relatively sessile marine invertebrates. Despite the increase in number of expended parachutes, parachutes used under Alternative 2 would be the same as those used under the No Action Alternative, and would have the same effects as described under the No Action Alternative.

Pursuant to the ESA, the use of parachutes expended during testing activities described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.5 Ingestion Stressors

This section analyzes the potential ingestion impacts of the various types of military expended materials used by the Navy during training and testing activities within the Study Area. Expended materials could be ingested by marine invertebrates in all large marine ecosystems and open ocean areas. Ingestion could occur at the surface, in the water column, or on the seafloor, depending on the size and buoyancy of the expended object and the feeding behavior of the animal. Floating material is more likely to be eaten by animals that feed at or near the water surface, while materials that sink to the seafloor present a higher risk to bottom-feeding animals. Marine invertebrates are universally present in the water and

the seafloor, but the majority of individuals are smaller than a few millimeters (e.g., zooplankton, most roundworms, and most arthropods). Most military expended materials and fragments of military expended materials are too large to be ingested by marine invertebrates. The potential for marine invertebrates to encounter fragments of ingestible size increases as the military expended materials degrades into smaller fragments.

If expended material is ingested by marine invertebrates, the primary risk is from a blocked digestive tract. Most military expended materials are relatively inert in the marine environment, and are not likely to cause injury or mortality via chemical effects (see Section 3.8.3.5.3.3, Secondary Stressors, for more information on the chemical properties of these materials).

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

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

3.8.3.5.1 No Action Alternative

3.8.3.5.1.1 Training Activities

Under the No Action Alternative, a variety of potentially ingestible military expended materials, such as chaff, would be released to the marine environment by Navy training activities. Ingestion is not likely in the majority of cases because most military expended materials are too large to be ingested by most marine invertebrates. The fractions of military expended materials that are of ingestible size, or become ingestible after degradation, are unlikely to impact individuals.

Pursuant to the ESA, the use of military expended materials of ingestible size during training activities described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.5.1.2 Testing Activities

Under the No Action Alternative, a variety of potentially ingestible military expended materials would be released to the marine environment by Navy testing activities. No chaff canisters would be released during testing activities under the No Action Alternative. Ingestion is not likely in the majority of cases because most military expended materials are too large to be ingested by most marine invertebrates. The fractions of military expended materials that are of ingestible size, or become ingestible after degradation, are unlikely to impact individuals.

Pursuant to the ESA, the use of military expended materials of ingestible size during testing activities described under the No Action Alternative:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.5.2 Alternative 1

3.8.3.5.2.1 Training Activities

Under Alternative 1, a variety of potentially ingestible military expended materials, such as chaff, would be released to the marine environment by Navy training activities. Under Alternative 1, the expended chaff would increase to 228 canisters per year within HRC and 32 per year within SOCAL (260 canisters per year throughout the Study Area) compared with the No Action Alternative. As with the No Action Alternative, ingestion is not likely because most military expended materials are too large to be ingested by most marine invertebrates. The fraction of military expended materials that are of ingestible size, or that become ingestible after degradation, may impact individual marine invertebrates, but are unlikely to have impacts on populations or sub-populations.

Pursuant to the ESA, the use of military expended materials of ingestible size during training activities described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.5.2.2 Testing Activities

Testing activities under Alternative 1 would introduce 504 canisters of chaff per year in the Study Area, compared to no use of chaff under the No Action Alternative. Within HRC, 300 canisters would be released from ships or aircraft. Within SOCAL, 204 canisters would be released. As with the No Action Alternative, ingestion is not likely because most military expended materials are too large to be ingested by most marine invertebrates. The fractions of military expended materials that are of ingestible size, or

that become ingestible after degradation, may impact individual marine invertebrates, but are unlikely to have impacts on populations or sub-populations.

Pursuant to the ESA, the use of military expended materials of ingestible size during testing activities described under Alternative 1:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.5.3 Alternative 2

3.8.3.5.3.1 Training Activities

Under Alternative 2, the Navy proposes the same numbers and types of chaff as described in Alternative 1. Therefore, the impacts of Alternative 2 training activities on marine invertebrates would be the same as for Alternative 1.

Pursuant to the ESA, the use of military expended materials of ingestible size during training activities described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.5.3.2 Testing Activities

Testing activities under Alternative 2 would introduce 554 canisters of chaff in the Study Area, compared to no use of chaff under the No Action Alternative. Within HRC, 300 canisters would be released from ships or planes. Within SOCAL, 254 canisters would be released. As with the No Action Alternative, ingestion is not likely because most military expended materials are too large to be ingested by most marine invertebrates. The fractions of military expended materials that are of ingestible size, or that become ingestible after degradation, may impact individual marine invertebrates, but are unlikely to have impacts on populations or sub-populations.

Pursuant to the ESA, the use of military expended materials of ingestible size during testing activities described under Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing,*
- *would have no effect on ESA-listed white abalone or black abalone species, and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.5.3.3 Secondary Stressors

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

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

3.8.3.5.4 Explosives, Explosion By-Products, and Unexploded Ordnance

High-order explosions consume most of the explosive material, creating typical combustion products. In the case of royal demolition explosive, 98 percent of the combustion products are common seawater constituents, with the remainder rapidly diluted by ocean currents and circulation (Table 3.1-10 in Section 3.1, Sediments and Water Quality). Explosion by-products from high order detonations present no indirect stressors to marine invertebrates through sediment or water. Low-order detonations and unexploded ordnance present an elevated likelihood of effects on marine invertebrates, and the potential impacts of these on marine invertebrates will be analyzed. Explosive material not completely consumed during a detonation from ordnance disposal and mine clearance training are collected after training is complete; therefore, potential impacts are assumed to be inconsequential and not detectable for these training and testing activities. Marine invertebrates may be exposed by contact with the explosive, contact with contaminants in the sediment or water, and ingestion of contaminated sediments. Most marine invertebrates are very small relative to ordnance or fragments, and direct ingestion of unexploded ordnance is unlikely.

Indirect impacts of explosives and unexploded ordnance on marine invertebrates via sediment are possible near the ordnance. Degradation of explosives proceeds via several pathways discussed in Section 3.1.3.1 (Explosives and Explosion By-Products). Degradation products of royal demolition explosive are not toxic to marine organisms at realistic exposure levels (Rosen and Lotufo 2010). Trinitrotoluene and its degradation products impact developmental processes in marine invertebrates and are acutely toxic to adults at concentrations similar to real-world exposures (Rosen and Lotufo 2007b, 2010). The relatively low solubility of most explosives and their degradation products indicate that concentrations of these contaminants in the marine environment are relatively low and readily diluted. Furthermore, while explosives and their degradation products were detectable in marine sediment approximately 6 to 12 inches (15 to 30 centimeters) from degrading ordnance, the concentrations of these compounds were not statistically distinguishable from background beyond 3 to 6 ft. (1 to 2 m) from the degrading ordnance (Durrach et al. 1998; Section 3.1.3.1, Explosives and Explosion By-Products). Taken together, marine invertebrates, eggs, and larvae probably would be adversely impacted by the indirect effects of degrading explosives within a very small radius of the explosive (1 to 6 ft. [0.3 to 2 m]).

Indirect impacts of explosives and unexploded ordnance on marine invertebrates via water are likely to be inconsequential and not detectable for two reasons. First, most explosives and explosive degradation products have very low solubility in sea water (Table 3.1-13 in Section 3.1, Sediments and Water Quality). This means that dissolution occurs extremely slowly, and harmful concentrations of explosives and degradation are not likely to accumulate except within confined spaces. Second, a low concentration of contaminants, slowly delivered into the water column, is readily diluted to non-harmful concentrations. While marine invertebrates may be adversely impacted by the indirect effects of degrading explosives via water (Rosen and Lotufo 2007a, 2010), this is extremely unlikely in realistic scenarios.

Impacts on marine invertebrates, including zooplankton, eggs, and larvae, are likely within a very small radius of the ordnance (1 to 6 ft. [0.3 to 2 m]). These impacts may continue as the ordnance degrades over months to decades. Because most ordnance is deployed as projectiles, multiple unexploded or

low-order detonations would not accumulate on spatial scales of 1 to 6 ft. (0.3 to 2 m); therefore, potential impacts are likely to remain local and widely separated. Given these conditions, the possibility of population-level impacts on marine invertebrates is inconsequential.

3.8.3.5.5 Metals

Certain metals are harmful to marine invertebrates at concentrations above background levels (e.g., cadmium, chromium, lead, mercury, zinc, copper, manganese, and many others) (Negri et al. 2002; Wang and Rainbow 2008). Metals are introduced into seawater and sediments as a result of training and testing activities involving vessel hulks, targets, ordnance, munitions, and other military expended materials (Section 3.1.3.2, Metals). Many metals bioaccumulate and physiological impacts begin to occur only after several trophic transfers concentrate the toxic metals. Indirect impacts of metals on marine invertebrates via sediment and water involve concentrations several orders of magnitude lower than concentrations achieved via bioaccumulation. Marine invertebrates may be exposed by contact with the metal, contact with contaminants in the sediment or water (e.g., from leached metals), and ingestion of contaminated sediments. Most marine invertebrates are very small relative to Navy military expended materials, and ingestion would be unlikely.

Because metals often concentrate in sediments, potential adverse indirect impacts are much more likely via sediment than via water. Despite the acute toxicity of some metals (e.g., hexavalent chromium or tributyltin) (Negri et al. 2002) concentrations above safe limits are rarely encountered even in live-fire areas of Vieques where deposition of metals from Navy activities is very high (see Section 3.1.3.2, Metals). Pait (2010) and others sampled in areas in which live ammunition and weapons were used. Other studies described in Section 3.1.3.2 (Metals) find no harmful concentrations of metals from deposition of military metals into the marine environment. Marine invertebrates (especially soft tissued marine invertebrates), eggs, or larvae could be indirectly impacted by metals via sediment within a few inches of the object.

Concentrations of metals in sea water are orders of magnitude lower than concentrations in marine sediments. Marine invertebrates probably would not be indirectly impacted by toxic metals via the water, or via sediment near the object (e.g., within a few inches); such impacts would be local and widely separated. Concentrations of metals in water are not likely to be high enough to cause injury or mortality to marine invertebrates. Therefore, indirect impacts of metals via water are likely to be inconsequential and not detectable. Given these conditions, population-level impacts on marine invertebrates are likely to be inconsequential and not detectable.

3.8.3.5.6 Chemicals

Several Navy training and testing activities introduce potentially harmful chemicals into the marine environment; principally, flares and propellants from rockets, missiles, and torpedoes. Properly functioning flares, missiles, rockets, and torpedoes combust most of their propellants, leaving benign or readily diluted soluble combustion by-products (e.g., hydrogen cyanide). Operational failures allow propellants and their degradation products to be released into the marine environment. The greatest risk to marine invertebrates from flares, missiles, and rocket propellants is perchlorate, which is highly soluble in water, persistent, and impacts metabolic processes in many plants and animals. Torpedo propellant poses little risk to marine invertebrates because the chemicals have relatively low toxicity (Section 3.1.3.3, Chemicals Other than Explosives). Marine invertebrates may be exposed by contact with the chemical, contact with chemical contaminants in the sediment or water, and ingestion of contaminated sediments. Most marine invertebrates are very small relative to Navy military expended

materials or fragments of military expended materials, and ingestion of military expended materials would be unlikely.

The principal toxic component of missiles and rockets is perchlorate, which is highly soluble and does not readily adsorb to sediments. Therefore, missile and rocket fuel poses inconsequential risks of indirect impacts on marine invertebrates via sediment. In contrast, the principal toxic components of torpedo fuel, propylene glycol dinitrate and nitrodiphenylamine, adsorb to sediments, have relatively low toxicity, and are readily degraded by biological processes (Section 3.1.3.3, Chemicals Other than Explosives). Marine invertebrates, eggs, or larvae could be indirectly impacted by propellants via sediment near the object (e.g., within a few inches), but these potential impacts would diminish rapidly as the propellant degrades (see discussion in Section 3.1.3.3, Chemicals Other than Explosives).

In seawater, however, perchlorate, the principal ingredient of solid missile and rocket propellant, is highly soluble, persistent, and impacts metabolic processes in many plants and animals. Perchlorate contamination rapidly disperses throughout the water column and water within sediments. While it impacts biological processes at low concentrations (e.g., less than 10 parts per billion), toxic concentrations are unlikely to be encountered in seawater. The principal mode of perchlorate toxicity in the environment is bioaccumulation.

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

In the past, polychlorinated biphenyls (PCBs) were a concern because they were present in certain materials (e.g., insulation, sires, felts, and gaskets) on vessels used as targets during sinking exercises. PCBs have a variety of deleterious effects on marine organisms. PCBs persist in the tissues of organisms at the bottom of the food chain. Consumers of those species may accumulate PCBs at concentrations many times higher than the PCB concentration in the surrounding water or sediments. Vessels now used for sinking exercises are selected from a list of U.S. Navy-approved vessels that were cleaned in accordance with U.S. Environmental Protection Agency (USEPA) guidelines, but may contain PCBs that could not be removed during cleaning.

3.8.3.5.7 Other Materials

Military expended materials that are re-mobilized after their initial contact with the seafloor (e.g., by waves or currents) may continue to strike or abrade marine invertebrates. Secondary physical strike and disturbances are relatively unlikely because most expended materials are more dense than the surrounding sediments (i.e., metal), and are likely to remain in place as the surrounding sediment moves. The principal exception is likely to be parachutes, which are moved easily relative to projectiles and fragments. Potential secondary physical strike and disturbance impacts may cease only: (1) when the military expended materials is too massive to be mobilized by typical oceanographic processes, (2) when the military expended material becomes encrusted by natural processes and incorporated into

the seafloor, or (3) when the military expended materials becomes permanently buried. The fitness of individual organisms would be impacted directly or indirectly, but not to the extent that the viability of populations or species would be impacted.

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

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

Pursuant to the ESA, secondary stressors from training and testing activities under the No Action Alternative, Alternative 1, and Alternative 2:

- *would have no effect on any of the four coral species currently proposed for ESA listing;*
- *may affect, but are not likely to adversely affect, ESA-listed white abalone or black abalone species; and*
- *would have no effect on ESA-listed black abalone critical habitat.*

3.8.3.5.8 Substressor Impacts on Sedentary Invertebrate Beds or Reefs as Essential Fish Habitats (Preferred Alternative)

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

3.8.4 SUMMARY OF POTENTIAL IMPACTS (COMBINED IMPACTS OF ALL STRESSORS) ON MARINE INVERTEBRATES

3.8.4.1 Combined Impacts of All Stressors

As described in Section 3.0.5.5 (Resource-Specific Impacts Analysis for Multiple Stressors), this section evaluates the potential for combined impacts of all the stressors from the proposed action. The analysis and conclusions for the potential impacts from each of the individual stressors are discussed in the sections above and summarized in Sections 3.8.4.2 (Endangered Species Act Determinations). Stressors associated with Navy training and testing activities do not typically occur in isolation but rather occur in some combination. For example, mine neutralization activities include elements of acoustic, physical disturbance and strike, entanglement, ingestion, and secondary stressors that are all coincident in space and time. An analysis of the combined impacts of all stressors considers the potential consequences of aggregate exposure to all stressors and the repetitive or additive consequences of exposure over multiple years. This analysis makes the reasonable assumption that the majority of exposures to stressors are non-lethal, and instead focuses on consequences potentially impacting the organism's fitness (e.g., physiology, behavior, reproductive potential).

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

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

Marine invertebrates are susceptible to multiple stressors (see Section 3.8.2.2, General Threats), and susceptibilities of many species are enhanced by additive or synergistic effects of multiple stressors (Section 3.8.2.11, Corals, Hydroids, Jellyfish [Phylum Cnidaria]). The global decline of corals, for example, is driven primarily by synergistic impacts of pollution, ecological consequences of overfishing, and climate change. As discussed in the analyses above, marine invertebrates are not particularly susceptible to energy, entanglement, or ingestion stressors resulting from Navy activities (Section 3.8.3.2, Energy Stressors, Section 3.8.3.4, Entanglement Stressors, and Section 3.8.3.5, Ingestion Stressors); therefore, the opportunity for Navy stressors to result in additive or synergistic consequences is most likely limited to acoustic, physical strike and disturbance, and secondary stressors.

Despite uncertainty in the nature of consequences resulting from combined impacts, the location of potential combined impacts can be predicted with more certainty because combinations are much more likely in locations that training and testing activities are concentrated. However, analyses of the nature of potential consequences of combined impacts of all stressors on marine invertebrates remain largely

qualitative and speculative. Where multiple stressors coincide with marine invertebrates, the likelihood of a negative consequence is elevated but it is not feasible to predict the nature of the consequence or its likelihood because not enough is known about potential additive or synergistic interactions. Even for shallow-water coral reefs, an exceptionally well-studied resource, predictions of the consequences of multiple stressors are semi-quantitative and generalized predictions remain qualitative (Hughes and Connell 1999; Jackson 2008; Norström et al. 2009). It is also possible that Navy stressors will combine with non-Navy stressors, and this is qualitatively discussed in Chapter 4 (Cumulative Impacts).

3.8.4.2 Endangered Species Act Determinations

Table 3.8-5 summarizes the Navy's determination of effect on ESA-listed marine invertebrates for each stressor based on the previous analysis sections. Accordingly, the Navy is including black abalone and white abalone in the Section 7 ESA consultation with NMFS, along with the four species of corals currently proposed for ESA listing (fuzzy table coral, irregular rice coral, blue rice coral, and sandpaper rice coral). No other ESA-listed invertebrate species or species currently proposed for ESA listing occur within the Study Area. The Navy's determinations of effect of ESA-listed marine invertebrates are consistent with the current draft of the NMFS Biological Opinion (National Marine Fisheries Service 2013b).

3.8.4.3 Essential Fish Habitat Determinations

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

Table 3.8-5: Summary of Endangered Species Act Determinations for Marine Invertebrates for the Preferred Alternative

Stressor		Black Abalone	White Abalone	Fuzzy Table Coral	Irregular Rice Coral	Blue Rice Coral	Sandpaper Rice Coral
Acoustic Stressors							
Sonar and Other Acoustic Sources	Training Activities	No effect	No effect	No effect	No effect	No effect	No effect
	Testing Activities	No effect	No effect	No effect	No effect	No effect	No effect
Explosives and Other Impulsive Acoustic Sources	Training Activities	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	No effect	No effect	No effect	No effect
	Testing Activities	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	No effect	No effect	No effect	No effect
Energy Stressors							
Electromagnetic Devices	Training Activities	No effect	No effect	No effect	No effect	No effect	No effect
	Testing Activities	No effect	No effect	No effect	No effect	No effect	No effect
Physical Disturbance and Strike Stressors							
Vessels and In-water Devices	Training Activities	No effect	No effect	No effect	No effect	No effect	No effect
	Testing Activities	No effect	No effect	No effect	No effect	No effect	No effect
Military Expended Materials	Training Activities	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	No effect	No effect	No effect	No effect
	Testing Activities	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	No effect	No effect	No effect	No effect
Seafloor devices	Training Activities	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	No effect	No effect	No effect	No effect
	Testing Activities	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	No effect	No effect	No effect	No effect
Entanglement Stressors							
Fiber Optic Cables and Guidance Wires	Training Activities	No effect	No effect	No effect	No effect	No effect	No effect
	Testing Activities	No effect	No effect	No effect	No effect	No effect	No effect
Parachutes	Training Activities	No effect	No effect	No effect	No effect	No effect	No effect
	Testing Activities	No effect	No effect	No effect	No effect	No effect	No effect

Table 3.8-5: Summary of Endangered Species Act Determinations for Marine Invertebrates for the Preferred Alternative (continued)

Stressor		Black Abalone	White Abalone	Fuzzy Table Coral	Irregular Rice Coral	Blue Rice Coral	Sandpaper Rice Coral
Ingestion Stressors							
Military Expended Materials	Training Activities	No effect	No effect	No effect	No effect	No effect	No effect
	Testing Activities	No effect	No effect	No effect	No effect	No effect	No effect
Secondary Stressors							
Explosives, Explosion By-Products, Unexploded Ordnance, Metals, Chemicals, and Other Materials	Training Activities	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	No effect	No effect	No effect	No effect
	Testing Activities	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	No effect	No effect	No effect	No effect

REFERENCES

Andre, M. M. Solé, M. Lenoir, M. Durfort, C. Quero, A. Mas, A. Lombarte, M. van der Schaar, M. López-Bejar, M. Morell, S. Zaugg, and L. Houégnigan. (2011). Low-frequency sounds induce acoustic trauma in cephalopods. Frontiers in Ecology and the Environment 9: 489–493.

Aplin, J. A. (1947). The effect of explosives on marine life. California Fish and Game, 33, 23-30.

Appeltans, W., Bouchet, P., Boxshall, G. A., Fauchald, K., Gordon, D. P., Hoeksema, B. W., Costello, M. J. (2010). *World Register of Marine Species*. [Web page]. Retrieved from http://www.marinespecies.org/index.php, 06 September 2010.

Arfsten, D. P., Wilson, C. L. & Spargo, B. J. (2002). Radio Frequency Chaff: The Effects of Its Use in Training on the Environment. *Ecotoxicology and Environmental Safety, 53*(1), 1-11. DOI: 10.1006/eesa.2002.2197 Retrieved from http://www.sciencedirect.com/science/article/B6WDM-482XDXP-1/2/8251fde540591fc2c72f20159f9d62b3

Bickel, S. L., Malloy Hammond, J. D. & Tang, K. W. (2011). Boat-generated turbulence as a potential source of mortality among copepods. *Journal of Experimental Marine Biology and Ecology, 401*(1-2), 105-109. DOI: 10.1016/j.jembe.2011.02.038 Retrieved from http://www.sciencedirect.com/science/article/B6T8F-52C45PW-1/2/2106d981f9d27a288d7bfadd4c38e23eBrierley 2003, as accessed on 31 October 2011.

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

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

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

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

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

Brown, E. & Wolf, S. (2009). *Petition to List 83 Coral Species under the Endangered Species Act*. (pp. 191). San Francisco, CA: Center for Biological Diversity.

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

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

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

Butler, J., Neuman, M., Pinkard, D., Kvitek, R. & Cochrane, G. (2006). The use of multibeam sonar mapping techniques to refine population estimates of the endangered white abalone (*Haliotis sorenseni*). *Fishery Bulletin, 104*(4), 521-532.

Bythell, J. C. (1986). A guide to the identification of the living corals (*Scleractinia*) of Southern California. *Occasional Papers of the San Diego Society of Natural History, 16*, 1-40.

Cairns, S. D. (1994). *Scleractinia* of the temperate North Pacific. *Smithsonian Contributions to Zoology, 557*.

Carpenter, K. E., Abrar M., Aeby G., Aronson R. B., Banks S., Bruckner A., Chiriboga A., Cortes J., Delbeek J. C., DeVantier L., Edgar G. J., Edwards A. J., Fenner D., Guzman H. M., Hoeksema B. W., Hodgson G., Johan O., Licuanan W. Y., Livingstone S. R., Lovell E. R., Moore J. A., Obura D. O., Ochavillo D., Polidoro B. A., Precht W. F., Quibilan M. C., Reboton C., Richards Z. T., Rogers A. D., Sanciangco J., Sheppard A., Sheppard C., Smith J., Stuart S., Turak E., Veron J. E. N., Wallace C., Weil E., and Wood E. (2008). One-third of reef-building corals face elevated extinction risk from climate change and local impacts. *Science* 321:560-563.

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

Cato, D. H. & M. J. Bell. (1992). Ultrasonic Ambient Noise in Australian Shallow Waters at Frequencies up to 200 kHz. Materials Research Labs Ascot Vale, Australia. Retrieved from: http://handle.dtic.mil/100.2/ADA251679, as accessed on 28 October 2011.

Chan, A., P. Giraldo-Perez, S. Smith & D. Blumstein. (2010). Anthropogenic noise affects risk assessment and attention: the distracted prey hypothesis. *Biology Letters. 23 August, 2010. Retrieved from: http://rsbl.royalsocietypublishing.org/content/6/4/458.full.pdf+html as accessed on 28 October 2011.*

Chave, E.H., and A. Malahoff. (1998). "In deeper waters: Photographic studies of Hawaiian deepsea habitats and life-forms," Honolulu: University of Hawai`i Press.

Chesapeake Biological Laboratory Maryland & Board of Natural Resources. Dept. of Research and Education. (1948). Effects of underwater explosions on oysters, crabs and fish: a preliminary report: Chesapeake Biological Laboratory.

Chess, J. R. & Hobson, E. S. (1997). *Benthic Invertebrates of Four Southern California Marine Habitats Prior to Onset of Ocean Warming in 1976, with Lists of Fish Predators*. (NOAA Technical Memorandum NMFS-SWFSC-243, pp. 110). Tiburon, CA: US Department of Commerce, NOAA, NMFS, Southwest Fisheries Science Center Tiburon Laboratory.

Christian, J. R., A. Mathieu, D. H. Thomson, D. White and R. A. Buchanan. (2003). Effect of Seismic Energy on Snow Crab (*Chionoecetes opilio*). Environmental Research Funds Report No. 144. Calgary. 106 p.

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

Clark, R., Morrison, W., Allen, M. J. & Claflin, L. (2005). Chapter 3: Biogeography of macroinvertebrates. In R. Clark, J. Christensen, C. Caldow, J. Allen, M. Murray and S. MacWilliams (Eds.), *A Biogeographic Assessment of the Channel Islands National Marine Sanctuary: A Review of Boundary Expansion Concepts for NOAA's National Marine Sanctuary Program*. (NOAA Technical Memorandum NOS NCCOS 21, pp. 57-88). Silver Spring, MD: NOAA National Centers for Coastal Ocean Science. Prepared by NCCOS's Biogeography Team in cooperation with the National Marine Sanctuary Program. Available from http://ccma.nos.noaa.gov/ecosystems/sanctuaries/chanisl_nms.html

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

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

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

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

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

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

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

Cortes, J., Edgar, G., Chiriboga, A., Sheppard, C., Turak, E. & Wood, E. (2008). *Psammocora stellata*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3*. [Online database]. Retrieved from http://www.iucnredlist.org/apps/redlist/details/132860/0, 29 September 2010.

Davis, G. E., Haaker, P. L. & Richards, D. V. (1996). Status and trends of white abalone at the California Channel Islands. *Transactions of the American Fisheries Society, 125*(1), 42-48.

Davis, G. E., Haaker, P. L. & Richards, D. V. (1998). The perilous condition of white abalone *Haliotis sorenseni*, Bartsch, 1940. *Journal of Shellfish Research, 17*(3), 871-875.

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

DeVantier, L., Hodgson, G., Huang, D., Johan, O., Licuanan, A., Obura, D., Turak, E. (2008a). *Cyphastrea agassizi*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1*. [Online database]. Retrieved from www.iucnredlist.org, 12 May 2010.

DeVantier, L., Hodgson, G., Huang, D., Johan, O., Licuanan, A., Obura, D., Turak, E. (2008b). *Montipora dilatata*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4*. [Online Database]. Retrieved from http://www.iucnredlist.org/apps/redlist/details/133170/0, 28 October 2010.

DeVantier, L., Hodgson, G., Huang, D., Johan, O., Licuanan, A., Obura, D., Turak, E. (2008c). *Montipora flabellata*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4*. [Online Database]. Retrieved from http://www.iucnredlist.org/apps/redlist/details/133229/0, 28 October 2010.

DeVantier, L., Hodgson, G., Huang, D., Johan, O., Licuanan, A., Obura, D., Turak, E. (2008d). *Montipora patula*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4*. [Online Database]. Retrieved from http://www.iucnredlist.org/apps/redlist/details/132942/0, 28 October 2010.

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

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

Dugan, J. E., Hubbard, D. M., Martin, D. L., Engle, J. M., Richards, D. M., Davis, G. E., Ambrose, R. F. (2000). Macrofauna communities of exposed sandy beaches on the southern California mainland and Channel Islands. In D. R. Browne, K. L. Mitchell and H. W. Chaney (Eds.), *Proceedings of the Fifth California Islands Symposium, 29 March - 1 April 1999 (OCS Study MMS 99-0038)* (pp. 339-346). Minerals Management Service.

Durrach, M. R., Chutjian, A. & Plett, G. A. (1998). Trace Explosives Signatures from World War II Unexploded Undersea Ordnance. *Environmental Science and Technology, 32*, 1354-1358.

Emmett, R. L., Hinton, S. A., Stone, S. L. & Monaco, M. E. (1991). *Distribution and Abundance of Fishes and Invertebrates in West Coast Estuaries*. (Vol. II: Species Life History Summaries, ELMR Report Number 8, pp. 329). Rockville, MD: NOAA/NOS Strategic Environmental Assessments Division.

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

Etnoyer P, Morgan L. (2003). Occurrences of habitat-forming deep sea corals in the northeast Pacific Ocean: A report to NOAA's office of habitat conservation. Redmond, Washington: Marine Conservation Biology Institute.

Etnoyer P, Morgan L.E. (2005). Habitat-forming deep-sea corals in the Northeast Pacific Ocean. In A. Freiwald, and J.M. Roberts, eds. Cold-water corals and ecosystems. Berlin Heidelberg: Springer-Verlag. pp 331-343.

Fenner, D. (2005). *Corals of Hawai'i: A Field Guide to the Hard, Black, and Soft Corals of Hawai'i and the Northwest Hawaiian Islands, including Midway* (pp. 192). Honolulu, HI: Mutual Publishing.

Field, D. B., Baumgartner, T. R., Charles, C. D., Ferreira-Bartrina, V. & Ohman, M. D. (2006). Planktonic Foraminifera of the California Current Reflect 20th-Century Warming. *Science, 311*(5757), 63-66. doi: 10.1126/science.1116220.

Food and Agriculture Organization of the United Nations. (2005). *Fishery Country Profile: United States of America*. [Electronic Data]. Retrieved from ftp://ftp.fao.org/FI/DOCUMENT/fcp/en/FI_CP_US.pdf

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

Friedlander, A., Aeby, G., Brown, E., Clark, A., Coles, S., Dollar, S., Wiltse, W. (2005). The state of coral reef ecosystems of the main Hawaiian islands. In J. Waddell (Ed.), *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005*. (NOAA Technical Memorandum NOS NCCOS 11, pp. 222-269). Silver Spring, MD: NOAA/NCCOS Center for Coastal Monitoring and Assessment's Biogeography Team.

Friedman, C. S., Hendrick, R. P. & Moore, J. D. (2003). *Tools for Management of Withering Syndrome in Abalone,* Haliotis spp*: PCR Detection and Feed-based Therapeutic Treatment*. (pp. 23) University of California, San Diego.

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

Gaspin, J.B., Peters, G.B., & M.L. Wisely. (1976). Experimental investigations of the effects of underwater explosions on swimbladder fish. II. 1975 Chesapeake Bay tests (Technical Report NSWC/WOL/TR 76-61). Naval Ordnance Lab. White Oak, MD.

Grigg, R. W. (1993). Precious coral fisheries of Hawaii and the U.S. Pacific Islands. *Marine Fisheries Review, 55*(2), 50-60.

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

Goodall, C., Chapman, C. & Neil, D. (1990). The acoustic response threshold of Norway lobster Nephrops norvegicus (L.) in a free found field. K. Weise, W. D. Krenz, J. Tautz, H. Reichert and B. Mulloney (Eds.), *Frontiers in Crustacean Neurobiology* (pp. 106 - 113). Basel: Birkhauser.

Guerra A. A.F. Gonzalez, and F, Rocha. (2004). A review of the records of giant squid in the north-eastern Atlantic and severe injuries in *Architeuthis dux* stranded after acoustic explorations. ICES C. M. CC: 29, 1- 17.

Guerra, A. & Gonzales, A. F. (2006). Severe injuries in the giant squid *Architeuthis dux* stranded after seismic explorations, *International Workshop: Impacts of seismic survey activities on whales and other marine biota* (pp. 32-36).

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

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

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

Hobday, A. J. & Tegner, M. (2000). Status Review of white abalone (*Haliotis sorensenit*) throughout its range in California and Mexico National Marine Fisheries Service (Ed.), *NOAA Technical Memorandum*. (pp. 1-90). Available from http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/whiteabalone.pdf

Hobday, A. J., Tegner, M. J. & Haaker, P. L. (2001). Over-exploitation of a broadcast spawning marine invertebrate: Decline of the white abalone. *Reviews in Fish Biology and Fisheries, 10*, 493-514.

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

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

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

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

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

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

International Union for Conservation of Nature and Natural Resources. (2010). IUCN Red List of Threatened Species. Version 2010.4. [Web Page]. Retrieved from www.iucnredlist.org, 12 May 2010.

Jackson, J. B. C. (2008). Ecological extinction and evolution in the brave new ocean. *Proceedings of the National Academy of Sciences of the United States of America, 105*(SUPPL. 1), 11458-11465. Retrieved from http://www.scopus.com/scopus/inward/record.url?eid=2-s2.0-50049124452&partnerID=40&rel=R8.2.0

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

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

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

Jokiel, P. L., Brown E., Rodgers K., and Smith W. (2007). Reef corals and the coral reefs of south Moloka'i. In The coral reef of south Moloka'i, Hawai`i--portrait of a sediment-threatened fringing reef (M. Field, S. Cochran, J. Logan, and C. Storlazzi, eds.), p. 43-50. US Geological Survey, Reston, VA.

Kaifu, K., T. Akamatsu, & S. Segawa. (2008). Underwater sound detection by cephalopod statocyst. *Fisheries Science 74*: 781–786.

Kalvass, P. (2001). The nearshore ecosystem invertebrate resources: Overview. In W. S. Leet, C. M. Dewees, R. Klingbeil and E. J. Larson (Eds.), *California's Living Marine Resources: A Status Report*. (SG01-11, pp. 87-88) California Department of Fish and Game. Available from http://www.dfg.ca.gov/marine/status/nearshore_invert_overview.pdf

Kenyon, J. C., and Brainard R. E. (2006). Second recorded episode of mass coral bleaching in the Northwestern Hawaiian Islands. *Atoll Research Bulletin* 543:505-523.

Kushner, D. J., Shaffer, D. L. J. & Hajduczek, B. (1999). *Kelp Forest Monitoring Annual Report 1999*. (Technical Report CHIS-01-05, pp. 74). Ventura, CA: National Park Service Channel Islands National Park.

Latha, G., S. Senthilvadivu, R. Venkatesan, & V. RajendranLindholm. (2005). Sound of shallow and deep water lobsters: Measurements, analysis, and characterization. *Journal of the Acoustical Society of America: 117,* 2720-2723. Retrieved from http://dx.doi.org/10.1121/1.1893525, as accessed on 28 October 2011.

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

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

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

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

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

Lohmann, S., H. Schmitz, H. Lubatschowski, & W. Ertmer. (1995). Photo-acoustic determination of optical parameters of tissue-like media with reference to opto-acoustic diffraction. Lasers in Medical Science 12: 357-363.

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

Lovell, J.M., M.M. Findlay, J.R. Nedwell, M.A. Pegg. (2006). The hearing abilities of the silver carp (*Hypopthalmichthys molitrix*) and bighead carp (*Aristichthys nobilis*). *Comparative Biochemistry and Physiology - Part A: Molecular & Integrative Physiology 143*: 268-291.

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

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

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

Maragos, J. E., Potts, D. C., Aeby, G., Gulko, D., Kenyon, J., Siciliano, D. & VanRavenswaay, D. (2004). 2000-2002 rapid ecological assessment of corals (*Anthozoa*) on shallow reefs of the northwestern Hawaiian Islands. Part 1: Species and distribution. *Pacific Science, 58*(2), 211-230.

Maragos, J.E. (1998). “Marine ecosystems,” pp. 111-120. In: S.P. Juvik and J.O. Juvik, eds.Atlas of Hawai`i, 3d ed. Honolulu, Hawaii: University of Hawaii Press.

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

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

McLennan, M. W. (1997). A simple model for water impact peak pressure and pulse width: a technical memorandum. Goleta, CA: Greeneridge Sciences Inc.

Miloslavich P, E. Klein, J.M. Díaz, C.E. Hernández, G. Bigatti. (2011). Marine Biodiversity in the Atlantic and Pacific Coasts of South America: Knowledge and Gaps. *PLoS ONE 6*(1).

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

Montgomery J.C., Jeffs A., Simpson S.D., Meekan M., & Tindle C. (2006). Sound as an orientation cue for the pelagic larvae of reef fishes and decapod crustaceans. Adv Mar Biol 51: 143–196.

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

Morgan, L. E. & Chuenpagdee, R. (2003). Shifting gears: addressing the collateral impacts of fishing methods in US waters *Pew Science Series on Conservation and the Environment*. (pp. 42) Pew Charitable Trusts.

National Marine Fisheries Service. (2001). Endangered and threatened species; Endangered status for white abalone. [Final Rule]. *Federal Register, 66*(103), 29046-29055.

National Marine Fisheries Service. (2007). *Species of Concern: Hawaiian Reef Coral,* Montipora dilatata. (pp. 5) National Oceanic and Atmospheric Administration.

National Marine Fisheries Service. (2008). White Abalone Recovery Plan *(Haliotis sorenseni)*. Long Beach, CA: National Marine Fisheries Service, Southwest Regional Office.

National Marine Fisheries Service. (2009). Endangered and threatened wildlife and plants; endangered status for black abalone. [Final Rule]. *Federal Register, 74*(9), 1937-1946.

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

National Marine Fisheries Service. (2013a). Medicine: NOAA Coral Reefs Conservation Program. http://coralreef.noaa.gov/aboutcorals/values/medicine/. Last accessed 11 June 2013.

National Marine Fisheries Service. (2013b). The U.S. Navy's Training Exercises and Testing Activities in the Hawaii-Southern California Training and Testing Study Area from January 2014 through January 2019.

National Oceanic and Atmospheric Administration. (2007). *Channel Islands National Marine Sanctuary: Final Environmental Impact Statement for the Establishment of Marine Reserves and Marine Conservation Areas*. (pp. 235) U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, National Marine Sanctuary Program.

National Oceanic and Atmospheric Administration. (2010a). Black Abalone *(Haliotis cracherodii)*. [Web Page] NOAA Fisheries Office of Protected Resources. Retrieved from http://www.nmfs.noaa.gov/pr/species/invertebrates/blackabalone.htm, 25 October 2010.

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

National Oceanic and Atmospheric Administration. (2010c). White Abalone *(Haliotis sorenseni)*. [Web Page] NOAA Fisheries Office of Protected Resources. Retrieved from http://www.nmfs.noaa.gov/pr/species/invertebrates/whiteabalone.htm, 25 October 2010.

National Oceanic and Atmospheric Administration. (2012). Supplemental Information Report on Status Review Report And Draft Management Report For 82 Coral Candidate Species. U.S. Department of Commerce. November 2012.

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

Negri, A. P., Smith, L. D., Webster, N. S. & Heyward, A. J. (2002). Understanding ship-grounding impacts on a coral reef: potential effects of anti-foulant paint contamination on coral recruitment. *Marine Pollution Bulletin, 44*(2), 111-117. doi: 10.1016/s0025-326x(01)00128-xO'Keefe 1984.

Neuman, M., B. Tissot, and G. VanBlaricom. (2010). Overall status and threats assessment of black abalone (Haliotis cracherodii Leach, 1814) populations in California. Journal of Shellfish Research 29(3): 577-586.

Normandeau, Exponent, T., T. & Gill, A. (2011). Effects of EMFs from Undersea Power.

Norström, A. V., Nyström, M., Lokrantz, J. & Folke, C. (2009). Alternative states on coral reefs: Beyond coral-macroalgal phase shifts. *Marine ecology progress series, 376*, 293-306. Retrieved from http://www.scopus.com/scopus/inward/record.url?eid=2-s2.0-62149119548&partnerID=40

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

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

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

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

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

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

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

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

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

Pawson, David L. (1995). Echinoderms of the tropical island Pacific: status of their sytematics and notes on their ecology and biogeography. In: *Marine and coastal biodiversity in the tropical island Pacific region.* pp.171-192.Payne, J. F., Andrews, C. A., Fancey, L. L., Cook, A. L. & Christian, J. R. (2007). Pilot Study on the Effects of Seismic Air Gun Noise on Lobster (Homarus Americanus).

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

Polovina, J. J., Kleiber, P. & Kobayashi, D. R. (1999). Application of TOPEX-POSEIDON satellite altimetry to simulate transport dynamics of larvae of spiny lobster, *Panulirus marginatus*, in the Northwestern Hawaiian Islands, 1993-1996. *Fishery Bulletin, 97*, 132-143.

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

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

Precht, W. F., Aronson, R. B. & Swanson, D. W. (2001). Improving scientific decision-making in the restoration of ship-grounding sites on coral reefs. *Bulletin of marine science, 69*, 1001-1012. Retrieved from http://www.ingentaconnect.com/content/umrsmas/bullmar/2001/00000069/00000002/art00058

Proctor, C. M., Garcia, J. C., Galvin, D. V., Joyner, T., Lewis, G. B., Loehr, L. C. & Massa, A. M. (1980). *An Ecological Characterization of the Pacific Northwest Coastal Region*. (Vol. 1. Conceptual Model, FWS/OBS-79/11) U.S. Fish and Wildlife Service, Biological Services Program.

Quanzi, L. & Wang, G. (2009). Diversity of fungal isolates from three Hawaiian marine sponges. *Microbiological Research, 164*(2), 233-241. doi: 10.1016/j.micres.2007.07.002.

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

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

Reinhall, P. G. & Dahl, P. H. (2011). Underwater Mach Wave Radiation from Impact Pile Driving: Theory and Observation. *Journal of the Acoustical Society of America, 130*(3), 1209-1216.

Richards, Z., Delbeek, J. C., Lovell, E., Bass, D., Aeby, G. & C., R. (2008). *Acropora paniculata*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4*. [Online Database]. Retrieved from http://www.iucnredlist.org/apps/redlist/details/132972/0, 25 October 2010.

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

Roberts, S., and M. Hirshfield. (2003). "Deep sea corals: Out of sight, but no longer out of mind," Frontiers in Ecology & the Environment, 2(3): 123–130.18 pp.

Rogers-Bennett, L., Haaker, P. L., Huff, T. O. & Dayton, P. K. (2002). Estimating Baseline Abundances of Abalone in California for Restoration. In *California Cooperative Oceanic Fisheries Investigations (CalCOFI) Reports*. (Vol. 43, pp. 97-111).

Rooney, J., Donham E., Montgomery A., Spalding H., Parrish F., Boland R., Fenner D., Gove J., and Vetter O. (2010). Mesophotic coral ecosystems in the Hawaiian Archipelago. *Coral Reefs 29*:361-367.

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

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

Sanders, H. L. (1968). Marine benthic diversity: A comparative study. *American Naturalist, 102*(925), 243.

Schoeman, D. S., McLachlan, A. & Dugan, J. E. (2000). Lessons from a Disturbance Experiment in the Intertidal Zone of an Exposed Sandy Beach. *Estuarine, Coastal and Shelf Science, 50*(6), 869-884. doi: 10.1006/ecss.2000.0612.

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

Sheppard, A., Fenner, D., Edwards, A., Abrar, M. & Ochavillo, D. (2008). *Porites pukoensis*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1*. [Online database]. Retrieved from http://www.iucnredlist.org/apps/redlist/details/133574/0, 18 June 2010.

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

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

Smith, G., Stamm, C. & Petrovic, F. (2003). *Haliotis cracherodii*. In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1*. [Online database]. Retrieved from www.iucnredlist.org, 27 April 2010.

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

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

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

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

Stierhoff, K.L., Neuman, M., & Butler, J.L. (2012). On the road to extinction? Population declines of the endangered white abalone, Haliotis sorenseni. *Biological Conservation*, 152(8).

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

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

Tissot, B. N., Yoklavich, M. M., Love, M. S., York, K. & Amend, M. (2006). Benthic invertebrates that form habitat on deep banks off southern California, with special reference to deep sea coral. *Fishery Bulletin, 104*(2), 167-181.

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

U.S. Department of the Navy. (2011). San Diego Bay Integrated Natural Resources Management Plan. Navy Regional Southwest, Naval Facilities Engineering Command, and the Unified Port of San Diego. Prepared by Tierra Data, Inc. Escondido, CA.

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

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

VanBlaricom, G., Butler, J., DeVogelaere, A., Gustafson, R., Mobley, C., Neuman, M., & Richards, D. (2009). *Status Review Report for Black Abalone (*Haliotis cracherodii *Leach, 1814)*. (pp. 135). Long Beach, CA: National Marine Fisheries Service.

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

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

Vilchis, L. I., Tegner, M. J., Moore, J. D., Friedman, C. S., Riser, K. L., Robbins, T. T. & Dayton, P. K. (2005). Ocean warming effects on growth, reproduction, and survivorship of southern California abalone. *Ecological Applications, 15*(2), 469-480.

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

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

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

Wallace, C. C. (1999). *Staghorn Corals of the World: a Revision of the Coral Genus Acropora (Scleractinia; Astrocoeniina; Acroporidae) Worldwide, with Emphasis on Morphology, Phylogeny and Biogeography*. CSIRO Publishing, Collingwood, Australia.

Wang, W.-X. & Rainbow, P. S. (2008). Comparative approaches to understand metal bioaccumulation in aquatic animals. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology, 148*(4), 315-323. doi: 10.1016/j.cbpc.2008.04.003.

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

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

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

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

Wilson, M., Hanlon, R. T., Tyack, P. L. & Madsen, P. T. (2007). Intense ultrasonic clicks from echolocating toothed whales do not elicit anti-predator responses or debilitate the squid *Loligo pealeii*. *Biology Letters, 3*, 225-227.

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

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

Zabin, C. (2003). *Hawai'i Intertidal Project*. [Web page]. Retrieved from http://intertidalhawaii.org, 14 May 2010.

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3.9 Fish

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3.9 FISH

FISH SYNOPSIS

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

- Acoustic (sonar and other active acoustic sources, and underwater explosives)
- Energy (electromagnetic devices)
- Physical disturbance and strikes (vessels and in-water devices, military expended materials, seafloor devices)
- Entanglement (fiber optic cables and guidance wires, parachutes)
- Ingestion (munitions, military expended materials other than munitions)
- Secondary stressors

Preferred Alternative (Alternative 2)

Acoustics: Pursuant to the Endangered Species Act (ESA), the use of sonar and other active acoustic sources may affect but is not likely to adversely affect ESA-listed steelhead trout. The use of explosives and other impulsive acoustic sources may affect and is likely to adversely affect ESA-listed steelhead trout. Acoustic sources would have no effect on critical habitat.

- Energy: Pursuant to the ESA, the use of electromagnetic devices may affect but is not likely to adversely affect ESA-listed steelhead trout. Electromagnetic devices would have no effect on critical habitat.
- Physical Disturbance and Strikes: Pursuant to the ESA, the use of vessels and in-water devices, military expended materials, and seafloor devices may affect but is not likely to adversely affect ESA-listed steelhead trout. Vessels and in-water devices, military expended materials, and seafloor devices would have no effect on critical habitat.
- Entanglement: Pursuant to the ESA, the use of fiber optic cables, guidance wires, and parachutes may affect but is not likely to adversely affect ESA-listed steelhead trout.
- Ingestions: Pursuant to the ESA, the potential for ingestion of military expended materials may affect but is not likely to adversely affect ESA-listed steelhead trout
- Secondary Stressors: Pursuant to the ESA, secondary stressors may affect, but are not likely to adversely affect, ESA-listed steelhead trout. Secondary stressors would have no effect on critical habitat.
- Pursuant to the Essential Fish Habitat requirements, the use of sonar and other active acoustic sources, explosives, pile driving, and electromagnetic devices may have a minimal and temporary adverse effect on the fishes that occupy water column Essential Fish Habitat.

3.9.1 INTRODUCTION

This section analyzes the potential impacts of the Proposed Action on fishes found in the Hawaii-Southern California Training and Testing (HSTT) Study Area (Study Area). Section 3.9 provides a synopsis of the United States (U.S.) Department of the Navy's (Navy) determinations of the impacts of the Proposed Action on fish. Section 3.9.1 (Introduction) introduces the species and taxonomic groups that occur in the Study Area. Section 3.9.2 (Affected Environment) discusses the baseline affected environment. The complete analysis of environmental consequences is in Section 3.9.3 (Environmental

Consequences), and the potential impacts of the Proposed Action on fishes are summarized in Section 3.9.4 (Summary of Potential Impacts on Fish).

For this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), marine fishes are evaluated as groups of species characterized by distribution, body type, or behavior relevant to the stressor being evaluated. Activities are evaluated for their potential impact on all fishes in general, by taxonomic groupings, and the one marine fish in the Study Area listed under the Endangered Species Act (ESA).

Fish species listed under the ESA, along with major taxonomic groups in the Study Area, are described in this section. Marine fish species that are regulated under the Magnuson-Stevens Fishery Conservation and Management Act are discussed in Section 3.9.1.3. Additional general information on the biology, life history, distribution, and conservation of marine fishes can be found on the websites of the following agencies and organizations, as well as many others:

- National Marine Fisheries Service (NMFS), Office of Protected Resources (including ESA-listed species distribution maps)
- Regional Fishery Management Councils
- International Union for Conservation of Nature

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

3.9.1.1 Endangered Species Act Species

There is only one marine fish, steelhead trout (*Oncorhynchus mykiss*) in the Study Area that is listed as endangered under the ESA (Table 3.9-1 and Section 3.9.2.3, Steelhead Trout).

One species (scalloped hammerhead shark [*Sphyrna lewini*]) is proposed for listing as threatened or endangered in the future, and there are three species of concern (basking shark [*Cetorhinus maximus*], bocaccio [*Sebastes paucispinis*], and cowcod [*Sebastes levis*]), defined as a species about which NMFS has some concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the ESA. The emphasis on species-specific information in the following profiles will be on the one ESA protected species because any threats or potential impacts on that species are subject to consultation with regulatory agencies. Consideration is also given to the broad taxonomic groups to cover the non-regulated fishes within the marine ecosystem of the Study Area.

Table 3.9-1: Status and Presence of Endangered Species Act-Listed Fish Species, Candidate Species, and Species of Concern Found in the Hawaii-Southern California Training and Testing Study Area

Species Name and Regulatory Status			Presence in Study Area	
Common Name	**Scientific Name**	**Endangered Species Act Listing**	**Open Ocean Area**	**Coastal Waters**
Steelhead trout	*Oncorhynchus mykiss*	Endangered (Southern California distinct population segment[1])	Santa Maria River, California to U.S.-Mexico Border	California Current
Scalloped Hammerhead Shark	*Sphyrna lewini*	Proposed	Southern California and waters off of Hawaii	Southern California and waters off of Hawaii
Basking shark	*Cetorhinus maximus*	Species of Concern (Eastern North Pacific population)	Canada to Southern California	California Current
Bocaccio	*Sebastes paucispinis*	Species of Concern (Southern California distinct population segment[1])	Oregon to Central Baja California	California Current
Cowcod	*Sebastes levis*	Species of Concern (Central Oregon to central Baja California and Guadalupe Island, Mexico evolutionarily significant unit[2])	Central Oregon to Central Baja California	California Current

[1] A species with more than one distinct population segment can have more than one ESA listing status, as individual distinct population segments can be either not listed under the ESA or can be listed as endangered, threatened, or a candidate species.
[2] Evolutionarily significant unit is a population of organisms that is considered distinct for purposes of conservation.

3.9.1.2 Taxonomic Groups

Taxonomic groupings of marine fishes are listed in Table 3.9-2 and are described further in Section 3.9.2 (Affected Environment). In order to capture all marine fishes representative of the Study Area, these taxonomic groups are presented to supplement the approach used for the ESA-protected species in this document.

Table 3.9-2: Major Taxonomic Groups of Marine Fishes within the Hawaii-Southern California Training and Testing Study Area

Major Marine Fish Groups[1]		Vertical Distribution Within Study Area[2]	
Common Name (Taxonomic Group)	**Description**	**Open Ocean**	**Coastal Waters**
Jawless fishes (order Myxiniformes and order Petromyzontiformes)	Primitive fishes with an eel-like body shape that feed on dead fishes or are parasitic on other fishes	Water column, seafloor	Seafloor
Sharks, rays, and chimaeras (class Chondrichthyes)	Cartilaginous (non-bony) fishes, many of which are open ocean predators	Surface, water column, seafloor	Surface, water column, seafloor

[1] Taxonomic groups are based on the following commonly accepted references (Helfman et al. 1997; Moyle and Cech 1996; Nelson 2006).
[2] Presence in the Study Area includes open ocean areas (portions of the North Pacific Subtropical Gyre and North Pacific Transition Zone) and coastal waters of two Large Marine Ecosystems-California Current and Insular Pacific-Hawaiian.

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

Major Marine Fish Groups[1]		Vertical Distribution Within Study Area[2]	
Common Name (Taxonomic Group)	**Description**	**Open Ocean**	**Coastal Waters**
Eels and bonefishes (order Anguilliformes, order Elopiformes)	Undergo a unique larval stage with a small head and elongated body; very different from other fishes	Surface, water column, seafloor	Surface, water column, seafloor
Smelt and salmonids (orders Argentiniformes, Osmeriformes, and Salmoniformes)	Most salmon and smelt are migratory between marine and estuarine/freshwater habitats; Argentiniformes occur in deep waters	Seafloor (Argentiniformes only), surface, water column	Surface, water column
Cods (orders Gadiformes and Ophidiiformes)	Important commercial fishery resources (cods), associated with bottom habitats, also includes some deepwater groups	Water column, seafloor	Water column, seafloor
Toadfishes and anglerfishes (orders Batrachoidiformes and Lophiiformes)	Includes the toadfishes and the anglerfishes, a lie-in-wait predator	Seafloor	Seafloor
Mullets, silversides, needlefishes, and killifish (orders Mugiliformes, Atheriniformes, Beloniformes, and Cyprinodontiformes)	Small-sized nearshore/coastal fishes, primarily feed on organic debris; also includes the surface-oriented flyingfishes	Surface	Surface, water column, seafloor
Oarfishes, squirrelfishes, dories (orders Lampridiformes, Beryciformes, Zeiformes)	Primarily open ocean or deepwater fishes, except for squirrelfishes (reef-associated)	Surface, water column, seafloor	Surface, water column, seafloor
Pipefishes and seahorses (order Gasterosteiformes)	Small mouth with tubular snout and armor like scales; gives birth to live young and shows a high level of parental care	None	Surface, water column, seafloor
Scorpionfishes (order Scorpaeniformes)	Bottom dwelling with modified pectoral fins to rest on the bottom	Seafloor	Seafloor
Snappers, drums, and croakers (families Sciaenidae and Lutjanidae)	Important game fishes and common predators of all marine waters; sciaenids produce sounds with their swim bladders	Surface, water column, seafloor	Surface, water column, seafloor
Groupers and seabasses (family Serranidae)	Important game fishes with vulnerable conservation status; some have a hermaphroditic strategy in which females become males as they mature	Water column, seafloor	Surface, water column, seafloor
Wrasses, damselfishes (family Pomacentridae), and parrotfishes (families Labridae and Scaridae)	Primarily reef-associated fishes with a hermaphroditic strategy in which females become males as they mature	Water column, seafloor	Surface, water column, seafloor
Gobies and blennies (families Gobiidae and Blennidae)	Gobies are the largest and most diverse family of marine fishes, mostly found in bottom habitats of coastal areas	Surface, water column, seafloor	Surface, water column, seafloor

[1] Taxonomic groups are based on the following commonly accepted references (Helfman et al. 1997; Moyle and Cech 1996; Nelson 2006).
[2] Presence in the Study Area includes open ocean areas (portions of the North Pacific Subtropical Gyre and North Pacific Transition Zone) and coastal waters of two Large Marine Ecosystems-California Current and Insular Pacific-Hawaiian.

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

Major Marine Fish Groups[1]		Vertical Distribution Within Study Area[2]	
Common Name (Taxonomic Group)	**Description**	**Open Ocean**	**Coastal Waters**
Gobies and blennies (families Gobiidae and Blennidae)	Gobies are the largest and most diverse family of marine fishes, mostly found in bottom habitats of coastal areas	Surface, water column, seafloor	Surface, water column, seafloor
Jacks, tunas, mackerels, and billfishes (families Carangidae, Scombridae, Xiphiidae, Istiophoridae)	Highly migratory predators found near the surface; they make up a major component of fisheries	Surface	Surface, water column
Flounders (order Pleuronectiformes)	Flatfishes that occur in bottom habitats throughout the world where they are well camouflaged	Seafloor	Seafloor
Triggerfishes, puffers, and molas (order Tetraodontiformes)	Unique body shapes and characteristics to avoid predators (e.g., spines); includes ocean sunfish, the largest bony fish	Surface, water column, seafloor	Surface, water column, seafloor

[1] Taxonomic groups are based on the following commonly accepted references (Helfman et al. 1997; Moyle and Cech 1996; Nelson 2006).
[2] Presence in the Study Area includes open ocean areas (portions of the North Pacific Subtropical Gyre and North Pacific Transition Zone) and coastal waters of two Large Marine Ecosystems-California Current and Insular Pacific-Hawaiian.

3.9.1.3 Federally Managed Species

The fisheries of the United States are managed within a framework of overlapping international, federal, state, interstate, and tribal authorities. Individual states and territories generally have jurisdiction over fisheries in marine waters within 3 nm of their coast. Federal jurisdiction includes fisheries in marine waters inside the U.S. Exclusive Economic Zone, which encompasses the area from 3 nm to 200 nm offshore of any U.S. coastline (National Oceanic and Atmospheric Administration 1996).

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

Federally managed species of marine fishes are listed in Table 3.9-3 and Table 3.9-4. These species are considered, along with ESA-listed species and other taxonomic groupings, in the analysis of impacts in Section 3.9.3 (Environmental Consequences). The analysis of impacts on commercial and recreational fisheries is provided in Section 3.11 (Socioeconomic Resources).

Table 3.9-3: Federally Managed Fish Species Within the Hawaii-Southern California Training and Testing Study Area, Western Pacific Regional Fishery Management Council

Western Pacific Regional Fishery Management Council		
Common Name	**Local Name**	**Scientific Name**
Hawaii Archipelago Bottomfish Management Unit Species (BMUS)		
Amberjack	kahala	*Seriola dumerili*
Black jack	ulua laʻuli	*Caranx lugubris*
Blue stripe snapper	taʻape	*Lutjanus kasmira*
Giant trevally	white papio/ulua au kea	*Caranx ignobilis*
Gray jobfish	uku	*Aprion virescens*
Longtail snapper	onaga or ʻulaʻula koaʻe	*Etelis coruscans*
Pink snapper	ʻopakapaka	*Pristipomoides filamentosus*
Pink snapper	kalekale	*Pristipomoides seiboldii*
Red snapper	ehu	*Etelis carbunculus*
Sea bass	hapuʻupuʻu	*Epinephelus quernus*
Silver jaw jobfish	lehi	*Aphareus rutilans*
Snapper	gindai	*Pristipomoides zonatus*
Thicklip trevally	pig ulua, butaguchi	*Pseudocaranx dentex*
Yellowtail snapper	kalekale	*Pristipomoides auricilla*
Hawaii Archipelago Bottomfish Management Unit Species - Seamount Groundfish		
Alfonsin	n/a	*Beryx splendens*
Armorhead	n/a	*Pseudopentaceros wheeleri*
Raftfish	n/a	*Hyperoglyphe japonica*
Hawaii Archipelago Coral Reef Ecosystem Management Units Species, Currently Harvested Coral Reef Taxa (CHCRT)		
Anchovies	nehu	Engraulidae
Anemones	n/a	Actinaria
Angelfishes	n/a	Pomacanthidae
Banded goatfish	kumu or moano	*Parupeneus* spp.
Bandtail goatfish	weke pueo	*Upeneus arge*
Barracudas	kaku	Sphyraenidae
Bigeye	ʻaweoweo	*Priacanthus hamrur*
Bigeye scad	akule or hahalu	*Selar crumenophthalmus*
Bigscale soldierfish	menpachi or ʻuʻu	*Myripristis berndti*
Black tongue unicornfish	kala holo	*Naso hexacanthus*
Black triggerfish	humuhumu ʻeleʻele	*Melichthys niger*
Blacktip reef shark	manō	*Carcharhinus melanopterus*
Blennies	pa oʻo	Blenniidae
Blue-lined squirrelfish	ʻalaʻihi	*Sargocentron tiere*
Blue-lined surgeon	maiko	*Acanthurus nigroris*
Bluespine unicornfish	kala	*Naso unicornus*
Brick soldierfish	menpachi or ʻuʻu	*Myripristis amaena*

Table 3.9-3: Federally Managed Fish Species Within the Hawaii-Southern California Training and Testing Study Area, Western Pacific Regional Fishery Management Council (continued)

Western Pacific Regional Fishery Management Council		
Common Name	**Local Name**	**Scientific Name**
Bridled triggerfish	n/a	*Sufflamen fraenatum*
Brown surgeonfish	maiʻiʻi	*Acanthurus nigrofuscus*
Butterflyfish	kikakapu	*Chaetodon auriga*
Butterflyfishes	kikakapu	Chaetodontidae
Cardinalfishes	ʻupapalu	Apogonidae
Cigar wrasse	kupoupou	*Cheilio inermis*
Convict tang	manini	*Acanthurus triostegus*
Coral crouchers	n/a	Caracanthidae
Cornetfish	nunu peke	Fistularia commersoni
Crown squirrelfish	ʻalaʻihi	*Sargocentron diadema*
Damselfishes	mamo	Pomacentridae
Doublebar goatfish	munu	*Parupeneus bifasciatus*
Dragon eel	puhi	*Enchelycore pardalis*
Eels (Those species not listed as CHCRT)	puhi	Muraenidae
		Congridae
		Ophichthidae
Eller's barracuda	kaweleʻa or kaku	*Sphyraena helleri*
Eye-striped surgeonfish	palani	*Acanthurus dussumieri*
False mullet	uouoa	*Neomyxus leuciscus*
File-lined squirrelfish	ʻalaʻihi	*Sargocentron microstoma*
Flounders and soles	pakiʻi	Bothidae
Flounders and soles	pakiʻi	Soleidae
Flounders and soles	pakiʻi	Pleuronectidae
Frogfishes	n/a	Antennariidae
Galapagos shark	manō	*Carcharhinus galapagensis*
Giant moray eel	puhi	*Gymnothorax javanicus*
Glasseye	ʻaweoweo	*Heteropriacanthus cruentatus*
Goatfishes	weke, moano, kumu	Mullidae
Gobies	ʻoʻopu	Gobiidae
Gray unicornfish	n/a	*Naso caesius*
Great barracuda	kaku	*Sphyraena barracuda*
Grey reef shark	manō	*Carcharhinus amblyrhynchos*
Groupers, seabass (Those species not listed as CHCRT or in BMUS)	roi, hapuʻupuʻu	Serrandiae
Hawaiian flag-tail	ʻaholehole	*Kuhlia sandvicensis*
Hawaiian squirrelfish	ʻalaʻihi	*Sargocentron xantherythrum*
Hawkfishes (Those species not listed as CHCRT)	poʻopaʻa	Cirrhitidae
Herrings	n/a	Clupeidae

Table 3.9-3: Federally Managed Fish Species Within the Hawaii-Southern California Training and Testing Study Area, Western Pacific Regional Fishery Management Council (continued)

Western Pacific Regional Fishery Management Council		
Common Name	**Local Name**	**Scientific Name**
Jacks and scads (Those species not listed as CHCRT or in BMUS)	dobe, kagami, paʻopaʻo, papa, omaka, ulua	Carangidae
Labridae wrasses (Those species not listed as CHCRT)	hinalea	Labridae wrasses
Mackerel scad	ʻopelu or ʻopelu mama	*Decapterus macarellus*
Moorish idol	kihikihi	*Zanclus cornutus*
Moorish Idols	kihikihi	Zanclidae
Multi-barred goatfish	moano	*Parupeneus multifaciatus*
Orange goatfish	weke nono	*Mulloidichthys pfleugeri*
Orangespine unicornfish	kalalei or umaumalei	*Naso lituratus*
Orange-spot surgeonfish	naʻenaʻe	*Acanthurus olivaceus*
Parrotfish	uhu or palukaluka	*Scarus* spp.
Pearly soldierfish	menpachi or ʻuʻu	*Myripristis kuntee*
Peppered squirrelfish	ʻalaʻihi	*Sargocentron punctatissimum*
Picassofish	humuhumu nukunuku apuaʻa	*Rhinecanthus aculeatus*
Pinktail triggerfish	humuhumu hiʻukole	*Melichthys vidua*
Pipefishes and seahorses	n/a	Syngnathidae
Puffer fishes and porcupine fishes	ʻoʻopu hue or fugu	Tetraodontidae
Raccoon butterflyfish	kikakapu	*Chaetodon lunula*
Razor wrasse	laenihi or nabeta	*Xyrichtys pavo*
Rays and skates	hihimanu	Dasyatididae
		Myliobatidae
Red ribbon wrasse	n/a	*Thalassoma quinquevittatum*
Remoras	n/a	Echeneidae
Ringtail surgeonfish	Pualu	*Acanthurus blochii*
Ring-tailed wrasse	poʻou	*Oxycheilinus unifasciatus*
Rockmover wrasse	n/a	*Novaculichthys taeniourus*
Rudderfish	nenue	*Kyphosus biggibus*
Rudderfish	nenue	*Kyphosus cinerascens*
Rudderfish	nenue	*Kyphosus vaigiensis*
Rudderfishes (Those species not listed as CHCRT)	nenue	Kyphosidae
Saber or long jaw squirrelfish	ʻalaʻihi	*Sargocentron spiniferum*
Saddleback butterflyfish	kikakapu	*Chaetodon ephippium*
Saddleback hogfish	ʻaʻawa	*Bodianus bilunulatus*
Sandperches	n/a	Pinguipedidae
Scorpionfishes, lionfishes	nohu, okoze	Scorpaenidae
Sharks	manō	Carcharhinidae
		Sphyrnidae
Side-spot goatfish	malu	*Parupeneus pleurostigma*

Table 3.9-3: Federally Managed Fish Species Within the Hawaii-Southern California Training and Testing Study Area, Western Pacific Regional Fishery Management Council (continued)

Western Pacific Regional Fishery Management Council		
Common Name	**Local Name**	**Scientific Name**
Snappers (Those species not listed as CHCRT or in BMUS)	to‘au	Lutjanidae
Trumpetfish	nunu	Aulostomus chinensis
Solderfishes and squirrelfishes	‘u‘u	Holocentridae
Sponges	n/a	Porifera
Spotfin squirrelfish	‘ala‘ihi	*Neoniphon* spp.
Spotted unicornfish	kala lolo	*Naso brevirostris*
Stareye parrotfish	panuhunuhu	*Calotomus carolinus*
Surgeonfishes	na‘ena‘e, maikoiko	Acanthuridae
Striped bristletooth	n/a	*Ctenochaetus striatus*
Stripped mullet	‘ama‘ama	*Mugil cephalus*
Sunset wrasse	n/a	*Thalassoma lutescens*
Surge wrasse	ho‘u	*Thalassoma purpureum*
Threadfin	moi	*Polydactylus sexfilis*
Tilefishes	n/a	Malacanthidae
	humu humu	Balistidae
Trunkfishes	makukana	Ostraciidae
Undulated moray eel	puhi laumilo	*Gymnothorax undulatus*
Whitebar surgeonfish	maiko or maikoiko	*Acanthurus leucopareius*
Whitecheek surgeonfish	n/a	*Acanthurus nigricans*
Whitemargin unicornfish	kala	*Naso annulatus*
White-spotted surgeonfish	‘api	*Acanthurus guttatus*
Whitetip reef shark	manō lalakea	*Triaenodon obesus*
Yellow goatfish	weke	*Mulloidichthys spp.*
Yellow tang	lau‘ipala	*Zebrasoma flavescens*
Yellow-eyed surgeonfish	kole	*Ctenochaetus strigosus*
Yellowfin goatfish	weke‘ula	*Mulloidichthys vanicolensis*
Yellowfin soldierfish	menpachi or ‘u‘u	*Myripristis chryseres*
Yellowfin surgeonfish	pualu	*Acanthurus xanthopterus*
Yellowmargin moray eel	puhi paka	*Gymnothorax flavimarginatus*
Yellowsaddle goatfish	moano kea or moano kale	*Parupeneus cyclostomas*
Yellowstripe goatfish	weke‘a or weke a‘a	*Mulloidichthys flavolineatus*

Notes: (1) All other coral reef ecosystem management unit species that are marine plants, invertebrates, and fishes that are not listed in the preceding tables or are not bottomfish management unit species, crustacean management unit species, Pacific pelagic management unit species, precious coral or seamount groundfish. (2) n/a = Not Applicable.
Source: Western Pacific Regional Fishery Management Council (2009)

Table 3.9-4: Federally Managed Fish Species within the Hawaii-Southern California Training and Testing Study Area, Pacific Regional Fishery Management Council

Pacific Regional Fishery Management Council	
Common Name	**Scientific Name**
Groundfish Management Unit Species	
Sharks and Skates	
Big skate	*Raja binoculata*
California skate	*Raja inornata*
Leopard shark	*Triakis semifasciata*
Longnose skate	*Raja rhina*
Soupfin shark	*Galeorhinus zyopterus*
Spiny dogfish	*Squalus acanthias*
Ratfish	
Ratfish	*Hydrolagus colliei*
Morids	
Finescale codling	*Antimora microlepis*
Grenadiers	
Pacific rattail	*Coryphaenoides acrolepis*
Roundfish	
Cabezon	*Scorpaenichthys marmoratus*
Kelp greenling	*Hexagrammos decagrammus*
Lingcod	*Ophiodon elongatus*
Pacific cod	*Gadus macrocephalus*
Pacific Regional Fishery Management Council	
Roundfish	
Pacific whiting (hake)	*Merluccius productus*
Sablefish	*Anoplopoma fimbria*
Rockfish[1]	
Aurora rockfish	*Sebastes aurora*
Bank rockfish	*Sebastes rufus*
Black rockfish	*Sebastes melanops*
Black and yellow rockfish	*Sebastes chrysomelas*
Blackgill rockfish	*Sebastes melanostomus*
Blue rockfish	*Sebastes mystinus*
Bocaccio	*Sebastes paucispinis*
Bronzespotted rockfish	*Sebastes gilli*
Brown rockfish	*Sebastes auriculatus*
Calico rockfish	*Sebastes dallii*
California scorpionfish	*Scorpaena gutatta*
Canary rockfish	*Sebastes pinniger*
Chameleon rockfish	*Sebastes phillipsi*
China rockfish	*Sebastes nebulosus*
Chilipepper	*Sebastes goodei*

Table 3.9-4: Federally Managed Fish Species within the Hawaii-Southern California Training and Testing Study Area, Pacific Regional Fishery Management Council (continued)

Pacific Regional Fishery Management Council	
Common Name	**Scientific Name**
Copper rockfish	*Sebastes caurinus*
Cowcod	*Sebastes levis*
Darkblotched rockfish	*Sebastes crameri*
Dusky rockfish	*Sebastes ciliatus*
Dwarf-red rockfish	*Sebastes rufinanus*
Flag rockfish	*Sebastes rubrivinctus*
Freckled rockfish	*Sebastes lentiginosus*
Gopher rockfish	*Sebastes carnatus*
Grass rockfish	*Sebastes rastrelliger*
Greenblotched rockfish	*Sebastes rosenblatti*
Greenspotted rockfish	*Sebastes chlorostictus*
Greenstriped rockfish	*Sebastes elongatus*
Halfbanded rockfish	*Sebastes semicinctus*
Harlequin rockfish	*Sebastes variegatus*
Honeycomb rockfish	*Sebastes umbrosus*
Kelp rockfish	*Sebastes atrovirens*
Longspine thornyhead	*Sebastolobus altivelis*
Mexican rockfish	*Sebastes macdonaldi*
Olive rockfish	*Sebastes serranoides*
Pink rockfish	*Sebastes eos*
Pinkrose rockfish	*Sebastes simulator*
Pygmy rockfish	*Sebastes wilsoni*
Pacific ocean perch	*Sebastes alutus*
Quillback rockfish	*Sebastes maliger*
Redbanded rockfish	*Sebastes babcocki*
Redstripe rockfish	*Sebastes proriger*
Rosethorn rockfish	*Sebastes helvomaculatus*
Rosy rockfish	*Sebastes rosaceus*
Rougheye rockfish	*Sebastes aleutianus*
Sharpchin rockfish	*Sebastes zacentrus*
Shortbelly rockfish	*Sebastes jordani*
Shortraker rockfish	*Sebastes borealis*
Shortspine thornyhead	*Sebastolobus alascanus*
Silvergray rockfish	*Sebastes brevispinis*
Speckled rockfish	*Sebastes ovalis*
Splitnose rockfish	*Sebastes diploproa*
Squarespot rockfish	*Sebastes hopkinsi*
Starry rockfish	*Sebastes constellatus*
Stripetail rockfish	*Sebastes saxicola*

Table 3.9-4: Federally Managed Fish Species within the Hawaii-Southern California Training and Testing Study Area, Pacific Regional Fishery Management Council (continued)

Pacific Regional Fishery Management Council	
Common Name	**Scientific Name**
Swordspine rockfish	*Sebastes ensifer*
Tiger rockfish	*Sebastes nigrocinctus*
Treefish	*Sebastes serriceps*
Vermilion rockfish	*Sebastes miniatus*
Widow rockfish	*Sebastes entomelas*
Yelloweye rockfish	*Sebastes ruberimus*
Yellowmouth rockfish	*Sebastes reedi*
Yellowtail rockfish	*Sebastes flavidus*
Flatfish	
Arrowtooth flounder (turbot)	*Atheresthes stomias*
Butter sole	*Isopsetta isolepis*
Curlfin sole	*Pleuronichthys decurrens*
Dover sole	*Microstomus pacificus*
English sole	*Parophrys vetulus*
Flathead sole	*Hippoglossoides elassodon*
Pacific sanddab	*Citharichthys sordidus*
Petrale sole	*Eopsetta jordani*
Rex sole	*Glyptocephalus zachirus*
Rock sole	*Lepidopsetta bilineata*
Sand sole	*Psettichthys melanostictus*
Starry flounder	*Platichthys stellatus*
Coastal Pelagic Management Unit Species	
Pacific sardine	*Sardinops sagax*
Pacific (chub) mackerel	*Scomber japonicus*
Northern anchovy, central and northern subpopulations	*Engraulis mordax*
Market squid	*Doryteuthis opalescens*
Jack mackerel	*Trachurus symmetricus*
Highly Migratory Species Management Unit Species	
North Pacific albacore	*Thunnus alalunga*
Yellowfin tuna	*Thunnus albacares*
Bigeye tuna	*Thunnus obesus*
Skipjack tuna	*Katsuwonus pelamis*
Pacific bluefin tuna	*Thunnus orientalis*
Sharks	
Common thresher shark	*Alopias vulpinus*
Pelagic thresher shark	*Alopias pelagicus*
Bigeye thresher shark	*Alopias superciliosus*
Shortfin mako or bonito shark	*Isurus oxyrinchus*

Table 3.9-4: Federally Managed Fish Species within the Hawaii-Southern California Training and Testing Study Area, Pacific Regional Fishery Management Council (continued)

Pacific Regional Fishery Management Council	
Common Name	**Scientific Name**
Highly Migratory Species Management Unit Species	
Sharks (continued)	
Blue shark	*Prionace glauca*
Billfish and Swordfish	
Striped marlin	*Tetrapturus audax*
Swordfish	*Xiphias gladius*
Other	
Dorado or dolphinfish	*Coryphaena hippurus*

[1] The category "rockfish" includes all genera and species of the family Scopaenidae, even if not listed, that occur in the Washington, Oregon, and California area. The Scopaenidae genera are *Sebastes*, *Scorpaena*, *Sebastolobus*, and *Scorpaenodes*.
Source: Pacific Fishery Management Council (2008)

3.9.2 AFFECTED ENVIRONMENT

The distribution and abundance of fishes depends greatly on the physical and biological factors of the marine ecosystem, such as salinity, temperature, dissolved oxygen, population dynamics, predator and prey interaction oscillations, seasonal movements, reproduction and life cycles, and recruitment success (Helfman et al. 1997). A single factor is rarely responsible for the distribution of fish species; more often, a combination of factors is accountable. For example, open ocean species optimize their growth, reproduction, and survival by tracking gradients of temperature, oxygen, or salinity (Helfman et al. 1997). Another major component in understanding species distribution is the location of highly productive regions, such as frontal zones. These areas concentrate various prey species and their predators, such as tuna, and provide visual cues for the location of target species for commercial fisheries (National Marine Fisheries Service 2001). These types of open ocean predatory fishes occupy the transit lane portion of the Study Area, located mostly within the North Pacific Subtropical Gyre.

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

Currently 566 species of reef and shore fishes are known to occur around the Insular Pacific-Hawaiian Large Marine Ecosystem within the Study Area. The high number of species that are found only in Hawaii can be explained by its geographical and hydrographical isolation; 24 percent of fishes that occur in Hawaii are found only in the Hawaiian Islands (Randall 1998). Migratory open ocean fishes, such as the larger tunas, the billfishes, and some sharks, are able to move across the great distance that separates the Hawaiian Islands from other islands or continents in the Pacific. Coral reef fish communities in the Hawaiian Islands (excluding Nihoa) show a consistent pattern of species throughout the year. Exceptions include the seasonal distributions of migratory, open ocean species. Several of the reef fish species (bigeye scad [*Selar crumenophthalmus*], mackerel scad [*Decapterus macarellus*], goatfishes [Mullidae], and squirrelfishes [Holocentridae]) in the Study Area also show seasonal

fluctuations which are usually related to movements of juveniles into new areas or spawning activity (U.S. Navy Office of Naval Research 2001).

The Southern California portion of the Study Area is in a region of highly productive fisheries (Leet et al. 2001) within the California Current Large Marine Ecosystem. The portion of the California Bight in the Study Area is a transitional zone between cold and warm water masses, geographically separated by Point Conception. The California Bight refers to the coastal area between Point Conception to just past San Diego, including much of the Southern California portion of the Study Area. The cold-water California Current Large Marine Ecosystem is rich in microscopic plankton (diatoms, krill, and other organisms), which form the base of the food chain in the Southern California portion of the Study Area. Small coastal pelagic fishes depend on this plankton and in turn are fed on by larger species (such as highly migratory species). Approximately 480 species of marine fish inhabit the southern California Bight, and numerous fish species utilize spawning, nursery, feeding, and seasonal grounds in nearshore, inshore (including bays and estuaries), and offshore waters of southern California (Cross and Allen 1993). The high fish diversity found in the Study Area occurs for several reasons: (1) the ranges of many temperate and tropical species extend into Southern California; (2) the area has complex bottom features and physical oceanographic features that include several water masses and a changeable marine climate (Allen et al. 2006; Horn and Allen 1978); and (3) the islands and coastal areas provide a diversity of habitats that include soft bottom, rocky reefs, kelp beds, and estuaries, bays, and lagoons.

3.9.2.1 Hearing and Vocalization

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

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

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

The inner ears of fish are directly sensitive to acoustic particle motion rather than acoustic pressure (for a more detailed discussion of particle motion versus pressure, see Section 3.0.4, Acoustic and Explosives Primer). Although a propagating sound wave contains both pressure and particle motion components, particle motion is most significant at low frequencies (less than a few hundred Hz) and closer to the sound source. However, a fish's gas-filled swim bladder can enhance sound detection by converting acoustic pressure into localized particle motion, which may then be detected by the inner ear. Fish with

swim bladders generally have better sensitivity and better high-frequency hearing than fish without swim bladders (Popper and Fay 2010). Some fish also have specialized structures such as small gas bubbles or gas-filled projections that terminate near the inner ear. These fish have been called "hearing specialists," while fish that do not possess specialized structures have been referred to as "generalists" (Popper et al. 2003). In reality many fish species possess a continuum of anatomical specializations that may enhance their sensitivity to pressure (versus particle motion), and thus higher frequencies and lower intensities (Popper and Fay 2010).

Past studies indicated that hearing specializations in marine fish were quite rare (Amoser and Ladich 2005; Popper 2003b). However, more recent studies have shown that there are more fish species than originally investigated by researchers, such as deep sea fish, that may have evolved structural adaptations to enhance hearing capabilities (Buran et al. 2005; Deng et al. 2011). Marine fish families Holocentridae (squirrelfish and soldierfish), Pomacentridae (damselfish), Gadidae (cod, hakes, and grenadiers), and Sciaenidae (drums, weakfish, and croakers) have some members that can potentially hear sound up to a few kHz. There is also evidence, based on the structure of the ear and the relationship between the ear and the swim bladder, that at least some deep-sea species, including myctophids, may have hearing specializations and thus be able to hear higher frequencies (Deng et al. 2011; Popper 1977; Popper 1980), although it has not been possible to do actual measures of hearing on these fish from great depths.

Several species of reef fish tested have shown sensitivity to higher frequencies (i.e., over 1000 Hz). The hearing of the shoulderbar soldierfish (*Myripristis kuntee*) has a high-frequency auditory range extending toward 3 kHz (Coombs and Popper 1979b), while other species tested in this family have been demonstrated to lack this high frequency hearing ability (e.g., Hawaiian squirrelfish [*Adioryx xantherythrus*] and saber squirrelfish [*Sargocentron spiniferum*]). Some damselfish can hear frequencies of up to 2 kHz, but with best sensitivity well below 1 kHz (Egner and Mann 2005b; Kenyon 1996b; Wright et al. 2005b; Wright, Higgs, et al. 2007).

Sciaenid research by Ramcharitar et al. (2006b) investigated the hearing sensitivity of weakfish (*Cynoscion regalis*). Weakfish were found to detect frequencies up to 2 kHz. The sciaenid with the greatest hearing sensitivity discovered thus far is the silver perch (*Bairdiella chrysoura*), which has responded to sounds up to 4 kHz (Ramcharitar et al. 2004). Other species tested in the family Sciaenidae have been demonstrated to lack this higher frequency sensitivity.

It is possible that the Atlantic cod (*Gadus morhua,* Family: Gadidae) is also able to detect high-frequency sounds (Astrup and Mohl 1993). However, in Astrup and Mohl's (1993) study it is feasible that the cod was detecting the stimulus using touch receptors that were over driven by very intense fish-finding sonar emissions (Astrup 1999)Ladich, 2004. Nevertheless, Astrup and Mohl (1993) indicated that cod have high frequency thresholds of up to 38 kHz at 185 to 200 decibels (dB) relative to (re) 1 micropascal (µPa), which likely only allows for detection of odontocete's clicks at distances no greater than 33 to 98 feet (ft.) (10.1 to 29.9 meters [m]) (Astrup 1999).Experiments on several species of the Clupeidae (i.e., herrings, shads, and menhadens) have obtained responses to frequencies between 40 and 180 kHz (Astrup 1999); however, not all clupeid species tested have demonstrated this very high-frequency hearing. Mann et al. (1998) reported that the American shad can detect sounds from 0.1 to 180 kHz with two regions of best sensitivity: one from 0.2 to 0.8 kHz, and the other from 25 kHz to 150 kHz. This shad species has relatively high thresholds (about 145 dB re 1µPa), which should enable the fish to detect odontocete clicks at distances up to about 656 ft. (200 m) (Mann et al. 1997). Likewise, other members of the subfamily Alosinae, including Alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*),

and Gulf menhaden (*Brevoortia patronus*), have upper hearing thresholds exceeding 100 to 120 kHz. In contrast, the Clupeidae bay anchovy (*Anchoa mitchilli*), scaled sardine (*Harengula jaguana*), and Spanish sardine (*Sardinella aurita*) did not respond to frequencies over 4 kHz (Gregory and Clabburn 2003; Mann et al. 2001b). Mann et al. (2005b) found hearing thresholds of 0.1 kHz to 5 kHz for Pacific herring (*Clupyea pallasii*).

Two other groups to consider are the jawless fish (Superclass: Agnatha – lamprey) and the cartilaginous fish (Class: Chondrichthyes – the sharks, rays, and chimeras). While there are some lampreys in the marine environment, virtually nothing is known about their hearing capability. They do have ears, but these are relatively primitive compared to the ears of other vertebrates, and it is unknown whether they can detect sound (Popper and Hoxter 1987). While there have been some studies on the hearing of cartilaginous fish, these have not been extensive. However, available data suggest detection of sounds from 20 to 1000 Hz, with best sensitivity at lower ranges (Casper et al. 2003b; Casper and Mann 2006b; Casper and Mann 2009; Myrberg 2001). It is likely that elasmobranchs only detect low-frequency sounds because they lack a swim bladder or other pressure detector.

Most other marine species investigated to date lack higher-frequency hearing (i.e., greater than 1000 Hz). This notably includes sturgeon species tested to date that could detect sound up to 400 or 500 Hz (Lovell et al. 2005; Meyer et al. 2010)and Atlantic salmon that could detect sound up to about 500 Hz (Hawkins and Johnstone 1978b; Kane et al. 2010). Both of these groups of fish have members within the Study Area listed or proposed for listing under the ESA.

Bony fish can produce sounds in a number of ways and use them for a number of behavioral functions (Ladich 2008). Over 30 families of fish are known to use vocalizations in aggressive interactions, whereas over 20 families known to use vocalizations in mating (Ladich 2008). Sound generated by fish as a means of communication is generally below 500 Hz (Slabbekoorn et al. 2010a). The air in the swim bladder is vibrated by the sound producing structures (often muscles that are integral to the swim bladder wall) and radiates sound into the water (Zelick et al. 1999). Sprague and Luczkovich (2004) calculated that silver perch can produce drumming sounds ranging from 128 to 135 dB re 1 µPa. Female midshipman fish apparently use the auditory sense to detect and locate vocalizing males during the breeding season (Sisneros and Bass 2003a). Sciaenids produce a variety of sounds, including calls produced by males on breeding grounds (Ramcharitar et al. 2001), and a “drumming” call produced during chorusing by reef fish (McCauley and Cato 2000). Other sounds produced by chorusing reef fish include “popping,” “banging,” and “trumpet” sounds; all together, these choruses produce sound levels 35 dB above background levels, at peak frequencies between 250 and 1200 Hz, and source levels between 144 and 157 dB re 1µPa (McCauley and Cato 2000).

3.9.2.2 General Threats

This section covers the existing condition of marine fishes as a resource and presents some of the major threats within the Study Area. Species-specific threats are addressed for each of the ESA-listed species. Human-made impacts are widespread throughout the world’s oceans, such that very few habitats remain unaffected by human influence (Halpern et al. 2008). These stressors have shaped the condition of marine fish populations, particularly those species with large body sizes and late maturity ages, making these species especially vulnerable to habitat losses and fishing pressure (Reynolds et al. 2005). This trend is evidenced by the world’s shark species, which make up 60 percent of the marine fishes of conservation concern (International Union for Conservation of Nature and Natural Resources 2009). Furthermore, the conservation status of only 3 percent of the world’s marine fish species has been

evaluated, so the threats to the remaining species are largely unknown at this point (Reynolds et al. 2005).

Overfishing is the most serious threat that has led to the listing of ESA-protected marine species (Crain et al. 2009; Kappel 2005), with habitat loss also contributing to extinction risk (Cheung et al. 2007; Dulvy et al. 2003; Jonsson et al. 1999; Limburg and Waldman 2009; Musick et al. 2000). Approximately 30 percent of the United States-managed fishery stocks are overfished (National Marine Fisheries Service 2009). Overfishing occurs when fishes are harvested in quantities above a sustainable level. Overfishing impacts targeted species, and non-targeted species (or "bycatch" species) that often are prey for other fishes and marine organisms. Bycatch may also include seabirds, turtles, and marine mammals. Additionally, in recent decades the marine fishes being targeted have changed such that when higher-level predators become scarce, different organisms on the food chain are subsequently targeted; this has negative implications for entire marine food webs (Crain et al. 2009; Pauly and Palomares 2005). Other factors, such as fisheries-induced evolution and intrinsic vulnerability to overfishing, have been shown to reduce the abundance of some populations (Kauparinen and Merila 2007). Fisheries-induced evolution describes a change in genetic composition of the population that results from intense fishing pressure, such as a reduction in the overall size and growth rates of fish in a population. Intrinsic vulnerability describes certain life history traits (e.g., large body size, late maturity age, low growth rate) that result in a species being more susceptible to overfishing than others (Cheung et al. 2007).

Pollution primarily impacts coastal fishes that occur near the sources of pollution. However, global oceanic circulation patterns result in a considerable amount of marine pollutants and debris scattered throughout the open ocean (Crain et al. 2009). Pollutants in the marine environment that may impact marine fishes include organic pollutants (e.g., pesticides, herbicides, polycyclic aromatic hydrocarbons, flame retardants, and oil), inorganic pollutants (e.g., heavy metals), and debris (e.g., plastics and wastes from dumping at sea) (Pews Oceans Commission 2003). High chemical pollutant levels in marine fishes may cause behavioral changes, physiological changes, or genetic damage in some species (Goncalves et al. 2008; Moore 2008; Pews Oceans Commission 2003; van der Oost et al. 2003). Bioaccumulation of pollutants (e.g., metals and organic pollutants) is also a concern, particularly in terms of human health, because people consume top predators with high pollutant loads. Bioaccumulation is the net buildup of substances (e.g., chemicals or metals) in an organism directly from contaminated water or sediment through the gills or skin, from ingesting food containing the substance (Newman 1998), or from ingestion of the substance itself (Moore 2008). Entanglement in abandoned commercial and recreational fishing gear has also caused pollution-related declines for some marine fishes; some species are more susceptible to entanglement by marine debris than others (Musick et al. 2000).

Other human-caused stressors on marine fishes are the introduction of non-native species, climate change, aquaculture, energy production, vessel movement, and underwater noise:

- Non-native fishes pose threats to native fishes when they are introduced into an environment lacking natural predators and then compete with, and prey upon, native marine fishes for resources (Crain et al. 2009).
- Global climate change is contributing to a shift in fish distribution from lower to higher latitudes (Brander 2010; Brander 2007; Dufour et al. 2010; Glover and Smith 2003; Limburg and Waldman 2009; Wilson et al. 2010).
- The threats of aquaculture operations on wild fish populations are reduced water quality, competition for food, predation by escaped or released farmed fishes, spread of disease, and

reduced genetic diversity (Kappel 2005). These threats become apparent when escapees enter the natural ecosystem (Hansen and Windsor 2006; Ormerod 2003). The National Oceanic and Atmospheric Administration is developing an aquaculture policy aimed at promoting sustainable marine aquaculture (National Oceanic and Atmospheric Administration 2011).

- Energy production and offshore activities associated with power-generating facilities results in direct and indirect fish injury or mortality from two primary sources; including cooling water withdrawal that results in entrainment mortality of eggs and larvae and impingement mortality of juveniles and adults (U.S. Environmental Protection Agency 2004), and offshore wind energy development that results in acoustic impacts (Madsen et al. 2006).
- Vessel strikes pose threats to some large, slow-moving fishes at the surface. Whale sharks, basking sharks, ocean sunfish, and manta rays are also vulnerable to ship strikes, and numerous collisions have been recorded (National Marine Fisheries Service 2010; Rowat et al. 2007b; Stevens 2007; The Hawaii Association for Marine Education and Research Inc. 2005).
- Underwater noise is a threat to marine fishes. However, the physiological and behavioral responses of marine fishes to underwater noise (Codarin et al. 2009; Popper 2003a)(Slabbekoorn et al. 2010b; Wright et al. 2010) have been investigated for only a limited number of species (Popper and Hastings 2009a, b). In addition to vessels, other sources of underwater noise include active sonar, pile-driving activity (California Department of Transportation 2001; Carlson and Hastings 2007; Feist et al. 1992; Mueller-Blenkle et al. 2010a; Nedwell et al. 2003a; Popper et al. 2006) and seismic activity (Popper and Hastings 2009a). Information on fish hearing is provided in Section 3.9.2.1 (Hearing and Vocalization), with further discussion in Section 3.9.3.1 (Acoustic Stressors).

3.9.2.3 Steelhead Trout (*Oncorhynchus mykiss*)

3.9.2.3.1 Life History

Steelhead are born in freshwater streams, where they spend their first 1-3 years. They later move into the ocean, where most of their growth occurs. After spending between 1 and 4 years in the ocean, steelhead return to their home freshwater stream to spawn. Unlike other species of Pacific salmon, steelhead do not necessarily die after spawning and are able to spawn more than once. Steelhead may exhibit either an anadromous lifestyle or they may spend their entire life in freshwater (McEwan and Jackson 1996). The name steelhead trout is used primarily for the anadromous form of this species.

There is considerable variation in this life history pattern within the population, partly due to Southern California's variable seasonal and annual climatic conditions. Some winters produce heavy rainfall and flooding, which allow juvenile steelhead easier access to the ocean, while dry seasons may close the mouths of coastal streams, limiting juvenile steelheads' access to marine waters (National Marine Fisheries Service 1997).

3.9.2.3.2 Status and Management

Steelhead trout are an anadromous form of rainbow trout and are federally protected by the designation of distinct population segments, which is defined as a population or group of populations that is discrete or separate from other populations of the same species and are equivalent to evolutionarily significant units. Distinct population segments are also the smallest division of a taxonomic species permitted to be protected under the ESA (West Coast Salmon Biological Review Team et al. 2003). NMFS has jurisdiction over the marine life form, while the U.S. Fish and Wildlife Service and respective state resource agencies have jurisdiction over the freshwater resident life forms.

Of the 15 steelhead trout distinct population segments, 2 are listed as endangered, 9 are listed as threatened, and 1 is an ESA species of concern (National Marine Fisheries Service 2010). NMFS listed the Southern California distinct population segment of steelhead as endangered in 1997 (National Marine Fisheries Service 1997). Critical habitat for 10 west coast steelhead distinct population segments has been designated and the Southern California critical habitat, relative to the Study Area is shown in Figure 3.9-1 and includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (e.g., spawning sites, rearing sites, and migration corridors), and are outside the Study Area.

3.9.2.3.3 Habitat and Geographic Range

The present distribution of steelhead extends from the Kamchatka Peninsula in Asia, east to Alaska and south to Southern California, although the species' historical range extended at least to Mexico (Good et al. 2005). Steelhead trout are found along the entire Pacific Coast of the United States. Worldwide, steelhead are also naturally found in the western Pacific as far as the Kamchatka Peninsula (Russia). This species has also been introduced (by stocking) in other locations throughout the world, including freshwater streams in Hawaii (Kokee State Park on the island of Kauai) (National Marine Fisheries Service 2010), although this particular population does not migrate into the ocean.

Since spawning occurs exclusively in freshwater systems outside of the Study Area, spawning habitats are not described here. However, information on freshwater habitats and spawning areas can be found in Pacific Fishery Management Council (2000), Beauchamp et al. (1983) and Emmett et al. (1991).

Of the six species of Pacific salmon that have evolutionarily significant units or distinct population segments along the West Coast, only the steelhead occurs within the Southern California portion of the Study Area (National Marine Fisheries Service 2005). The Southern California distinct population segment range for steelhead extends from Santa Maria River south to San Mateo Creek (National Marine Fisheries Service 2002), within the California Current Large Marine Ecosystem. It was expanded in 2002 to include streams south of Malibu Creek, specifically Topanga and San Mateo Creeks (National Marine Fisheries Service 2002). The lower portion of San Mateo Creek flows through Marine Corps Base Camp Pendleton and into the Southern California portion of the Study Area. Except for this possible small population in San Mateo Creek, the species is considered completely extinct from the Santa Monica Mountains in California to the U.S.-Mexico border.

Steelhead tend to move immediately offshore on entering the marine environment although, in general, steelhead tend to remain closer to shore than other Pacific salmon species (Beamish et al. 2005). They generally remain within the coastal waters of the California Current (Beamish et al. 2005; Quinn and Myers 2004).

3.9.2.3.4 Population and Abundance

Most of the distinct population segments have a low abundance relative to historical levels, and there is widespread occurrence of hatchery fish in naturally spawning populations (Good et al. 2005; National Marine Fisheries Service 2010). NMFS has reported population sizes from individual distinct population segments, but because all of these units occur together while at sea, it is difficult to estimate the marine population numbers. Specific population numbers, based on freshwater returns, within each of the distinct population segments is found in Good et al. (2005).

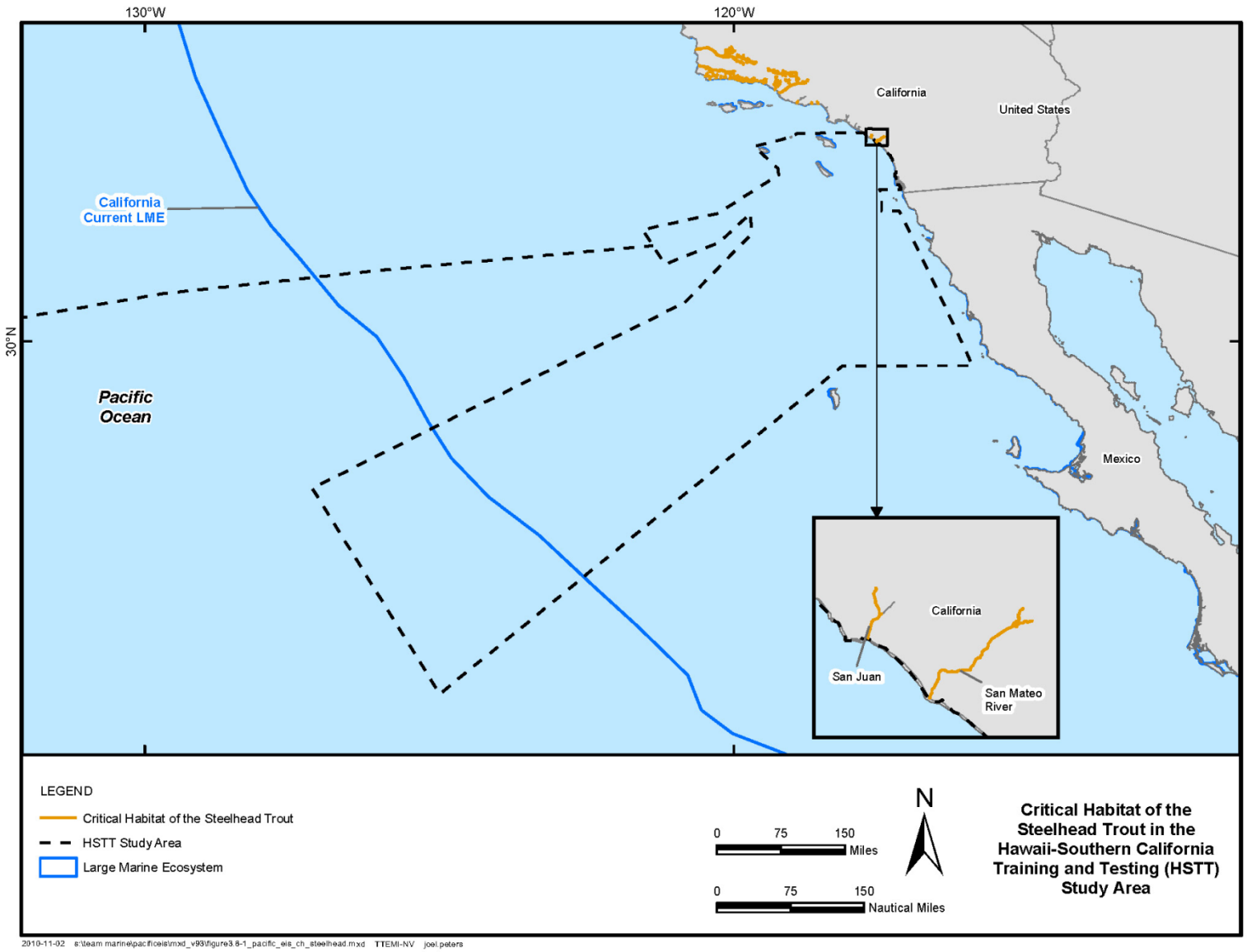

Figure 3.9-1: Critical Habitat of the Steelhead Trout Within and Adjacent to the Southern California Study Area

3.9.2.3.5 Predator/Prey Interactions

Predators of steelhead include fish-eating birds, such as terns and cormorants, and pinnipeds, such as sea lions and harbor seals, especially within coastal areas (National Marine Fisheries Service 2010). Juveniles in freshwater feed mostly on zooplankton (small animals that drift in the water), while adults feed on aquatic and terrestrial insects, mollusks, crustaceans, fish eggs, minnows, and other small fishes, including other trout and salmon depending on whether they are inhabiting streams or the ocean (National Marine Fisheries Service 2010).

3.9.2.3.6 Migration

Adult steelhead can migrate up to 930 mi. (1,496.7 km) from their ocean habitats to reach their freshwater spawning grounds in high elevation tributaries. In the Southern California portion of the Study Area, the primary rivers that steelhead migrate into are the Santa Maria, Santa Ynez, Ventura, and Santa Clara Rivers (Good et al. 2005), although some of these rivers contain considerable migration barriers such as dams.

3.9.2.3.7 Species-Specific Threats

There are many threats to the survival of the Southern California steelhead distinct population segment. Principle threats include, but are not limited to, alteration of stream flow patterns and habitat degradation, barriers to fish passages, channel alterations, water quality problems, non-native exotic fish and plants and climate change. These threats pose a serious challenge to the persistence of Southern California steelhead, and most threats are increasing in magnitude as human population grows in Southern California.

3.9.2.4 Scalloped Hammerhead Shark (*Sphyrna lewini*)

3.9.2.4.1 Status and Management

In August 2011, NMFS received a petition to list the scalloped hammerhead shark as threatened or endangered under the ESA and to designate critical habitat concurrently with the listing (National Marine Fisheries Service 2011). In 2013, based on the best scientific and commercial information available, including the status review report (Miller et al. 2013), and other information available since completion of the status review report, NMFS determined that the species is comprised of six distinct population segments (DPSs) that qualify as species under the ESA: Northwest Atlantic and Gulf of Mexico (NW Atlantic & GOM DPS); Central and Southwest Atlantic (Central & SW Atlantic DPS); Eastern Atlantic DPS; Indo-West Pacific DPS; Central Pacific DPS; and Eastern Pacific DPS. After reviewing the best available scientific and commercial information on the DPSs, we have determined that two DPSs warrant listing as endangered, the Eastern Atlantic and Eastern Pacific DPSs; two DPSs warrant listing as threatened, the Central & SW Atlantic and Indo-West Pacific DPSs; and two DPSs do not warrant listing at this time, the NW Atlantic & GOM DPS and the Central Pacific DPS.

3.9.2.4.2 Habitat and Geographic Range

The scalloped hammerhead shark is circumglobal, occurring in all temperate to tropical waters (Duncan and Holland 2006) from the surface to depths of 275 m (902 ft.). It typically inhabits nearshore waters of bays and estuaries where water temperatures are at least 22 degrees (°) Celsius (C) (72° Fahrenheit [F]) (Castro 1983; Compagno 1984). The scalloped hammerhead shark remains close to shore during the day and moves to deeper waters at night to feed (Bester 1999). A genetic marker study suggests that females typically remain close to coastal habitats, while males are more likely to disperse across larger open ocean areas (Daly-Engel et al. 2012). In the eastern Pacific, the scalloped hammerhead ranges from

southern California (including the Gulf of California) to Panama, Ecuador, and northern Peru, and includes waters

3.9.2.4.3 Population and Abundance

National Marine Fisheries Service data and information provided in the listing petition suggest that the scalloped hammerhead shark has undergone substantial declines throughout its range (National Marine Fisheries Service 2011). Specific information for scalloped hammerhead in Eastern Central and Southeast Pacific region is unavailable, but informal observations and overall shark estimates are available. Reports from divers and tourists in the Galapagos Islands indicate a severe decrease in the number of sharks observed, as well as a decrease in the sightings of hammerhead schools. Reports from Costa Rica's exclusive economic zone for catch rates of pelagic sharks, including scalloped hammerhead, from 1991 to 2000 show a decrease of 60 percent. In Ecuador, concern has grown over illegal fishing around the Galapagos. Because the fins of the scalloped hammerhead are highly valuable in worldwide markets, experts expect that a large portion of this illegal fishing targets scalloped hammerheads

3.9.2.4.4 Predator and Prey Interactions

Scalloped hammerhead sharks follow daily vertical movement patterns within their home range (Holland et al. 1993; Klimley and Nelson 1984), and feed primarily at night (Compagno 1984). They are a high trophic level predator, and feed opportunistically on all types of teleost fish, cephalopods, crustaceans, and rays (Bethea et al. 2011; Compagno 1984; Torres-Rojas et al. 2010; Vaske et al. 2009).

3.9.2.4.5 Species-Specific Threats

The primary threat to the scalloped hammerhead shark is direct take, especially by the foreign commercial shark fin market (National Marine Fisheries Service 2011). Scalloped hammerheads are a principal component of the total shark bycatch in the swordfish and tuna longline fishery, and are particularly susceptible to overfishing and bycatch in gillnet fisheries because of schooling habits (Food and Agriculture Organization of the United Nations 2012). Longline mortality for this species is estimated between 91 and 94 percent (National Marine Fisheries Service 2011).

3.9.2.5 Jawless Fishes (Orders Myxiniformes and Petromyzontiformes)

Hagfishes (Myxiniformes) occur exclusively in marine habitats and are represented by 70 species worldwide within temperate marine locations. This group feeds on dead or dying fishes and has very limited external features often associated with fishes, such as fins and scales (Helfman et al. 1997). The members of this group are important scavengers that recycle nutrients back through the ecosystem. Lampreys (Petromyzontiformes) are represented by approximately 11 marine or saltwater/freshwater species distributed primarily throughout the temperate regions of the Northern Hemisphere. Lampreys typically are parasitic, feeding on other live fishes. The most striking feature of the lampreys is the oral disc mouth, which they use to attach to other fishes and feed on their blood (Moyle and Cech 1996; Nelson 2006).

Hagfishes and lampreys occur in the seafloor habitats of open ocean waters in the transit lane and California Current Large Marine Ecosystem portions of the Study Area, but not in the Hawaii portion of the Study Area (Paxton and Eshmeyer 1994). Hagfishes are typically found at depths greater than 80 ft. (24.4 m) and temperatures below 55°F (13°C).

3.9.2.6 Sharks, Rays, and Chimaeras (Class Chondrichthyes)

The cartilaginous (non-bony) marine fishes of the class Chondrichthyes are distributed throughout the world's oceans, occupying all areas of the water column. This group is mainly predatory and contains many of the apex predators found in the ocean (e.g., great white shark, mako shark, and tiger shark) (Helfman et al. 1997). The whale shark and basking shark are notable exceptions as filter-feeders. Sharks and rays have some unique features among marine fishes; no swim bladder; protective toothlike scales; unique sensory systems (electroreception, mechanoreception); and some species bear live young in a variety of life history strategies (Moyle and Cech 1996). The subclass Elasmobranchii contains more than 850 marine species, including sharks, rays and skates, spread across nine orders (Nelson 2006). Very little is known about the subclass Holocephali, which contains 58 marine species of chimaeras (Nelson 2006).

Sharks and rays occupy relatively shallow temperate and tropical waters throughout the world. More than half of these species occur in less than 655 ft. (199.6 m) of water, and nearly all are found at depths less than 6,560 ft. (1,999.4 m) (Nelson 2006). Sharks and rays are found in all open ocean areas and coastal waters of the Study Area (Paxton and Eshmeyer 1994) and throughout the North Pacific Subtropical Gyre, the Insular Pacific-Hawaiian Large Marine Ecosystem, and the California Current Large Marine Ecosystem that encompass the Study Area. While most sharks occur in the water column, many rays occur on or near the seafloor. Chimaeras are cool-water marine fishes that are found at depths between 260 and 8,500 ft. (79.2 and 2,590.8 m) (Nelson 2006). They occur in the open ocean of the transit lane and Hawaii portions of the Study Area, up to the lower continental shelf (Paxton and Eshmeyer 1994).

3.9.2.7 Eels and Bonefishes (Orders Anguilliformes and Elopiformes)

These fishes have a unique larval stage, called leptocephalus, in which leptocephali grow to much larger sizes during an extended larval period as compared to most other fishes. The eels (Anguilliformes) have an elongated snakelike body; most of the 780 eel species do not inhabit the deep ocean. Eels generally feed on other fishes or small bottom-dwelling invertebrates, but they also feed on larger organisms (Helfman et al. 1997). Moray eels, snake eels, and conger eels are well represented by many species that occur in the Study Area (Paxton and Eshmeyer 1994). The fishes in the order Elopiformes include two distinct groups that exhibit very different forms: the bonefishes, predators of shallow tropical waters; and the little-known spiny eels, elongated seafloor feeders of decaying organic matter in deep ocean areas (Paxton and Eshmeyer 1994).

Eels are found in all marine habitat types, although most inhabit shallow subtropical or tropical marine habitats (Paxton and Eshmeyer 1994) within the Insular Pacific-Hawaiian and California Current Large Marine Ecosystems in the water column and seafloor. The bonefishes and spiny eels occur in deep ocean waters, ranging from 400 to 16,000 ft. (121.9 to 4,876.8 m) within the open ocean area of the Study Area and throughout the North Pacific Subtropical Gyre on the seafloor and water column (Paxton and Eshmeyer 1994).

3.9.2.8 Smelt and Salmonids (Orders Argentiniformes, Osmeriformes, and Salmoniformes)

A distinguishing feature of this group of fishes is an adipose fin composed of fatty tissue on their backs. The deepwater smelts of the order Argentiniformes differ from the true smelts of the order Osmeriformes, mostly by their preferred habitat (deepwater versus coastal). The true smelts are found in large abundances within coastal areas throughout the Northern Hemisphere, while the deepwater

smelts are limited mainly to deepwater regions of the world's oceans. Smelts are an important forage fish for other marine organisms, including other fishes, birds, and marine mammals.

The native distribution of Salmoniformes is restricted to the cold waters of the Northern Hemisphere. Most species of salmon spawn in freshwater and live in the sea; they are among the most thoroughly studied fish groups in the world.

3.9.2.9 Dragonfishes and Lanternfishes (Orders Stomiiformes and Myctophiformes)

The orders Stomiiformes and Myctophiformes comprise one of the largest groups of the world's deepwater fishes—more than 500 total species, many of which are not very well described in the scientific literature (Nelson 2006). The ecological role of many of these species is also not well understood (Helfman et al. 1997). These fishes are known for their unique body forms (e.g., slender bodies, or disc-like bodies, often possessing light-producing capabilities) and adaptations that likely present some advantages within the deepwater habitats in which they occur (e.g., large mouths, sharp teeth, and sensitive lateral line (sensory) systems) (Haedrich 1996; Koslow 1996; Marshall 1996; Rex and Etter 1998; Warrant and Locket 2004).

Overall the dragonfishes and lanternfishes occur in deep ocean waters, ranging from 3,280 to 16,000 ft. (999.7 to 4,876.8 m), making diurnal migrations within the open ocean area of the Study Area and throughout the North Pacific Subtropical Gyre (Froese and Pauly 2010; Paxton and Eshmeyer 1994).

3.9.2.10 Greeneyes, Lizardfishes, Lancetfishes, and Telescopefishes (Order Aulopiformes)

Fishes of the order Aulopiformes are a diverse group that possess both primitive (adipose [fatty] fin, rounded scales) and advanced (unique swim bladder and jawbone) features of marine fishes (Paxton and Eshmeyer 1994). They are common in estuarine and coastal waters as well as deep ocean waters. The lizardfishes (Synodontidae), Bombay ducks (Harpadontidae), and greeneyes (Chlorophthalmidae) primarily occur in coastal waters to the outer shelf, where they rest on the bottom and are well camouflaged with the substrate (Paxton and Eshmeyer 1994). Lancetfishes (Alepisauridae) are primarily mid-water column fishes, but can be found ranging from the surface to deep-waters. Telescopefishes are primarily found in deep waters 1,640 to 3,280 ft. (499.9 to 999.7 m), but can also be found at shallower depths and may approach the surface at night (Paxton and Eshmeyer 1994).

In general greeneyes, lizardfishes, and lancetfishes occur in the coastal waters of the Study Area, including all of the Insular Pacific-Hawaiian and California Current Large Marine Ecosystems. Telescopefishes occur primarily in the deeper waters associated with the open ocean areas of the Study Area (Paxton and Eshmeyer 1994).

3.9.2.11 Cods and Cusk-eels (Orders Gadiformes and Ophidiiformes)

The cods and cusk-eels include over 900 species, some of which are target species of commercial fisheries. The cods, or groundfish, account for approximately half of the world's commercial fishery landings (Food and Agriculture Organization of the United Nations 2005). Gadiforms, such as cods, are almost exclusively marine fishes, and occupy seafloor habitats in temperate, arctic, and Antarctic regions.

The order Ophidiiformes includes cusk-eels and brotulas, which have long eel-like tapering bodies and are distributed in deepwater areas throughout tropical and temperate oceans. The characteristics of ophidiiforms are similar to those of the other deepwater groups. Other fishes of this order are also

found in shallow waters on coral reefs. In addition, there are several cusk-eel species which are pelagic or found on the continental shelves and slopes.

Cods are generally found near the seafloor and feed on bottom-dwelling organisms. They do not occur in the Study Area (Paxton and Eshmeyer 1994). Cusk-eels occur near the seafloor of the coastal waters and in the open ocean areas of the HSTT Study Area (Paxton and Eshmeyer 1994).

3.9.2.12 Toadfishes and Anglerfishes (Orders Batrachoidiformes and Lophiiformes)

The toadfishes and anglerfishes include nearly 400 species. The order Batrachoidiformes includes only the toadfish family. Some species of toadfishes produce and detect sounds by vibrating the swimbladder. They spawn in and around bottom structures and invest a substantial amount of parental care by defending their nests, Moyle and Cech 1996; Paxton and Eshmeyer 1994). The order Lophiiformes includes all of the world's anglerfishes, goosefishes, frogfishes, batfishes, and deepwater anglerfishes—most of which occur in seafloor habitats of all oceans. Some deepwater anglerfish use highly modified "lures" to attract prey (Helfman et al. 1997; Koslow 1996). These fishes are also an important predator among the deepwater, seafloor habitats of the Study Area (Nelson 2006). The anglerfishes can be broken into two groups: (1) those that dwell in the deep water (10 families); and (2) those that live on the bottom or attached to drifting seaweed in shallow water (5 families).

The primary distribution of the toadfishes in the Study Area is limited to seafloor habitats of the California Current Large Marine Ecosystem. Anglerfishes are also found in seafloor habitats, but with a wider distribution covering all waters of the Study Area (Froese and Pauly 2010; Moyle and Cech 1996; Paxton and Eshmeyer 1994).

3.9.2.13 Mullets, Silversides, Needlefish, and Killifish (Orders Mugiliformes, Atheriniformes, Beloniformes, and Cyprinodontiformes)

Mugiliformes (mullets) contain 71 marine species that occupy coastal marine and estuarine waters of all tropical and temperate oceans. There has been disagreement in the taxonomic classification of this group; some have included this group within the superorder Athinerimorpha (Nelson 2006), while others have placed it as a suborder within the Perciformes (Moyle and Cech 1996). Mullets feed on decaying organic matter in estuaries and possess a filter feeding mechanism with a gizzard like digestive tract. They feed on the bottom by scooping up food that is retained by their very small gill rakers (Moyle and Cech 1996). Most species within these groups are important prey for predators in all estuarine habitats within the Study Area.

Most of these fishes are found in tropical or temperate marine waters and occupy shallow habitats near the water surface. An exception to this nearshore distribution includes the flyingfishes and halfbeaks, which occur within oceanic or shallow seacoast regions where light penetrates, in tropical to warm-temperate regions. The silversides are a small inshore species often found in intertidal habitats. The Cyprinodontiformes include the killifishes that are often associated with intertidal coastal zones and salt marsh habitats and are highly tolerant of pollution. These fishes are found in all coastal waters and open ocean areas of the Study Area (Froese and Pauly 2010; Paxton and Eshmeyer 1994).

3.9.2.14 Oarfishes, Squirrelfishes, and Dories (Orders Lampridiformes, Beryciformes, and Zeiformes)

There are only 19 species in the order Lampridiformes—the oarfishes. They exhibit diverse body shapes, and some have a protruding mouth, which allows for a suction feeding technique while feeding on plankton. Other species, including the crestfish, posses grasping teeth used to catch prey. They occur

only in the mid-water column of the open ocean, but are rarely observed (Nelson 2006). Fishes in the order Beryciformes are primarily deepwater or nocturnal species, many of which are poorly described. There are a few shallow water exceptions, including squirrelfishes, which are distributed throughout reef systems in tropical and subtropical marine regions (Nelson 2006). Squirrelfishes are an important food source relied upon by some communities who catch their own food (Froese and Pauly 2010). They possess specialized eyes and large mouths and primarily feed on bottom-dwelling crustaceans (Goatley and Bellwood 2009). Very little is known about the order Zeiformes, or dories, which include some very rare families, many containing only a single species (Paxton and Eshmeyer 1994). Even general information on their biology, ecology, and behavior is limited.

Squirrelfishes are common in coral reef systems in the Study Area within the Insular Pacific-Hawaiian Large Marine Ecosystem. Most of the Lampridiformes and Zeiformes are confined to seafloor regions in all coastal waters of the Study Area, as well as the open ocean areas at depths of 130 to 330 ft. (39.6 to 100.6 m) (Moyle and Cech 1996; Paxton and Eshmeyer 1994).

3.9.2.15 Pipefishes and Seahorses (Order Gasterosteiformes)

Gasterosteiformes include sticklebacks, pipefishes, and seahorses, many of which are common within the Study Area. Most of these species are found in brackish water (a mixture of seawater and freshwater) throughout the world (Nelson 2006) and occur in surface, water column, and seafloor habitats. Small mouths on a long snout and armorlike scales are characteristic of this group. Most of these species exhibit a high level of parental care, either through nest building (sticklebacks) or brooding pouches (male seahorses have a pouch where eggs develop), which results in relatively few young being produced (Helfman et al. 1997). This group also includes the trumpetfishes and cornetfishes, ambush predators, with a large mouth used to capture smaller lifestages of fishes.

This group is associated with tropical and temperate reef systems. They are found in the coastal waters of the Study Area within the Insular Pacific-Hawaiian and California Current Large Marine Ecosystems, but not in the open ocean (Froese and Pauly 2010; Moyle and Cech 1996; Paxton and Eshmeyer 1994).

3.9.2.16 Scorpionfishes (Order Scorpaeniformes)

The order Scorpaeniformes is a diverse group of more than 1,400 marine species, all with bony plates or spines near the head. This group contains the scorpionfishes, waspfishes, rockfishes, velvetfishes, pigfishes, sea robins, gurnards, sculpins, snailfishes, and lumpfishes (Froese and Pauly 2010; Moyle and Cech 1996; Paxton and Eshmeyer 1994). Many of these fishes are adapted for inhabiting the seafloor of the marine environment (e.g., modified pectoral fins or suction discs), where they feed on smaller crustaceans and fishes. Sea robins are capable of generating sounds with their swimbladders (Moyle and Cech 1996).

Scorpionfishes are widely distributed in open ocean and coastal habitats, at all depths, throughout the world. They occur in all waters of the Study Area. Most occur in depths less than 330 ft. (100.6 m), but others are found in deepwater habitat, down to 7,000 ft. (2,133.6 m) (Paxton and Eshmeyer 1994).

3.9.2.17 Croakers, Drums, and Snappers (Families Sciaenidae and Lutjanidae)

The families Sciaenidae and Lutjanidae include mainly predatory coastal marine fishes, including the recreationally important snappers, drums, and croakers. These fishes are sometimes distributed in schools as juveniles, and then become more solitary as they grow larger. They feed on fishes and crustaceans. Drums and croakers (Sciaenidae) produce sounds via their swimbladders, which generate a

drumming sound. The snappers (Lutjanidae) are generally associated with seafloor habitats and tend to congregate near structured habitats, including natural/artificial reefs and oil platforms (Moyle and Cech 1996). Other representative groups include the brightly colored and diverse forms of reef-associated cardinalfishes, butterflyfishes, angelfishes, dottybacks, and goatfishes (Paxton and Eshmeyer 1994).

Like the scorpionfishes, this group is widely distributed in open ocean and coastal habitats throughout the world. They occur in all waters of the Study Area, but are particularly concentrated, and exhibit the most varieties, in depths less than 330 ft. (100 m), often associated with reef systems within the Insular Pacific-Hawaiian and California Current Large Marine Ecosystems portion of the Study Area (Froese and Pauly 2010; Paxton and Eshmeyer 1994).

3.9.2.18 Groupers and Seabasses (Family Serranidae)

The Serranidae are primarily nearshore marine fishes that support recreational and commercial fisheries. Most seabasses and groupers are nocturnal predators found primarily within reef systems. They generally possess large mouths and feed mostly on bottom-dwelling fishes and crustaceans (Goatley and Bellwood 2009). Some groupers and seabasses take advantage of feeding opportunities in the low-light conditions of twilight when countershaded fishes become conspicuous and easier for these predators to locate (Rickel and Genin 2005). Other groupers are active during the daytime and exhibit a variety of opportunistic predatory strategies, such as ambush (Wainwright and Richard 1995) to benefit from mistakes made by prey species. Many of the serranids begin life as females and then become male as they grow larger (Moyle and Cech 1996). Their slow maturation has resulted in many of the grouper species within the Study Area to be designated with vulnerable to critically endangered conservation status (International Union for Conservation of Nature and Natural Resources 2010). This group occurs in all coastal waters of the Study Area, but are mostly concentrated, in depths less than 100 ft. (30.5 m), within the Insular Pacific-Hawaiian and California Current Large Marine Ecosystems portion of the Study Area (Froese and Pauly 2010, Moyle and Cech 1996, Paxton and Eshmeyer 1994).

3.9.2.19 Wrasses, Parrotfish, and Damselfishes (Families Labridae, Scaridae, and Pomacentridae)

The suborder Labroidei contains many nearshore marine reef or structure-associated fishes, including the diverse wrasses (Labridae), parrotfishes (Scaridae), and damselfishes (Pomacentridae). Most of the wrasses are conspicuous, brightly colored, coral reef fishes, but others are found in temperate waters. Most are active during the daytime and exhibit a variety of opportunistic predatory strategies, such as ambush (Wainwright and Richard 1995) to capitalize on mistakes made by prey species. Parrotfishes provide important ecological functions to the reef system by grazing on coral and processing sediments (Goatley and Bellwood 2009). Similar to the Serranidae, many wrasses and parrotfishes begin life as females but change into males as they grow larger and exhibit with a variety of reproductive strategies found among the species and between populations (Moyle and Cech 1996). Damselfishes are noted for their territoriality and are brightly colored. This group occurs in all coastal waters of the Study Area, but are mostly concentrated in depths less than 100 ft. (30.5 m) within the Insular Pacific-Hawaiian and California Current Large Marine Ecosystems portion of the Study Area (Froese and Pauly 2010, Moyle and Cech 1996, Paxton and Eshmeyer 1994).

3.9.2.20 Gobies, Blennies, and Surgeonfishes (Suborders Gobioidei, Blennioidei, and Acanthuroidei)

The seafloor-dwelling gobies (Gobioidei) include Gobiidae, the largest family of marine fishes (Nelson 2006); they exhibit modified pelvic fins that allow them to adhere to varying bottom surfaces (Helfman et al. 1997). Fishes of the suborder Blennioidei primarily occupy the intertidal zones throughout the

world, including the clinid blennies and the combtooth blennies of the family Blenniidae (Mahon et al. 1998, Moyle and Cech 1996, Nelson 2006). The blennies and gobies primarily feed on detritus on the seafloor. The suborder Acanthuroidei contains the surgeonfishes, moorish idols, and rabbitfishes of tropical reef systems. They have elongated small mouths used to scrape algae from coral. These grazers provide an important function to the reef system by controlling the growth of algae on the reef (Goatley and Bellwood 2009). Some of these species are adapted to target particular prey species; for example, the elongated snouts of butterflyfishes allow for biting off exposed parts of invertebrates (Leysen et al. 2010).

These fishes occur in all coastal waters of the Study Area, but are mostly concentrated, and exhibit the most varieties, in depths less than 100 ft. (30.5 m), within the Insular Pacific-Hawaiian and California Current Large Marine Ecosystems portion of the Study Area (Froese and Pauly 2010, Moyle and Cech 1996, Paxton and Eshmeyer 1994).

3.9.2.21 Jacks, Tunas, Mackerels, and Billfishes (Families Carangidae, Scombridae, Xiphiidae, and Istiophoridae)

The suborder Scombroidei contain some of the most voracious open ocean predators: the jacks, mackerels, barracudas, billfishes, and tunas (Estrada et al. 2003, Sibert et al. 2006). Many jacks are known to feed nocturnally (Goatley and Bellwood 2009) and in the low-light conditions of twilight (Rickel and Genin 2005), by ambushing their prey (Sancho 2000). The open ocean, highly migratory tunas, mackerels, and billfishes are extremely important to fisheries; they together account for approximately one-third of total annual worldwide catch, by weight, with tunas, and swordfish as the most important species (Food and Agriculture Organization of the United Nations 2005, 2009). There are two Hawaii-based longline fisheries that target bigeye tuna and swordfish, with fishing grounds occurring in the Study Area. One unique adaptation found in these fishes is ram ventilation (Wegner et al. 2006). Ram ventilation uses the motion of the fish through the water to increase respiratory efficiency in large, fast-swimming open ocean fishes (Wegner et al. 2006). Many fishes in this group have large-scale migrations that allow for feeding in highly productive areas, which vary by season (Pitcher 1995).

These fishes occupy the open ocean areas that comprise the largest area of ocean but make up only about 5 percent of the total marine fishes (Froese and Pauly 2010, Helfman et al. 1997). They are mostly found near the surface, or the upper portion of the water column, located within all coastal waters and open ocean areas of the Study Area, including all of the Insular Pacific-Hawaiian and California Current Large Marine Ecosystems (Froese and Pauly 2010, Paxton and Eshmeyer 1994).

3.9.2.22 Flounders (Order Pleuronectiformes)

The order Pleuronectiformes includes flatfishes (flounders, dabs, soles, and tonguefishes) that are found in all marine seafloor habitats throughout the world (Nelson 2006). Fishes in this group have eyes on either the left side or the right side of the head as larvae mature and are not symmetrical like other fishes (Saele et al. 2004). All flounder species are ambush predators, feeding mostly on other fishes and bottom-dwelling invertebrates (Drazen and Seibel 2007, Froese and Pauly 2010).

This group is widely distributed on the seafloor of open ocean and coastal habitats throughout the world. They occur in all waters of the Study Area, but are particularly concentrated, and exhibit the most varieties, in depths less than 330 ft. (100.6 m), often associated with sand bottoms within the Insular Pacific-Hawaiian and California Current Large Marine Ecosystems and open ocean portions of the Study Area (Froese and Pauly 2010, Paxton and Eshmeyer 1994).

3.9.2.23 Triggerfish, Puffers, and Molas (Order Tetraodontiformes)

The fishes in the order Tetraodontiformes are the most advanced group of modern bony fishes. This order includes the triggerfishes, filefishes, puffers, and ocean sunfishes. Like the flounders, this group exhibits body shapes unique among marine fishes, including modified spines or other structures advantageous in predator avoidance. The unique body shapes also require the use of a tail swimming style because some species lack the muscle structure and body shape of other fishes. Most of these fishes are active during the daytime and exhibit a variety of strategies for catching prey, such as ambushing their prey (Wainwright and Richard 1995). The ocean sunfishes (*Mola* species) are the largest bony fish and the most prolific vertebrate species, with females producing more than 300 million eggs in a breeding season (Moyle and Cech 1996). The ocean sunfishes occur very close to the surface. They are slow swimming and feed on a variety of plankton, like jellyfish, crustaceans, and fishes (Froese and Pauly 2010). Their only natural predators are sharks, orcas, and sea lions (Helfman et al. 1997).

Most species within this group are associated with reef systems. This group is widely distributed in tropical and temperate bottom or mid-water column habitats (open ocean and coastal) throughout the world. They occur in all waters of the Study Area, but are particularly concentrated, and exhibit the most varieties, in depths less than 330 ft. (100.6 m), often associated with reefs or structured seafloor habitats within the Insular Pacific-Hawaiian and California Current Large Marine Ecosystems and open ocean portions of the Study Area (Froese and Pauly 2010, Paxton and Eshmeyer 1994). One major exception is for the molas (ocean sunfishes), which occur at the surface in all open ocean areas (Helfman et al. 1997).

3.9.3 Environmental Consequences

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) potentially impact marine fishes known to occur within the Study Area. Tables 2.8-1 through 2.8-5 present the baseline and proposed training and testing activity locations for each alternative (including number of activities and ordnance expended). The stressors vary in intensity, frequency, duration, and location within the Study Area. The stressors applicable to marine fish in the Study Area and analyzed below include the following:

- Acoustic (sonar, other non-impulsive acoustic sources, underwater explosives)
- Energy (electromagnetic devices)
- Physical disturbance and strike (vessels and in-water devices, military expended materials, seafloor devices)
- Entanglement (fiber optic cables and guidance wires, parachutes)
- Ingestion (munitions, fragments from munitions, military expended materials other than munitions)
- Secondary

Each of these components was carefully analyzed for potential impacts on fishes within the stressor categories contained in this section. The specific analysis of the training and testing activities considers these components within the context of geographic location and overlap of marine fish resources. In addition to the analysis here, the details of all training and testing activities, stressors, components that cause the stressor, and geographic overlap within the Study Area are included in Chapter 2.

3.9.3.1 Acoustic Stressors

The following sections analyze potential impacts on fish from proposed activities that involve acoustic stressors (non-impulsive and impulsive).

3.9.3.1.1 Analysis Background and Framework

This section is largely based on a technical report prepared for the Navy: *Effects of Mid- and High-Frequency Sonars on Fish* (Popper 2008). Additionally, Popper and Hastings (2009) provide a critical overview of some of the most recent research regarding potential effects of anthropogenic sound on fish.

Studies of the effects of human-generated sound on fish have been reviewed in numerous places (e.g., National Research Council 1994, 2003; Popper 2003; Popper et al. 2004; Hastings and Popper 2005a; Popper 2008; Popper and Hastings 2009). Most investigations, however, have been in the gray literature (non-peer-reviewed reports—see Hastings and Popper 2005a, Popper 2008, and Popper and Hastings 2009 for extensive critical reviews of this material).

Fish have been exposed to short-duration, high-intensity signals such as might be found near high-intensity sonar, pile driving, or a seismic air gun survey. The investigators in such studies examined short-term effects that could result in death to the exposed fish, as well as hearing loss and long-term consequences. Recent experimental studies have provided additional insight into the issues (e.g., Doksæter et al. 2009; Govoni et al. 2003; McCauley et al. 2003; Popper et al. 2005, 2007).

3.9.3.1.1.1 Direct Injury

Non-Impulsive Acoustic Sources

Potential direct injuries from non-impulsive sound sources, such as sonar, are unlikely because of to the relatively lower peak pressures and slower rise times than potentially injurious sources such as explosives. Non-impulsive sources also lack the strong shock wave such as that associated with an explosion. Therefore, direct injury is not likely to occur from exposure to non-impulsive sources such as sonar, vessel noise, or subsonic aircraft noise. The theories of sonar induced acoustic resonance, bubble formation, neurotrauma, and lateral line system injury are discussed below, although these phenomena are difficult to recreate under real-world conditions and are therefore unlikely to occur.

Two unpublished reports examined the effects of mid-frequency sonar-like signals (1.5 to 6.5 kHz) on larval and juvenile fish of several species (Jørgensen et al. 2005; Kvadsheim and Sevaldsen 2005). In the first study, Jørgensen et al. (2005) exposed larval and juvenile fish to various sounds in order to investigate potential effects on survival, development, and behavior. The study used herring (*Clupea harengus*) (standard lengths 2 to 5 centimeters [cm]), Atlantic cod (*Gadus morhua*) (standard length 2 and 6 cm), saithe (*Pollachius virens*) (4 cm), and spotted wolffish (*Anarhichas minor*) (4 cm) at different developmental stages. The researchers placed the fish in plastic bags 10 ft. (3 m) from the sound source and exposed them to between four and 100 pulses of one-second duration of pure tones at 1.5, 4, and 6.5 kHz. The fish in only two groups out of the 82 tested exhibited any adverse effects. These two groups were both composed of herring, a hearing specialist, and were tested with sound pressure levels of 189 dB re 1 µPa, which resulted in a post-exposure mortality of 20 to 30 percent. In the remaining 80 tests, there were no observed effects on behavior, growth (length and weight), or the survival of fish that were kept as long as 34 days post exposure. While statistically significant losses were documented in the two groups impacted, the researchers only tested that particular sound level once, so it is not known if this increased mortality was due to the level of the test signal or to other unknown factors.

High sound pressure levels may cause bubbles to form from micronuclei in the blood stream or other tissues of animals, possibly causing embolism damage (Ketten 1998). Fish have small capillaries where these bubbles could be caught and lead to the rupturing of the capillaries and internal bleeding. It has also been speculated that this phenomena could also take place in the eyes of fish due to potentially high gas saturation within the fish's eye tissues (Popper and Hastings 2009).

As reviewed in Popper and Hastings (2009), Hastings (1990, 1995) found 'acoustic stunning' (loss of consciousness) in blue gouramis (*Trichogaster trichopterus*) following an 8-minute exposure to a 150 Hz pure tone with a peak sound pressure level (SPL) of 198 dB re 1 µPa. This species of fish has an air bubble in the mouth cavity directly adjacent to the animal's braincase that may have caused this injury. Hastings (1990, 1995) also found that goldfish exposed to two hours of continuous wave sound at 250 Hz with peak pressures of 204 dB re 1 µPa, and fathead minnows exposed to 0.5 hours of 150 Hz continuous wave sound at a peak level of 198 dB re 1 µPa did not survive.

The only study on the effect of exposure of the lateral line system to continuous wave sound (conducted on one freshwater species) suggests no effect on these sensory cells by intense pure tone signals (Hastings et al. 1996).

Explosives and Other Acoustic Sources

The greatest potential for direct, non-auditory tissue effects is primary blast injury and barotrauma following exposure to explosions. Primary blast injury refers to those injuries that result from the initial compression of a body exposed to a blast wave. Primary blast injury is usually limited to gas-containing structures (e.g., swim bladder) and the auditory system. Barotrauma refers to injuries caused when the swim bladder or other gas-filled structures vibrate in response to the signal, particularly if there is a relatively sharp rise-time and the walls of the structure strike near-by tissues and damage them.

An underwater explosion generates a shock wave that produces a sudden, intense change in local pressure as it passes through the water (U.S. Department of the Navy 1998, 2001). Pressure waves extend to a greater distance than other forms of energy produced by the explosion (i.e., heat and light) and are therefore the most likely source of negative effects to marine life from underwater explosions (Craig 2001, Scripps Institution of Oceanography 2005, U.S. Department of the Navy 2006).

The shock wave from an underwater explosion is lethal to fish at close range (see Section 3.0.5.3.1.2, Explosions, for a discussion of ranges for mortality dependent on charge size), causing massive organ and tissue damage and internal bleeding (Keevin and Hempen 1997). At greater distance from the detonation point, the extent of mortality or injury depends on a number of factors including fish size, body shape, orientation, and species (Keevin and Hempen 1997, Wright 1982). At the same distance from the source, larger fish are generally less susceptible to death or injury, elongated forms that are round in cross-section are less at risk than deep-bodied forms, and fish oriented sideways to the blast suffer the greatest impact (Edds-Walton and Finneran 2006, O'Keeffe 1984, O'Keeffe and Young 1984, Wiley et al. 1981, Yelverton et al. 1975). Species with gas-filled organs have higher mortality than those without them (Continental Shelf Associates Inc. 2004, Goertner et al. 1994).

Two aspects of the shock wave appear most responsible for injury and death to fish: the received peak pressure and the time required for the pressure to rise and decay (Dzwilewski and Fenton 2002). Higher peak pressure and abrupt rise and decay times are more likely to cause acute pathological effects (Wright and Hopky 1998). Rapidly oscillating pressure waves might rupture the kidney, liver, spleen, and sinus and cause venous hemorrhaging (Keevin and Hempen 1997). They can also generate bubbles in

blood and other tissues, possibly causing embolism damage (Ketten 1998). Oscillating pressure waves might also burst gas-containing organs. The swim bladder, the gas-filled organ used by most fish to control buoyancy, is the primary site of damage from explosives (Wright 1982, Yelverton et al. 1975). Gas-filled swim bladders resonate at different frequencies than surrounding tissue and can be torn by rapid oscillation between high- and low-pressure waves. Swim bladders are a characteristic of many bony fish but are not present in sharks and rays.

Studies that have documented fish killed during planned underwater explosions indicate that most fish that die do so within one to four hours, and almost all die within a day (Hubbs and Rechnizer 1952, Yelverton et al. 1975). Fitch and Young (1948) found that the type of fish killed changed when blasting was repeated at the same marine location within 24 hours of previous blasting. They observed that most fish killed on the second day were scavengers, presumably attracted by the victims of the previous day's blasts. However, fishes collected during these types of studies have mostly been recovered floating on the water's surface. Gitschlag et al. (2001) collected both floating fish and those that were sinking or lying on the bottom after explosive removal of nine oil platforms in the northern Gulf of Mexico. They found that 3 to 87 percent (46 percent average) of the specimens killed during a blast might float to the surface. Other impediments to accurately characterizing the magnitude of fish mortality included currents and winds that transported floating fishes out of the sampling area and predation by seabirds or other fishes.

There have been few studies of the impact of underwater explosions on early life stages of fishes (eggs, larvae, juveniles). Fitch and Young (1948) reported the demise of larval anchovies exposed to underwater blasts off California, and Nix and Chapman (1985) found that anchovy and smelt larvae died following the detonation of buried charges. It has been suggested that impulsive sounds, such as that produced by seismic airguns, may cause damage to the cells of the lateral line in fish larvae and fry when in close proximity (15 ft. [5 m]) to the sound source (Booman et al. 1996).Similar to adult fishes, the presence of a swim bladder contributes to shock wave-induced internal damage in larval and juvenile fishes (Settle et al. 2002). Shock wave trauma to internal organs of larval pinfish and spot from shock waves was documented by Govoni et al. (2003). These were laboratory studies, however, and have not been verified in the field.

It has been suggested that impulsive sounds, such as those produced by seismic airguns, may cause damage to the cells of the lateral line in fish larvae and juveniles when in proximity (16 ft. [4.9 m]) to the sound source (Booman et al. 1996).

There have been a number of studies that suggest that the sounds from impact pile driving, and particularly from driving of larger piles, kill fish that are very close to the source. The source levels in such cases often reach peak sound pressure level of 193 - 212 dB re 1 μPa and there is some evidence of tissue damage accompanying exposure (e.g., Abbott and Reyff 2004, Caltrans 2001) reviewed in (Hastings and Popper 2005b). However, there is reason for concern in analysis of such data since, in many cases the only dead fish that were observed were those that came to the surface. It is not clear whether fish that did not come to the surface survived the exposure to the sounds, or died and were carried away by currents.

There are also a number of studies that placed fish in cages at different distances from the pile driving operations and attempted to measure mortality and tissue damage as a result of sound exposure. However, in most cases the studies' (e.g., Abbott et al. 2002, Abbott and Reyff 2004, Abbott et al. 2005, Caltrans 2001, Nedwell et al. 2003b) work was done with few or no controls, and the behavioral and

histopathological observations done very crudely (the exception being Abbott et al. 2005). As a consequence of these limited and unpublished data, it is not possible to know the real effects of pile driving on fish.

Interim criteria for injury of fish were discussed in Stadler and Woodbury (2009). The onset of physical injury would be expected if either the peak sound pressure level exceeds 206 dB re 1 µPa, or the cumulative sound exposure level, accumulated over all pile strikes generally occurring within a single day, exceeds 187 dB re 1 μPa^2-s for fish 2 grams or larger, or 183 dB re 1 μPa^2-s for smaller fish (Stadler and Woodbury 2009). A more recent study by Halvorsen et al., (2011) used carefully controlled laboratory conditions to determine the level of pile driving sound that may cause a direct injury to the fish tissues (barotrauma). The investigators found that juvenile Chinook salmon (*Oncorhynchus tshawytscha*) which received less than a single strike sound exposure level of 179 to 181 dB re 1μPa^2-s and cumulative sound exposure level of less than 211 dB re 1μPa^2-s over the duration of the pile driving activity would sustain no more than mild, non-life-threatening injuries.

3.9.3.1.1.2 Hearing Loss

Exposure to high intensity sound can cause hearing loss, also known as a noise-induced threshold shift, or simply a threshold shift (Miller 1974). A temporary threshold shift (TTS) is a temporary, recoverable loss of hearing sensitivity. A TTS may last several minutes to several weeks and the duration may be related to the intensity of the sound source and the duration of the sound (including multiple exposures). A permanent threshold shift is non-recoverable, results from the destruction of tissues within the auditory system, and can occur over a small range of frequencies related to the sound exposure. As with temporary threshold shift, the animal does not become deaf but requires a louder sound stimulus (relative to the amount of PTS) to detect a sound within the affected frequencies; however, in this case, the effect is permanent.

Permanent hearing loss, or permanent threshold shift, has not been documented in fish. The sensory hair cells of the inner ear in fish can regenerate after they are damaged, unlike in mammals where sensory hair cells loss is permanent (Lombarte et al. 1993; Smith et al. 2006). As a consequence, any hearing loss in fish may be as temporary as the timeframe required to repair or replace the sensory cells that were damaged or destroyed (e.g., Smith et al. 2006).

Non-Impulsive Acoustic Sources

Studies of the effects of long-duration sounds with sound pressure levels below 170–180 dB re 1 µPa indicate that there is little to no effect of long-term exposure on species that lack notable anatomical hearing specialization (Amoser and Ladich 2003; Scholik and Yan 2001; Smith et al. 2004a, b; Wysocki et al. 2007). The longest of these studies exposed young rainbow trout (*Onorhynchus mykiss*), to a level of noise equivalent to one that fish would experience in an aquaculture facility (e.g., on the order of 150 dB re 1 µPa) for about nine months. The investigators found no effect on hearing (i.e., TTS) as compared to fish raised at 110 dB re 1 µPa.

In contrast, studies on fish with hearing specializations (i.e., greater sensitivity to lower sound pressures and higher frequencies) have shown that there is some hearing loss after several days or weeks of exposure to increased background sounds, although the hearing loss seems to recover (e.g., Scholik and Yan 2002, Smith et al. 2006, Smith et al. 2004a). Smith et al. (2006; 2004b) exposed goldfish to noise at 170 dB re 1 µPa and found a clear relationship between the amount of hearing loss (TTS) and the duration of exposure until maximum hearing loss occurred after 24 hours of exposure. A 10-minute exposure resulted in a 5 dB TTS, whereas a 3-week exposure resulted in a 28 dB TTS that took over 2

weeks to return to pre-exposure baseline levels (Smith et al. 2004a) (Note: recovery time not measured by investigators for shorter exposure durations).

Similarly, Wysocki and Ladich (2005) investigated the influence of noise exposure on the auditory sensitivity of two freshwater fish with notable hearing specializations, the goldfish and the lined Raphael catfish (*Platydoras costatus*), and on a freshwater fish without notable specializations, the pumpkinseed sunfish (*Lepomis gibbosus*). Baseline thresholds showed greatest hearing sensitivity around 0.5 kHz in the goldfish and catfish and at 0.1 kHz in the sunfish. For the goldfish and catfish, continuous white noise of approximately 130 dB re 1 µPa at 1 m resulted in a significant TTS of 23 to 44 dB. In contrast, the auditory thresholds in the sunfish declined by 7 to 11 dB. The duration of exposure and time to recovery was not addressed in this study. Scholik and Yan (2001) demonstrated TTS in fathead minnows (*Pimephales promelas*) after a 24-hour exposure to white noise (0.3–2.0 kHz) at 142 dB re 1 µPa, that did not recover as long as 14 days post-exposure.

Studies have also examined the effects of the sound exposures from Surveillance Towed Array Sensor System Low-Frequency Active sonar on fish hearing (Kane et al. 2010; Popper et al. 2007). Hearing was measured both immediately post exposure and for several days thereafter. Maximum received sound pressure levels were 193 dB re 1 µPa for 324 or 628 seconds. Catfish and some specimens of rainbow trout showed 10-20 dB of hearing loss immediately after exposure to the low-frequency active sonar when compared to baseline and control animals; however, another group of rainbow trout showed no hearing loss. Recovery in trout took at least 48 hours, but studies were not completed. The different results between rainbow trout groups is difficult to understand, but may be due to developmental or genetic differences in the various groups of fish. Catfish hearing returned to, or close to, normal within about 24 hours after exposure to low-frequency active sonar. Furthermore, examination of the inner ears of the fish during necropsy (note: maximum time fish were held post exposure before sacrifice was 96 hours) revealed no differences from the control groups in cilliary bundles or other features indicative of hearing loss (Kane et al. 2010).

The study of mid-frequency active sonar by the same investigators also examined potential effects on fish hearing and the inner ear (Halvorsen et al. 2012; Kane et al. 2010). Out of the four species tested (rainbow trout, channel catfish, largemouth bass, and yellow perch) only one group of channel catfish, tested in December, showed any hearing loss after exposure to mid-frequency active sonar. The signal consisted of a 2 second (s) long, 2.8–3.8 kHz frequency sweep followed by a 3.3 kHz tone of 1 s duration. The stimulus was repeated five times with a 25 second interval. The maximum received sound pressure level was 210 dB re 1 µPa. These animals, which have the widest hearing range of any of the species tested, experienced approximately 10 dB of threshold shift that recovered within 24 hours. Channel catfish tested in October did not show any hearing loss. The investigators speculated that the difference in hearing loss between catfish groups might have been due to the difference in water temperature of the lake where all of the testing took place (Seneca Lake, New York) between October and December. Alternatively, the observed hearing loss differences between the two catfish groups might have been due to differences between the two stocks of fish (Halvorsen et al. 2012). Any effects on hearing in channel catfish due to sound exposure appear to be transient (Halvorsen et al. 2012; Kane et al. 2010). Investigators observed no damage to cilliary bundles or other features indicative of hearing loss in any of the other fish tested including the catfish tested in October (Kane et al. 2010).

Some studies have suggested that there may be some loss of sensory hair cells due to high intensity sources; however, none of these studies concurrently investigated effects on hearing. Enger (1981) found loss of cilliary bundles of the sensory cells in the inner ears of Atlantic cod (*Gadus morhua*)

following 1-5 hours of exposure to pure tone sounds between 50 and 400 Hz with a sound pressure level of 180 dB re 1 µPa. Hastings (1995) found auditory hair-cell damage in a species with notable anatomical hearing specializations, the goldfish (*Carassius auratus*) exposed to 250 Hz and 500 Hz continuous tones with maximum peak levels of 204 dB re 1 µPa and 197 dB re 1 µPa, respectively, for about 2 hours. Similarly, Hastings et al. (1996) demonstrated damage to some sensory hair cells in oscars (*Astronotus ocellatus*) following a one hour exposure to a pure tone at 300 Hz with a peak pressure level of 180 dB re 1 µPa. In none of the studies was the hair cell loss more than a relatively small percent (less than a maximum of 15 percent) of the total sensory hair cells in the hearing organs.

Explosives and Other Impulsive Acoustic Sources

Popper et al. (2005) examined the effects of a seismic airgun array on a fish with hearing specializations, the lake chub (*Couesius plumbeus*), and two species that lack notable specializations, the northern pike (*Esox lucius*) and the broad whitefish (*Coregonus nasus*) (a salmonid). In this study the average received exposure levels were a mean peak pressure level of 207 dB re 1 µPa; sound pressure level of 197 dB re 1 µPa; and single-shot sound exposure level of 177 dB re 1 μPa^2-s. The results showed temporary hearing loss for both lake chub and northern pike to both 5 and 20 airgun shots, but not for the broad whitefish. Hearing loss was approximately 20 to 25 dB at some frequencies for both the northern pike and lake chub, and full recovery of hearing took place within 18 hours after sound exposure. Examination of the sensory surfaces of the ears by an expert on fish inner ear structure showed no damage to sensory hair cells in any of the fish from these exposures (Song et al. 2008).

McCauley et al. (2003) showed loss of a small percent of sensory hair cells in the inner ear of the pink snapper (*Pagrus auratus*) exposed to a moving airgun array for 1.5 hours. Maximum received levels exceeded 180 dB re 1 μPa^2s for a few shots. The loss of sensory hair cells continued to increase for up to at least 58 days post exposure to 2.7 percent of the total cells, with disproportionate damage (approximately 15 percent of hair cells) in the caudal portion of the ear. It is not known if this hair cell loss would result in hearing loss since fish have tens or even hundreds of thousands of sensory hair cells in the inner ear Popper and Hoxter 1984; Lombarte and Popper 1994) and only a small portion were affected by the sound. The question remains as to why McCauley et al. (2003) found damage to sensory hair cells while Popper et al. (2005) did not. There are many differences between the studies, including species, precise sound source, and spectrum of the sound that it is hard to speculate.

Hastings et al. (2008) exposed the pinecone soldierfish (*Myripristis murdjan*), a fish with anatomical specializations to enhance their hearing; and three species without notable specializations: the blue green damselfish (*Chromis viridis*), the saber squirrelfish (*Sargocentron spiniferum*), and the bluestripe seaperch (*Lutjanus kasmira*) to an airgun array. Fish in cages in 16 ft. (4.9 m) of water were exposed to multiple airgun shots with a cumulative sound exposure level of 190 dB re 1 μPa^2s. The authors found no hearing loss in any fish following exposures.

As with other impulsive sound sources, it is assumed that sound from pile driving may cause hearing loss in fish located near the site (Popper and Hastings 2009c), however research definitively demonstrating this is lacking.

3.9.3.1.1.3 Auditory Masking

Auditory masking refers to the presence of a noise that interferes with a fish's ability to hear biologically relevant sounds. Fish use sounds to detect predators and prey, and for schooling, mating, and navigating, among other uses (Myrberg 1980; Popper et al. 2003). Masking of sounds associated with

these behaviors could have impacts to fish by reducing their ability to perform these biological functions.

Any noise (i.e., unwanted or irrelevant sound, often of an anthropogenic nature) detectable by a fish can prevent the fish from hearing biologically important sounds including those produced by prey or predators (Myrberg 1980; Popper et al. 2003). Auditory masking may take place whenever the noise level heard by a fish exceeds ambient noise levels, the animal's hearing threshold, and the level of a biologically relevant sound. Masking is found among all vertebrate groups, and the auditory system in all vertebrates, including fish, is capable of limiting the effects of masking noise, especially when the frequency range of the noise and biologically relevant signal differ (Fay 1988; Fay and Megela-Simmons 1999).

The frequency of the sound is an important consideration for fish because many marine fish are limited to detection of the particle motion component of low frequency sounds at relatively high sound intensities (Amoser and Ladich 2005). The frequency of the acoustic stimuli must first be compared to the animal's known or suspected hearing sensitivity to establish if the animal can potentially detect the sound.

One of the problems with existing fish auditory masking data is that the bulk of the studies have been done with goldfish, a freshwater fish with well-developed anatomical specializations that enhance hearing abilities. The data on other species are much less extensive. As a result, less is known about masking in marine species, many of which lack the notable anatomical hearing specializations. However, Wysocki and Ladich (2005) suggest that ambient sound regimes may limit acoustic communication and orientation, especially in animals with notable hearing specializations.

Tavolga (1974a, b) studied the effects of noise on pure-tone detection in two species without notable anatomical hearing specializations, the pin fish (*Lagodon rhomboids*) and the African mouth-Breeder (*Tilapia macrocephala*), and found that the masking effect was generally a linear function of masking level, independent of frequency. In addition, Buerkle (1968, 1969) studied five frequency bandwidths for Atlantic cod in the 20 to 340 Hz region and showed masking across all hearing ranges. Chapman and Hawkins (1973b) found that ambient noise at higher sea states in the ocean has masking effects in cod, *Gadus morhua* (L.), haddock, *Melanogrammus aeglefinus* (L.), and pollock, *Pollochinus pollachinus* (L.), and similar results were suggested for several sciaenid species by Ramcharitar and Popper (2004c). Thus, based on limited data, it appears that for fish, as for mammals, masking may be most problematic in the frequency region near the signal.

There have been a few field studies that may suggest masking could have an impact on wild fish. Gannon et al. (2005) showed that bottlenose dolphins (*Tursiops truncatus*) move toward acoustic playbacks of the vocalization of Gulf toadfish (*Opsanus beta*). Bottlenose dolphins employ a variety of vocalizations during social communication including low-frequency pops. Toadfish may be able to best detect the low-frequency pops since their hearing is best below 1 kHz, and there is some indication that toadfish have reduced levels of calling when bottlenose dolphins approach (Remage-Healey et al. 2006a). Silver perch have also been shown to decrease calls when exposed to playbacks of dolphin whistles mixed with other biological sounds (Luczkovich et al. 2000). Results of the Luczkovich et al. (2000) study, however, must be viewed with caution because it is not clear what sound may have elicited the silver perch response (Ramcharitar et al. 2006b). Astrup (1999) and Mann et al. (1998) hypothesized that high frequency detecting species (e.g., clupeids) may have developed sensitivity to

high frequency sounds to avoid predation by odontocetes. Therefore, the presence of masking noise may hinder a fish's ability to detect predators and therefore increase predation.

Of considerable concern is that human-generated sounds could mask the ability of fish to use communication sounds, especially when the fish are communicating over some distance. In effect, the masking sound may limit the distance over which fish can communicate, thereby having an impact on important components of their behavior. For example, the sciaenids, which are primarily inshore species, are one of the most active sound producers among fish, and the sounds produced by males are used to "call" females to breeding sights (Ramcharitar et al. 2001) reviewed in (2006b). If the females are not able to hear the reproductive sounds of the males, there could be a significant impact on the reproductive success of a population of sciaenids. Since most sound production in fish used for communication is generally below 500 Hz (Slabbekoorn et al. 2010a), sources with significant low-frequency acoustic energy could affect communication in fish.

Also potentially vulnerable to masking is navigation by larval fish, although the data to support such an idea are still exceedingly limited. There is indication that larvae of some reef fish (species not identified in study) may have the potential to navigate to juvenile and adult habitat by listening for sounds emitted from a reef (either due to animal sounds or non-biological sources such as surf action) (e.g., Higgs 2005). In a study of an Australian reef system, the sound signature emitted from fish choruses was between 0.8 and 1.6 kHz (Cato 1978) and could be detected by hydrophones 3 to 4 nm (5.6 to 7.4 km) from the reef (McCauley and Cato 2000). This bandwidth is within the detectable bandwidth of adults and larvae of the few species of reef fish, such as the dameslefish, *Pomacentrus partitus,* and bicolor damselfish, *Eupomacentrus partitus,* that have been studied (Kenyon 1996b; Myrberg 1980). At the same time, it has not been demonstrated conclusively that sound, or sound alone, is an attractant of larval fish to a reef, and the number of species tested has been very limited. Moreover, there is also evidence that larval fish may be using other kinds of sensory cues, such as chemical signals, instead of, or alongside of, sound (Atema et al. 2002).

3.9.3.1.1.4 Physiological Stress and Behavioral Reactions

As with masking, a fish must first be able to detect a sound above its hearing threshold for that particular frequency and the ambient noise before a behavioral reaction or physiological stress can occur. There are little data available on the behavioral reactions of fish, and almost no research conducted on any long-term behavioral effects or the potential cumulative effects from repeated exposures to loud sounds (Popper and Hastings 2009c).

Stress refers to biochemical and physiological responses to increases in background sound. The initial response to an acute stimulus is a rapid release of stress hormones into the circulatory system, which may cause other responses such as elevated heart rate and blood chemistry changes. Although an increase in background sound has been shown to cause stress in humans, only a limited number of studies have measured biochemical responses by fish to acoustic stress (Remage-Healey et al. 2006a, Smith et al. 2004b, Wysocki et al. 2007, Wysocki et al. 2006) and the results have varied. There is evidence that a sudden increase in sound pressure level or an increase in background noise levels can increase stress levels in fish (Popper and Hastings 2009). Exposure to acoustic energy has been shown to cause a change in hormone levels (physiological stress) and altered behavior in some species such as the goldfish (*Carassius auratus*) (Pickering 1981; Smith et al. 2004a, b), but not all species tested to date, such as the rainbow trout (*Oncorhynchus mykiss*) (Wysocki et al. 2007).

Behavioral effects to fish could include disruption or alteration of natural activities such as swimming, schooling, feeding, breeding, and migrating. Sudden changes in sound level can cause fish to dive, rise, or change swimming direction. There is a lack of studies that have investigated the behavioral reactions of unrestrained fish to anthropogenic sound. Studies of caged fish have identified three basic behavioral reactions to sound: startle, alarm, and avoidance (McCauley et al. 2000; Pearson et al. 1992; Scripps Institution of Oceanography and Foundation. 2008). Changes in sound intensity may be more important to a fish's behavior than the maximum sound level. Sounds that fluctuate in level tend to elicit stronger responses from fish than even stronger sounds with a continuous level (Schwartz 1985).

Non-Impulsive Acoustic Sources

Remage-Healey et al. (2006a) found elevated cortisol levels, a stress hormone, in Gulf toadfish (*Opsanus beta*) exposed to low frequency bottlenose dolphin sounds. Additionally, the toadfish' call rates dropped by about 50 percent, presumably because the calls of the toadfish, a primary prey for bottlenose dolphins, give away the fish's location to the dolphin. The researchers observed none of these effects in toadfish exposed to an ambient control sound (i.e., low-frequency snapping shrimp 'pops').

Smith et al. (2004b) found no increase in corticosteroid, a stress hormone, in goldfish (*Carassius auratus*) exposed to a continuous, band-limited noise (0.1 to 10 kHz) with a sound pressure level of 170 dB re 1 µPa for 1 month. Wysocki et al. (2007) exposed rainbow trout (*Onorhynchus mykiss*) to continuous band-limited noise with a sound pressure level of about 150 dB re 1 µPa for 9 months with no observed stress effects. Growth rates and effects on the trout's immune system were not significantly different from control animals held at sound pressure level of 110 dB re 1 µPa.

Gearin et al. (2000) studied responses of adult sockeye salmon (*Oncorhynchus nerka*) and sturgeon (*Acipenser* sp.) to pinger sounds produced by acoustic devices designed to deter marine mammals from gillnet fisheries. The pingers produced sounds with broadband energy with peaks at 2 kHz or 20 kHz. They found that fish did not exhibit any reaction or behavior change to the pingers, which demonstrated that the alarm was either inaudible to the salmon and sturgeon, or that neither species was disturbed by the mid-frequency sound (Gearin et al. 2000). Based on hearing threshold data, it is highly likely that the salmonids did not hear the sounds.

Culik et al. (2001) did a very limited number of experiments to determine the catch rate of herring (*Clupea harengus*) in the presence of pingers producing sounds that overlapped with the frequency range of hearing for herring (base frequency of 2.7 kHz with harmonics to 19 kHz). They found no change in catch rates in gill nets with or without the higher frequency (greater than 20 kHz) sounds present, although there was an increase in the catch rate with the signals from 2.7 kHz to 19 kHz (a different source than the higher frequency source). The results could mean that the fish did not "pay attention" to the higher frequency sound or that they did not hear it, but that lower frequency sounds may be attractive to fish. At the same time, it should be noted that there were no behavioral observations on the fish, and so how the fish actually responded when they detected the sound is not known.

Doksæter et al (2009) studied the reactions of wild, overwintering herring to Royal Netherlands Navy experimental mid-frequency active sonar and killer whale feeding sounds. The behavior of the fish was monitored using upward looking echosounders. The received levels from the 1 to 2 kHz and 6 to 7 kHz sonar signals ranged from 127 to 197 dB re 1 µPa and 139 to 209 dB re 1 µPa, respectively. Escape reactions were not observed upon the presentation of the mid-frequency active sonar signals; however, the playback of the killer whale sounds elicited an avoidance reaction. The authors concluded that these

mid-frequency sonars could be used in areas of overwintering herring without substantially affecting the fish.

There is evidence that elasmobranchs respond to human-generated sounds. Myrberg and colleagues did experiments in which they played back sounds and attracted a number of different shark species to the sound source (e.g., Myrberg et al. 1969; Myrberg et al. 1976; Myrberg et al. 1972; Nelson and Johnson 1972). The results of these studies showed that sharks were attracted to low-frequency sounds (below several hundred Hz), in the same frequency range of sounds that might be produced by struggling prey. However, sharks are not known to be attracted by continuous signals or higher frequencies (which they presumably cannot hear since their best hearing sensitivity is around 20 Hz, and drops off above 1000 Hz [Casper and Mann 2006; Casper and Mann 2009]).

Studies documenting behavioral responses of fish to vessels show that Barents Sea capelin (*Mallotus villosus*) may exhibit avoidance responses to engine noise, sonar, depth finders, and fish finders (Jørgensen et al. 2004). Avoidance reactions are quite variable depending on the type of fish, its life history stage, behavior, time of day, and the sound propagation characteristics of the water (Schwartz 1985). Misund (1997a) found that fish ahead of a ship, that showed avoidance reactions, did so at ranges of 160 to 490 ft. (48.8–149.4 m). When the vessel passed over them, some species of fish responded with sudden escape responses that included lateral avoidance or downward compression of the school.

In a study by Chapman and Hawkins (1973b) the low-frequency sounds of large vessels or accelerating small vessels caused avoidance responses by herring. Avoidance ended within 10 seconds after the vessel departed. Twenty-five percent of the fish groups habituated to the sound of the large vessel and 75 percent of the responsive fish groups habituated to the sound of small boats.

Explosives and Other Impulsive Acoustic Sources

Pearson et al. (1992) exposed several species of rockfish (*Sebastes spp.*) to a seismic airgun. The investigators placed the rockfish in field enclosures and observed the fish's behavior while firing the airgun at various distances for 10 minute trials. Dependent upon the species, rockfish exhibited startle or alarm reactions between peak-to-peak sound pressure levels of 180 dB re 1 µPa and 205 dB re 1 µPa. The authors reported the general sound level where behavioral alterations became evident was at about 161 dB re 1 µPa for all species. During all of the observations, the initial behavioral responses only lasted for a few minutes, ceasing before the end of the 10-minute trial.

Similarly, Skalski et al. (1992) showed a 52 percent decrease in rockfish (*Sebastes* sp.) caught with hook-and-line (as part of the study–fisheries independent) when the area of catch was exposed to a single airgun emission at 186-191 dB re 1 µPa (mean peak level) (See also Pearson et al. 1987, 1992). They also demonstrated that fish would show a startle response to sounds as low as 160 dB re 1 µPa, but this level of sound did not appear to elicit decline in catch. Wright (1982) also observed changes in fish behavior as a result of the sound produced by an explosion, with effects intensified in areas of hard substrate.

Wardle et al. (2001) used a video system to examine the behaviors of fish and invertebrates on reefs in response to emissions from seismic airguns. The researchers carefully calibrated the airguns to have a peak level of 210 dB re 1 µPa at 16 m and 195 dB re 1 µPa at 109 m from the source. There was no indication of any observed damage to the marine organisms. They found no substantial or permanent changes in the behavior of the fish or invertebrates on the reef throughout the course of the study, and no marine organisms appeared to leave the reef.

Engås et al. (1996) and Engås and Løkkeborg (2002) examined movement of fish during and after a seismic airgun study by measuring catch rates of haddock (*Melanogrammus aeglefinus*) and Atlantic cod (*Gadus morhua*) as an indicator of fish behavior using both trawls and long-lines as part of the experiment. These investigators found a significant decline in catch of both species that lasted for several days after termination of airgun use. Catch rate subsequently returned to normal. The conclusion reached by the investigators was that the decline in catch rate resulted from the fish moving away from the airgun sounds at the fishing site. However, the investigators did not actually observe behavior, and it is possible that the fish just changed depth.

The same research group showed, more recently, parallel results for several additional pelagic species including blue whiting and Norwegian spring spawning herring (Slotte et al. 2004). However, unlike earlier studies from this group, the researchers used fishing sonar to observe behavior of the local fish schools. They reported that fish in the area of the airguns appeared to go to greater depths after the airgun exposure compared to their vertical position prior to the airgun usage. Moreover, the abundance of animals 18 to 31 mi. (30 to 50 km) away from the ensonification increased, suggesting that migrating fish would not enter the zone of seismic activity.

Alteration in natural behavior patterns due to exposure to pile driving noise has not been well studied. However, one study (Mueller-Blenkle et al. 2010b) demonstrated behavioral reactions of cod (*Gadus morhua*) and Dover sole (*Solea solea*) to pile driving sounds using acoustic telemetry to track animals confined in large net pens. Sole showed a significant increase in swimming speed. Cod reacted, but not significantly, and both species showed directed movement away from the sources with signs of habituation after multiple exposures. For sole, reactions were seen with peak sound pressure levels of 144–156 dB re 1µPa; and cod showed altered behavior at peak sound pressure levels of 140–161 dB re 1 µPa. For both species, this corresponds to a peak particle motion between 6.51×10^{-3} and 8.62×10^{-4} m/s^2.

3.9.3.1.2 Impacts from Sonar and Other Active Sources

Non-impulsive sources from the Proposed Action include sonar and other active acoustic sources, vessel noise, and subsonic aircraft noise. Potential acoustic effects to fish from non-impulsive sources may be considered in four categories, as detailed in Section 3.9.3.1.1 (Analysis Background and Framework): (1) direct injury; (2) hearing loss; (3) auditory masking; and (4) physiological stress and behavioral reactions.

As discussed in Section 3.9.3.1.1.1 (Direct Injury), direct injury to fish as a result of exposure to non-impulsive sounds is highly unlikely to occur. Therefore, direct injury as a result of exposure to non-impulsive sound sources is not discussed further in this analysis.

Research discussed in Section 3.9.3.1.1.2 (Hearing Loss), indicates that exposure of fish to transient, non-impulsive sources is unlikely to result in any hearing loss. Most sonar sources are outside of the hearing and sensitivity range of most marine fish, and noise sources such as vessel movement and aircraft overflight lack the duration and intensity to cause hearing loss. Furthermore, permanent threshold shift has not been demonstrated in fish as they have been shown to regenerate lost sensory hair cells. Therefore, hearing loss as a result of exposure to non-impulsive sound sources is not discussed further in this analysis.

3.9.3.1.2.1 No Action Alternative – Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1, and Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources), training activities under the No Action

Alternative include activities that produce in-water noise from the use of sonar and other active acoustic sources, and could occur throughout the Study Area. Sonar and other active acoustic sources proposed for use are transient in most locations as active sonar activities pass through the Study Area. A few activities involving sonar and other active acoustic sources occur in inshore water (within bays and estuaries), specifically at pierside locations. Sonar maintenance activities that would occur at pierside locations occur infrequently and typically emit only a few pings per activity.

Only a few species of shad within the Clupeidae family (herrings) are known to be able to detect high-frequency sonar and other active acoustic sources (greater than 10,000 Hz). Other marine fish would not detect these sounds and would therefore experience no stress, behavioral disturbance, or auditory masking. Shad species, especially in nearshore and inland areas where mine warfare activities take place that often employ high-frequency sonar systems, could have behavioral reactions and experience auditory masking during these activities. However, mine warfare activities are typically limited in duration and geographic extent. Furthermore, sound from high-frequency systems may only be detectable above ambient noise regimes in these coastal habitats from within a few kilometers. Behavioral reactions and auditory masking if they occurred for some shad species are expected to be transient. Long-term consequences for the population would not be expected.

Most marine fish species are not expected to be able to detect sounds in the mid-frequency range of the operational sonars. The fish species that are known to detect mid-frequencies (some sciaenids [drum], most clupeids [herring], and potentially deep-water fish such as myctophids [lanternfish]) do not have their best sensitivities in the range of the operational sonars. Thus, these fish may only detect the most powerful systems, such as hull mounted sonar within a few kilometers; and most other, less powerful mid-frequency sonar systems, for a kilometer or less. Due to the limited time of exposure from the moving sound sources, most mid-frequency active sonar used in the Study Area would not have the potential to substantially mask key environmental sounds or produce sustained physiological stress or behavioral reactions. Furthermore, although some species may be able to produce sound at higher frequencies (greater than 1 kHz), vocal marine fish, such as sciaenids, largely communicate below the range of mid-frequency levels used by most sonars. Other marine species cannot detect mid-frequency sonar (1,000 – 10,000 Hz) and therefore impacts are not expected for these fish. However, any such impacts would be temporary and infrequent as a vessel operating mid-frequency sonar transits an area. As such, sonar use is unlikely to impact fish species. Long-term consequences for fish populations due to exposure to mid-frequency sonar and other active acoustic sources are not expected.

A large number of marine fish species may be able to detect low-frequency sonars and other active acoustic sources. However, low-frequency active usage is rare and most low-frequency active operations are conducted in deeper waters, usually beyond the continental shelf break. The majority of fish species, including those that are the most highly vocal, exist on the continental shelf and within nearshore, estuarine areas. Fish within a few tens of kilometers around a low-frequency active sonar could experience brief periods of masking, physiological stress, and behavioral disturbance while the system is used, with effects most pronounced closer to the source. However, overall effects would be localized and infrequent. Based on the low level and short duration of potential exposure to low-frequency sonar and other active acoustic sources, long-term consequences for fish populations are not expected.

Vessel Noise

As discussed in Section 3.0.5.3.1.6 (Vessel Noise), training activities under the No Action Alternative include vessel movement. Navy vessel traffic could occur anywhere within the Study Area; however, it would be concentrated near ports or naval installations and training ranges (e.g., San Diego, Silver

Strand Training Complex (SSTC), San Clemente Island, Pearl Harbor). Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to 2 weeks. Additionally, a variety of smaller craft would be operated within the Study Area. Small craft types, sizes and speeds vary. These activities would be spread across the coastal and open ocean areas designated within the Study Area. Vessel movements involve transit to and from ports to various locations within the Study Area, and many ongoing and proposed training and testing activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels).

A detailed description of vessel noise associated with the Proposed Action is provided in Section 3.0.5.3.1.6 (Vessel Noise). Vessel noise has the potential to expose fish to sound and general disturbance, which could result in short-term behavioral or physiological responses (e.g., avoidance, stress, increased heart rate). Training and testing activities involving vessel movements occur intermittently and range in duration from a few hours up to a few weeks. These activities are widely dispersed throughout the Study Area. While vessel movements have the potential to expose fish occupying the water column to sound and general disturbance, potentially resulting in short-term behavioral or physiological responses, such responses would not be expected to compromise the general health or condition of individual fish. In addition, most activities involving vessel movements are infrequent and widely dispersed throughout the Study Area. The exception is for pierside activities; although these areas are located inshore, these are industrialized areas that are already exposed to high levels of anthropogenic noise due to numerous waterfront users (e.g., industrial and marinas). Therefore, impacts from vessel noise would be temporary and localized. Long-term consequences for the population are not expected.

Aircraft Noise

As described in Section 3.0.5.3.1.7 (Aircraft Overflight Noise), training activities under the No Action Alternative include fixed and rotary wing aircraft overflights. Certain portions of the Study Area, such as areas near Navy airfields, installations, and ranges are used more heavily by Navy aircraft than other portions. These activities would be spread across the coastal and open ocean areas designated within the Study Area. A detailed description of aircraft noise as a stressor is provided in Section 3.0.5.3.1.7 (Aircraft Overflight Noise). Aircraft produce extensive airborne noise from either turbofan or turbojet engines. A severe but infrequent type of aircraft noise is the sonic boom, produced when the aircraft exceeds the speed of sound. Rotary wing aircraft (helicopters) produce low-frequency sound and vibration (Pepper et al. 2003).

Fish may be exposed to aircraft-generated noise wherever aircraft overflights occur; however, sound is primarily transferred into the water from air in a narrow cone under the aircraft. Most of these sounds would occur near airbases and fixed ranges within each range complex. Some species of fish could respond to noise associated with low-altitude aircraft overflights or to the surface disturbance created by downdrafts from helicopters. Aircraft overflights have the potential to affect surface waters and, therefore, to expose fish occupying those upper portions of the water column to sound and general disturbance potentially resulting in short-term behavioral or physiological responses. If fish were to respond to aircraft overflights, only short-term behavioral or physiological reactions (e.g., swimming away and increased heart rate) would be expected. Therefore, long-term consequences for individuals would be unlikely and long-term consequences for the populations are not expected.

3.9.3.1.2.2 Summary of Impacts from Non-impulsive Acoustic Sources

The majority of fish species exposed to non-impulsive sources would likely have no reaction or mild behavioral reactions. Overall, long-term consequences for individual fish are unlikely in most cases because acoustic exposures are intermittent and unlikely to repeat over short periods. Since long-term consequences for most individuals are unlikely, long-term consequences for populations are not expected.

Steelhead trout, as summarized in Section 3.9.2.3, are anadromous and spend a portion of their lives in both the marine environment as well as in the riverine and estuarine systems from the Kamchatka Peninsula in Asia, east to Alaska, and south to Southern California. Steelhead trout have the potential to be exposed to non-impulsive sound associated with training activities under the No Action Alternative in the coastal areas of the Southern California (SOCAL) Range Complex and SSTC.

It is believed that steelhead trout, which are anatomically similar to Atlantic salmon, are unable to detect the sound produced by mid- or high-frequency sonar and other active acoustic sources (Section 3.9.2.1, Hearing and Vocalization). Therefore acoustic impacts from these sources are not expected. Effects to designated steelhead trout critical habitat would not occur as activities do not overlap.

Low-frequency active sonar and other active acoustic sources are not typically operated in coastal or nearshore waters. If low frequency sources are used in coastal waters, then adult steelhead trout could be exposed to sound within their hearing range within these areas. If this did occur, steelhead trout could experience behavioral reactions, physiological stress, and auditory masking, although these impacts would be expected to be short-term and infrequent based on the low probability of co-occurrence between the activity and species. Long-term consequences for the populations would not be expected. Effects to designated steelhead trout critical habitat would not occur as activities do not overlap.

The primary exposure to vessel and aircraft noise would occur around the Navy ranges, ports, and air bases. Vessel and aircraft overflight noise have the potential to expose steelhead trout to sound and general disturbance, potentially resulting in short-term behavioral responses. However, as discussed above, any short-term behavioral reactions, physiological stress, or auditory masking are unlikely to lead to long-term consequences for individuals. Therefore, long-term consequences for populations are not expected.

Pursuant to the ESA, the use of non-impulsive sound sources for training activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of non-impulsive sound sources under the No Action Alternative during training activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.1.2.3 No Action Alternative – Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Tables 2.8-2 to 2.8-5 and in Section 3.0.5.3.1 (Acoustic Stressors), testing activities under the No Action Alternative include activities that use sonar and other active acoustic sources that produce underwater sound, and could occur throughout the Study Area. Proposed testing activities under the No Action Alternative that involve sonar and other active acoustic sources differ in number and location from training activities under the

No Action Alternative, however the types and severity of impacts would not be discernable from those described in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities).

As discussed in Section 3.0.5.3.1.6 (Vessel Noise), testing activities under the No Action Alternative include vessel movement in many events. Navy vessel traffic could occur anywhere within the Study Area; however, it would be concentrated near ports or naval installations and training ranges (e.g., San Diego, Silver Strand Training Complex [SSTC], San Clemente Island, Pearl Harbor). Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to 2 weeks. Additionally, a variety of smaller craft would be operated within the Study Area. Small craft types, sizes, and speeds vary. During testing, speeds generally range from 10 to 14 knots; however, vessels can and will, on occasion, operate within the entire spectrum of their specific operational capabilities. In all cases, the vessels would be operated in a safe manner consistent with the local conditions. These events would occur throughout the entire Study Area. Proposed testing activities under the No Action Alternative that involve vessel movement differ in number and location from training activities under the No Action Alternative, however the types and severity of impacts would not be discernable from those described in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities).

As discussed in Section 3.0.5.3.1.7 (Aircraft Overflight Noise), testing activities under the No Action Alternative include fixed and rotary wing aircraft overflights. Certain portions of the Study Area, such as areas near Navy airfields, installations, and ranges are used more heavily by Navy aircraft than other portions. These events would occur throughout the entire Study Area. Proposed testing activities under the No Action Alternative that involve aircraft overflights differ in number and location from training activities under the No Action Alternative, however, the types and severity of impacts would not be discernable from those described in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities).

Impacts to fish due to non-impulsive sound are expected to be limited to short-term, minor behavioral reactions. Long-term consequences for populations would not be expected. Predicted effects to ESA-listed steelhead trout and any designated critical habitat would not be discernable from those described in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities). Effects to designated steelhead trout critical habitat would not occur as activities do not overlap.

Pursuant to the ESA, the use of non-impulsive sound sources for testing activities as described in the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of non-impulsive sound sources under the No Action Alternative during testing activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.1.2.4 Alternative 1 Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1 and Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources), the number of annual training activities that produce in-water noise from the use of sonar and other active acoustic sources under Alternative 1 would increase, however the locations, types, and severity of impacts would not be discernable from those described in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities).

As discussed in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1, and Section 3.0.5.3.1.6 (Vessel Noise), training activities, under Alternative 1 include an increase in the numbers of activities that involve vessels compared to the No Action Alternative; however, the locations

and predicted impacts would not differ. Proposed training activities under Alternative 1 that involve vessel movement differ in number from training activities proposed under the No Action Alternative, however, the locations, types, and severity of impacts would not be discernable from those described in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities).

As discussed in Chapter 2 (Description of Proposed Action And Alternatives), Table 2.8-1, and Section 3.0.5.3.1.7 (Aircraft Overflight Noise), training activities under Alternative 1 include an increase in the number of activities that involve aircraft as compared to the No Action Alternative, however, the training locations, types of aircraft, and types of activities would not differ. The number of individual predicted impacts associated with Alternative 1 aircraft overflight noise may increase, however, the locations, types, and severity of impacts would not be discernable from those described in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities).

Despite the increase in activity, the potential impacts of training activities involving sonar and other active acoustic sources under Alternative 1 on fish species would be similar to those described above for training activities under the No Action Alternative, and are expected to be limited to short-term, minor behavioral reactions. Impacts to fish populations would not occur as a result of non-impulsive sounds associated with training activities under Alternative 1. Predicted effects to ESA-listed steelhead trout and designated critical habitat would not be discernable from those described in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities). Effects to designated steelhead trout critical habitat would not occur as activities do not overlap.

Pursuant to the ESA, the use of non-impulsive acoustic sources for training activities under Alternative 1 may affect, but is not likely to adversely affect ESA-listed steelhead trout.

The use of non-impulsive acoustic sources under Alternative 1 during training activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.1.2.5 Alternative 1 - Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Tables 2.8-2 to 2.8-5, and Section 3.0.5.3.1 (Acoustic Stressors), the number of annual testing activities that produce in-water sound from the use of sonar and other active acoustic sources analyzed under Alternative 1 would increase over what was analyzed for the No Action Alternative. These activities would happen in the same general locations under Alternative 1 as described under the No Action Alternative in Section 3.9.3.1.2.1 (No Action Alternative – Testing Activities).

Despite the increase in activity, the potential impacts of testing activities involving sonar and other active acoustic sources under Alternative 1 on fish species would be similar to those described above for training activities under the No Action Alternative, and are expected to be limited to short-term, minor behavioral reactions. Impacts to fish populations would not occur as a result of non-impulsive acoustic sources associated with testing activities under Alternative 1. Predicted effects to ESA-listed steelhead trout and designated critical habitat would not be discernable from those described in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities).

Pursuant to the ESA, the use of non-impulsive acoustic sources for testing activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of non-impulsive acoustic sources under Alternative 1 during testing activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.1.2.6 Alternative 2 – Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1 and Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources), the number of annual training activities that produce in-water noise from the use of sonar and other active acoustic sources under Alternative 2 would increase, however the locations, types, and severity of impacts would not be discernable from those described in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities).

As discussed in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1, and Section 3.0.5.3.1.6 (Vessel Noise), training activities, under Alternative 2 include an increase in the numbers of activities that involve vessels compared to the No Action Alternative; however, the locations and predicted impacts would not differ. Proposed training activities under Alternative 2 that involve vessel movement differ in number from training activities proposed under the No Action Alternative, however, the locations, types, and severity of impacts would not be discernable from those described in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities).

As discussed in Chapter 2 (Description of Proposed Action And Alternatives), Table 2.8-1, and Section 3.0.5.3.1.7 (Aircraft Overflight Noise), training activities under Alternative 2 include an increase in the number of activities that involve aircraft as compared to the No Action Alternative, however, the training locations, types of aircraft, and types of activities would not differ. The number of individual predicted impacts associated with Alternative 2 aircraft overflight noise may increase, however, the locations, types, and severity of impacts would not be discernable from those described in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities).

Despite the increase in activity, the potential impacts of training activities involving sonar and other active acoustic sources under Alternative 2 on fish species would be similar to those described above for training activities under the No Action Alternative, and are expected to be limited to short-term, minor behavioral reactions. Impacts to fish populations would not occur as a result of non-impulsive acoustic sources associated with training activities under Alternative 2. Predicted effects to ESA-listed steelhead trout and designated critical habitat would not be discernable from those described in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities). Effects to designated steelhead trout critical habitat would not occur as activities do not overlap.

Pursuant to the ESA, the use of non-impulsive acoustic sources for training activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of non-impulsive acoustic sources under Alternative 2 *during training activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.*

3.9.3.1.2.7 Alternative 2 - Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Tables 2.8-2 to 2.8-5, and Section 3.0.5.3.1 (Acoustic Stressors), the number of annual testing activities that produce in-water sound from the use of sonar and other active acoustic sources analyzed under Alternative 2 would increase over what was analyzed for the No Action Alternative. These activities would occur in the same

general locations under Alternative 2 as described under the No Action Alternative in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities).

Despite the increase in activity, the potential impacts of testing activities involving sonar and other active acoustic sources under Alternative 2 on fish species would be similar to those described above for training activities under the No Action Alternative, and are expected to be limited to short-term, minor behavioral reactions. Impacts to fish populations would not occur as a result of non-impulsive sounds associated with testing activities under Alternative 2. Predicted effects to ESA-listed steelhead trout and designated critical habitat would not be discernable from those described in Section 3.9.3.1.2.1 (No Action Alternative – Training Activities). Effects to designated steelhead trout critical habitat would not occur as activities do not overlap.

Pursuant to the ESA, the use of non-impulsive acoustic sources for testing activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of non-impulsive acoustic sources under Alternative 2 during testing activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.1.3 Impacts from Explosives and Other Impulsive Acoustic Sources

Explosions and other impulsive sound sources include explosions from underwater detonations and explosive ordnance, swimmer defense airguns, pile driving, and noise from weapons firing, launch, and impact with the water's surface. Potential acoustic effects to fish from impulsive sources may be considered in four categories, as detailed in Section 3.9.3.1 (Acoustic Stressors): (1) direct injury, (2) hearing loss, (3) auditory masking, and (4) physiological stress and behavioral reactions.

3.9.3.1.3.1 No Action Alternative – Training Activities

Training activities do not include the use of swimmer defense airguns.

Explosives

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1, and Section 3.0.5.3.1.2 (Explosives), training activities under the No Action Alternative would use underwater detonations and explosive ordnance. Training activities involving explosives could be conducted throughout the Study Area, although activities do not normally occur within 3 nm of shore except at designated underwater detonation areas (e.g., Puuloa Underwater Range, Barbers Point Underwater Range, NISMF, Lima Landing, Ewa Training Minefield, Pyramid cove, NW Harbor, Imperial Beach, SSTC).

Concern about potential fish mortality associated with the use of at-sea explosives led military researchers to develop mathematical and computer models that predict safe ranges for fish and other animals from explosions of various sizes (e.g., Yelverton et al. 1975, Goertner 1982, Goertner et al. 1994). Young (1991) provides equations that allow estimation of the potential effect of underwater explosions on fish possessing swim bladders using a damage prediction method developed by Goertner (1982). Young's parameters include the size of the fish and its location relative to the explosive source, but are independent of environmental conditions (e.g., depth of fish and explosive shot frequency). An example of such model predictions is shown in Table 3.9-5, which lists estimated explosive-effects ranges using Young's (1991) method for fish possessing swim bladders exposed to explosions that would typically occur during training exercises. The 10 percent mortality range is the distance beyond which 90

percent of the fish present would be expected to survive. It is difficult to predict the range of more subtle effects causing injury but not mortality (CSA 2004).

Fish not killed or driven from a location by an explosion might change their behavior, feeding pattern, or distribution. Changes in behavior of fish have been observed as a result of sound produced by explosives, with effect intensified in areas of hard substrate (Wright 1982). Stunning from pressure waves could also temporarily immobilize fish, making them more susceptible to predation.

Table 3.9-5: Estimated Explosive Effects Ranges for Fish with Swim Bladders

Training Operation and Type of Ordnance	Net Explosive Weight (lb.)	Depth of Explosion (ft.)	10% Mortality Range (ft.)		
			1-oz. Fish	1-lb. Fish	30-lb. Fish
Mine Neutralization					
MK 103 Charge	0.002	10	40	28	18
AMNS Charge	3.24	20	366	255	164
20 lb NEW UNDET Charge	20	30	666	464	299
Missile Exercise					
Hellfire	8	3.3	317	221	142
Maverick	100	3.3	643	449	288
Firing Exercise at Sea					
HE Naval Gun Shell, 5-inch	8	1	244	170	109
Bombing Exercise					
MK 20	109.7	3.3	660	460	296
MK 82	192.2	3.3	772	539	346
MK 83	415.8	3.3	959	668	430
MK 84	945	3.3	1,206	841	541

Notes: AMNS = airborne mine neutralization system, HE = high-explosive, NEW = Net Explosive Weight, lb. = pound, ft. = foot/feet, oz. = ounce, UNDET = underwater detonation

The number of fish killed by an underwater explosion would depend on the population density in the vicinity of the blast, as well as factors discussed above such as net explosive weight, depth of the explosion, and fish size. For example, if an explosion occurred in the middle of a dense school of menhaden, herring, or other schooling fish, a large number of fish could be killed. Furthermore, the probability of this occurring is low based on the patchy distribution of dense schooling fish.

Sounds from explosions could cause hearing loss in nearby fish (dependent upon charge size). Permanent hearing loss has not been demonstrated in fish, as lost sensory hair cells can be replaced unlike in mammals. Fish that experience hearing loss could miss opportunities to detect predators or prey, or reduce interspecific communication. If an individual fish were repeatedly exposed to sounds from underwater explosions that caused alterations in natural behavioral patterns or physiological stress, these impacts could lead to long-term consequences for the individual such as reduced survival, growth, or reproductive capacity. However, the time scale of individual explosions is very limited, and training exercises involving explosions are dispersed in space and time. Consequently, repeated exposure of individual fish to sounds from underwater explosions is not likely and most acoustic effects are expected to be short-term and localized. Long-term consequences for populations would not be expected.

Weapons Firing, Launch, and Impact Noise

As described in Chapter 2 (Description of Proposed Action and Alternatives), and Table 2.8-1, training activities under the No Action Alternative include activities that produce in water noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface. Activities are spread throughout the Study Area, and could take place within coastal or open ocean areas. Most activities involving large caliber naval gunfire or the launching of targets, missiles, bombs, or other ordnance are conducted greater than 12 nm from shore.

A detailed description of weapons firing, launch, and impact noise is provided in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise). Noise under the muzzle blast of a 5-inch gun and directly under the flight path of the shell (assuming the shell is a few meters above the water's surface) would produce a peak sound pressure level of approximately 200 dB re 1 µPa near the surface of the water (1–2 m depth). Sound due to missile and target launches is typically at a maximum during initiation of the booster rocket and rapidly fades as the missile or target travels downrange. Many missiles and targets are launched from aircraft, which would produce minimal noise in the water due to the altitude of the aircraft at launch. Mines, non-explosive bombs, and intact missiles and targets could impact the water with great force and produce a large impulse and loud noise of up to approximately 270 dB re 1 µPa at 1 m, but with very short pulse durations, depending on the size, weight, and speed of the object at impact (McLennan 1997). This corresponds to sound exposure levels of around 200 dB re 1 μPa^2-s at 1 m. These sounds from weapons firing launch, and impact noise would be transient and of short duration, lasting no more than a few seconds at any given location.

Fish that are exposed to noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface may exhibit brief behavioral reactions, however due to the short term, transient nature of weapons firing, launch, and non-explosive impact noise, animals are unlikely to be exposed multiple times within a short period. Behavioral reactions would likely be short term (minutes) and substantive costs or long-term consequences for individuals or populations would not be expected.

Pile Driving

Pile driving would occur during the construction and removal phases of the elevated causeway training activities at the SSTC. The training involves the use of an impact hammer to drive the piles into the sediment and a vibratory hammer to later remove the piles. The pile driving locations are adjacent to Navy pier side locations in industrialized waterways that carry a high volume of vessel traffic in addition to Navy vessels using the pier. These coastal areas tend to have high ambient noise levels due to natural and anthropogenic sources present.

The results to date show only the most limited mortality, and then only when fish are very close to an intense sound source. Although there is evidence that fish within a few meters of a pile driving operation would potentially be killed, very limited data suggest that fish further from the source are not killed, and may not be harmed. As a consequence of these limited and unpublished data, it is not possible to know the quantitative effects of pile driving on fish.

Elevated causeway system pile installation and removal within the project area would result in temporary increased underwater noise levels. Underwater sound levels likely to result from unattenuated impact pile driving would be 190 dB re 1 µPa (root mean square), 210 dB re 1 µPa (peak), and 177 dB re 1 μPa^2-sec (sound exposure level) at 10 meters. Underwater sound levels likely to result from vibratory pile driving would be 170 dB re 1 µPa (root mean square) at 10 meters. Since many fish use their swim bladders for buoyancy, they are susceptible to rapid expansion/decompression due to

peak pressure waves from underwater noises (Hastings and Popper 2005a). At a sufficient level this exposure can be fatal. Recently, underwater noise effects criteria for fish were revised and accepted for in-water projects following a multi-agency agreement that included concurrence from National Marine Fisheries Service and the U.S. Fish and Wildlife Service (Fisheries Hydroacoustic Working Group 2008). The underwater noise thresholds for fish for behavioral disturbance and the onset of injury are presented in Table 3.9-6. The Navy evaluated the distance at which pile driving noise would meet or exceed these thresholds, resulting in zones within the water column where behavioral or injurious effects could occur. However, due to the absence of any data from which the density of fish species could be determined, the Navy was unable to calculate the number or percent of the fish population that may be exposed to these effects within each zone. As a result, the remaining analysis presents the distance(s) from the pile at which these criteria or effects would be experience by fish and a qualitative assessment of the impacts that these sounds would have on the behavior and physiology of these animals.

Table 3.9-6: Range of Effects for Fish from Pile Driving

Criteria/ Predicted Effect	Size of Fish	Criteria	Distance of Effect for Impact Hammer (meters)	Distance of Effect for Vibratory Pile Driving (meters)
Onset of Injury	All Fish	206 dB re 1 µPa (peak)	18	n/a
	Fish two grams or greater	187 dB re 1 µPa (rms) (SEL)	2	n/a
	Fish less than two grams	183 dB re 1 µPa (rms) (SEL)	4	n/a
Behavioral impacts[1]	All Fish	150 dB re 1 µPa (rms)	4642	215

[1]Behaviorial criteria was not set forth by the Fisheries Hydroacoustic Working Group, so as a conservative measure, National Oceanic and Atmospheric Administration Fisheries and U.S. Fish and Wildlife Service generally use 150 dB root mean square as the threshold for behavioral effects to ESA-listed fish species (salmon and bull trout) for most biological opinions evaluating pile driving, however there are currently no research or data to support this threshold.

Notes: SEL=sound exposure level, rms=root mean square, n/a = not applicable, dB re 1 µPa = decibel level referenced to one micro Pascal at one meter

Source: Fisheries Hydroacoustic Working Group (2008)

For impact pile driving, the underwater noise threshold criteria for fish injury from a single pile strike occurs at a peak sound pressure level of 206 dB re 1 µPa. This sound level may be exceeded during impact pile driving within a circle centered at the location of the driven pile, out to a distance of approximately 60 ft. (18.3 m).

Alternatively, fish can also be impacted by the cumulative effects of underwater noise from impact pile driving, and the extent of effects is evaluated by calculating the accumulated sound exposure level, based on the number of strikes per day. An impact hammer could be used for up to 200 to 300 impact strikes per pile, with a speed of 30 to 50 strikes per minute. It is expected that any pile driven using an impact hammer would probably require more than one strike. The results of the cumulative noise analysis for this proposed action indicate that the 187 dB and 183 dB accumulated sound exposure level threshold could be exceeded within a circle centered at the location of the driven pile out to a distance of approximately 6.6 ft. (2.01 m), and 13.2 ft. (4.02 m), respectively. The accumulated sound exposure level distance is shorter than the distance to the peak pressure of 206 dB re 1 µ Pa; therefore the fish are likely to be injured from peak pressure before accumulating enough exposure to cause injury. During

impact pile driving, the associated underwater noise levels would result in behavioral responses, including avoidance of the pile driving location, and would have the potential to cause injury.

A vibratory hammer would be used to remove all piles during elevated causeway system training. When using the vibratory driver method, the distances at which the underwater noise thresholds occur (150 dB root mean square) would be reduced to 710 ft. (216.4 m) for behavioral disruption. There are currently no criteria or expected occurrences of injury to fish from vibratory pile driving (Table 3.9-6).

Fish near the pile driving location may display a startle response during initial stages of pile driving, and would likely avoid the immediate area during pile driving activities. However, field investigations in Puget Sound in the state of Washington on salmonid behavior, when occurring near pile driving projects (Feist 1991; Feist et al. 1992), found little evidence that normally nearshore migrating salmonids move further offshore to avoid the general project area. In fact, some studies indicate that construction site behavioral responses, including site avoidance, may be as strongly tied to visual stimuli as well as underwater sound (Feist 1991; Feist et al. 1992; Ruggerone et al. 2008). Any fish which are behaviorally disturbed may change their normal behavior patterns (i.e., swimming speed or direction, foraging habits, etc.) or be temporarily displaced from the area of construction.

The number of fish affected by pile driving would depend on the population density in the vicinity of the location of the activity, as well as factors discussed above such as pile driving method used and fish size. The number of fish potentially killed would not, however, represent significant mortality in terms of the total population of such fish in the Study Area. Furthermore, the probability of this occurring is low based on the patchy distribution of dense schooling fish. Fish density in a given area is inherently dynamic and varies seasonally, daily, and over shorter time frames. Consequently, fish density data are not available for the Study Area and the number of fish affected by pile driving cannot be accurately quantified.

To summarize, a limited number of fish would be killed in the immediate proximity of the pile driving locations. Additional fish would be injured and could subsequently die or suffer greater rates of predation. Beyond the range of injurious effects, there could be short-term impacts such as masking, stress, behavioral changes, and hearing threshold shifts. However, given the relatively small area that would be affected, and the abundance and distribution of the species concerned, no population-level impacts would be expected. When training and testing activities are completed, any fish species disrupted by the exercise should repopulate the area over time. The regional abundance and diversity of fish are unlikely to measurably decrease.

Conclusion

Potential impacts on fish from explosions and impulsive acoustic sources can range from no impact, brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin et al. 1997). Occasional behavioral reactions to intermittent explosions and impulsive acoustic sources are unlikely to cause long-term consequences for individual fish or populations.

Fish that experience hearing loss (permanent or temporary threshold shift) as a result of exposure to explosives and impulsive acoustic sources may have a reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. It is uncertain whether some permanent hearing loss over a part of a fish's hearing range would have long-term consequences for that individual. If this did affect the fitness of a few individuals, it is unlikely to have long-term consequences for the population.

It is possible for fish to be injured or killed by explosives; however, long-term consequences for a loss of a few individuals is unlikely to have measureable effects on overall stocks or populations. Therefore, long-term consequences to fish populations would not be expected.

Steelhead trout, as summarized in Section 3.9.2.3, are anadromous and spend a portion of their lives in both the marine environment as well as in the riverine and estuarine systems from the Kamchatka Peninsula in Asia, east to Alaska, and south to Southern California. Steelhead trout have the potential to be exposed to explosive energy and sound associated with training activities under the No Action Alternative in the coastal areas of the SOCAL Range Complex and SSTC. Since steelhead trout spawn in rivers and the early lifestages of the fish occur in riverine and estuarine environments, eggs and larvae would not be exposed to impulsive acoustic sources produced by explosives, weapons firing, launch, and non-explosive ordnance impact with the water's surface during training activities.

Training activities involving impulsive acoustic sources in the SOCAL Range Complex and SSTC have the possibility to affect steelhead trout, potentially resulting in short-term behavioral or physiological responses, hearing loss, injury, or mortality. However, given the infrequent nature of training activities involving impulsive acoustic sources in the SOCAL Range Complex and SSTC and the rarity of the species, the likelihood of steelhead trout encountering an explosive activity taking place anywhere within the range complex is remote. Effects to designated steelhead trout critical habitat would not occur as activities do not overlap.

Pursuant to the ESA, the use of impulsive acoustic sources for training activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of impulsive acoustic sources under the No Action Alternative during training activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.1.3.2 No Action Alternative – Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-2 and Table 2.8-5, and Section 3.0.5.3.1.2 (Explosives), testing activities under the No Action Alternative would involve underwater detonations and explosive ordnance. No explosive bombs, Improved Extended Echo Ranging sonobuoys, or pile driving are proposed under the No Action Alternative.

Testing activities involving explosives could be conducted throughout the Study Area, although activities do not normally occur within 3 nm of shore except at designated underwater detonation areas (e.g., Puuloa Underwater Range, Barbers Point Underwater Range, Lima Landing, Ewa Training Minefield, Pyramid cove, NW Harbor, Imperial Beach, SSTC). Proposed testing activities under the No Action Alternative that involve explosives and other impulsive sources differ in number and location from training activities under the No Action Alternative, however the types and severity of impacts would not be discernable from those described in Section 3.9.3.1.3.1 (No Action Alternative – Training Activities).

As described in Tables 2.8-2 to 2.8-5, testing activities under the No Action Alternative include activities that produce in water noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface. Activities are spread throughout the Study Area and could take place within coastal or open ocean area. Proposed testing activities under the No Action Alternative that produce in-water noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface differ in

number and location from training activities under the No Action Alternative, however the types and severity of impacts would not be discernable from those described in Section 3.9.3.1.3.1 (No Action Alternative – Training Activities).

Swimmer Defense Airguns

Testing activities under the No Action Alternative would include the use of swimmer defense airguns up to five times per year pierside in San Diego Bay, California as described in Table 2.8-3. See the discussion in Section 3.0.5.3.1.4 (Swimmer Defense Airguns) for details on swimmer defense airguns. Source levels are estimated to be 185 to 195 dB re 1 μPa^2-s at 1 m. For 100 shots, the cumulative sound exposure level would be approximately 215 to 225 dB re 1 μPa^2-s at 1 m.

Single, small airguns (60 in^3) are unlikely to cause direct trauma to marine fish. Impulses from airguns lack the strong shock wave and rapid pressure increase, as would be expected from explosive sources that can cause primary blast injury or barotrauma. As discussed in Section 3.9.3.1.1.1 (Direct Injury), there is little evidence that airguns can cause direct injury to adult fish, with the possible exception of injuring small juvenile or larval fish nearby (approximately 16 ft. [4.9 m]). Therefore, larval and small juvenile fish within a few meters of the airgun may be injured or killed. Considering the small footprint of this hypothesized injury zone, and the isolated and infrequent use of the swimmer defense airgun, population consequences would not be expected.

As discussed in Section 3.9.3.1.1.2 (Hearing Loss), temporary hearing loss in fish could occur if fish were exposed to impulses from swimmer defense airguns, although some studies have shown no hearing loss from exposure to airguns within 16 ft. (4.9 m). Therefore, fish within a few meters of the airgun may receive temporary hearing loss. However, due to the relatively small size of the airgun, and their limited use in pierside areas, impacts would be minor, and may only impact a few individual fish. Population consequences would not be expected.

Airguns do produce broadband sounds; however, the duration of an individual impulse is about one-tenth of a second. Airguns could be fired up to 100 times per activity, but would generally be used less based on the actual testing requirements. The pierside areas where these activities are proposed are inshore, with high levels of use, and therefore have high levels of ambient noise, see Section 3.0.4.5 (Ambient Noise). Auditory masking is discussed in Section 3.9.3.1.1.3 (Auditory Masking), and only occurs when the interfering signal is present. Due to the limited duration of individual shots and the limited number of shots proposed for the swimmer defense airgun, only brief, isolated auditory masking to marine fish would be expected. Population consequences would not be expected.

In addition, fish that are able to detect the airgun impulses may exhibit alterations in natural behavior. As discussed in Section 3.9.3.1.1.4 (Physiological Stress and Behavioral Reactions), some fish species with site fidelity such as reef fish may show initial startle reactions, returning to normal behavioral patterns within a matter of a few minutes. Pelagic and schooling fish that typically show less site fidelity may avoid the immediate area for the duration of the activities. Due to the limited use and relatively small footprint of swimmer defense airguns, impacts to fish are expected to be minor. Population consequences would not be expected.

Conclusion

As discussed for training activities, potential impacts on fish from explosions and impulsive acoustic sources can range from no impact, brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin et al. 1997).

Occasional behavioral reactions to intermittent explosives and impulsive acoustic sources are unlikely to cause long-term consequences for individual fish or populations.

Animals that experience hearing loss (permanent or temporary threshold shift) as a result of exposure to explosions and impulsive acoustic sources may have a reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. It is uncertain whether some permanent hearing loss over a part of a fish's hearing range would have long-term consequences for that individual. If this did affect the fitness of a few individuals, it is unlikely to have long-term consequences for the population.

It is possible for fish to be injured or killed by an explosion; however, long-term consequences for a loss of a few individuals is unlikely to have measureable impacts on overall stocks or populations. Therefore, long-term consequences to fish populations would not be expected.

Underwater explosives, particularly those associated with mine warfare testing that occur in shallow water areas in the SOCAL Range Complex and SSTC, have the possibility to affect steelhead trout. Exposures may result in behavioral responses, hearing loss, physical injury, or death to fish near the activities. However, given the infrequent nature of activities involving underwater explosions in the SOCAL Range Complex and SSTC and the rarity of the species, the likelihood of steelhead trout encountering an explosive activity taking place anywhere within the range complex is remote. Effects to designated steelhead trout critical habitat would not occur as activities do not overlap.

Pursuant to the ESA, the use of impulsive acoustic sources for testing activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of impulsive acoustic sources under the No Action Alternative during testing activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.1.3.3 Alternative 1- Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1, and Section 3.0.5.3.1.2 (Explosives), the number of annual training activities that use explosions under Alternative 1 would increase.

Proposed training activities under Alternative 1 that involve underwater explosives differ in number from training activities proposed under the No Action Alternative; however the locations, types, and severity of impacts would not be discernable from those described in Section 3.9.3.1.3.1 (No Action Alternative – Training Activities).

As discussed for the No Action Alternative, potential impacts on fish from explosions and impulsive sound sources can range from no impact, brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin et al. 1997). Occasional behavioral reactions to intermittent explosives and impulsive acoustic sources are unlikely to cause long-term consequences for individual fish or populations. While serious injury or mortality to individual fish would be expected if they were present in the immediate vicinity of explosive ordnance use, despite the increase in activities under Alternative 1, impacts from at-sea explosives from training activities would be temporary and localized since the activities are infrequent and widely dispersed throughout the Study Area, and the distribution of potentially affected fishes also varies.

Underwater explosives, particularly those associated with mine warfare testing that occur in shallow water areas in the SOCAL Range Complex and SSTC, have the possibility to affect steelhead trout. Exposures may result in behavioral responses, hearing loss, physical injury, or death to fish near the activities. However, given the infrequent nature of activities involving underwater explosives in the SOCAL Range Complex and SSTC and the rarity of the species, the likelihood of steelhead trout encountering an explosive activity taking place anywhere within the range complex is remote. Effects to designated steelhead trout critical habitat would not occur as activities do not overlap.

Pursuant to the ESA, the use of impulsive acoustic sources for training activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of impulsive acoustic sources under Alternative 1 during training activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.1.3.4 Alternative 1 – Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Tables 2.8-2 to 2.8-5, and in Section 3.0.5.3.1.2 (Explosives), the number of annual testing activities that use explosives under Alternative 1 would increase over the No Action Alternative. No explosive bombs, Improved Extended Echo Ranging sonobuoys, or pile driving are proposed under Alternative 1. These activities would occur in the same general locations under Alternative 1 as under the No Action Alternative.

Testing activities involving explosives could be conducted throughout the Study Area, although activities do not normally occur within 3 nm of shore except at designated underwater detonation areas (e.g., Puuloa Underwater Range, Barbers Point Underwater Range, Lima Landing, Ewa Training Minefield, Pyramid cove, NW Harbor, Imperial Beach, SSTC). Proposed testing activities under Alternative 1 that involve explosives and other impulsive sources differ in number and location from training activities under the No Action Alternative, however the types and severity of impacts would not be discernable from those described in Section 3.9.3.1.3.1 (No Action Alternative – Training Activities).

As described in Tables 2.8-2 to 2.8-3, testing activities under Alternative 1 include activities that produce in water noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface. Activities are spread throughout the Study Area and could take place within coastal or open ocean area. Proposed testing activities under Alternative 1 that produce in-water noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface differ in number and location from testing activities under the No Action Alternative, however the types and severity of impacts would not be discernable from those described in Section 3.9.3.1.3.1 (No Action Alternative – Training Activities).

As discussed for training activities, potential impacts on fish from explosives and impulsive acoustic sources can range from no effect, brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin et al. 1997). Occasional behavioral reactions to intermittent explosives and impulsive acoustic sources are unlikely to cause long-term consequences for individual fish or populations. While serious injury or mortality to individual fish would be expected if they were present in the immediate vicinity of explosive ordnance use, impacts from at-sea explosives from testing activities would be temporary and localized since activities are infrequent and widely dispersed throughout the Study Area.

Underwater explosives, particularly those associated with mine warfare testing that occur in shallow water areas in the SOCAL Range Complex and SSTC, have the possibility to affect steelhead trout. Exposures may result in behavioral responses, hearing loss, physical injury, or death to fish near the activities. However, given the infrequent nature of activities involving underwater explosives in the SOCAL Range Complex and SSTC and the rarity of the species, the likelihood of steelhead trout encountering an explosive activity taking place anywhere within the range complex is remote. Effects to designated steelhead trout critical habitat would not occur as activities do not overlap.

Pursuant to the ESA, the use of impulsive acoustic sources for testing activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed steelhead trout

The use of impulsive acoustic sources under Alternative 1 during testing activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.1.3.5 Alternative 2 – Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1, and Section 3.0.5.3.1.2 (Explosives), the total number of explosive bombs, missiles, rockets, gun rounds, underwater explosives, and Improved Extended Echo Ranging sonobuoys proposed under Alternative 2 to be expended during training activities in the Study Area would be the same as Alternative 1.

As discussed for the No Action Alternative, potential impacts on fish from explosives and impulsive acoustic sources can range from no effect, brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin et al. 1997). Occasional behavioral reactions to intermittent explosions and impulsive acoustic sources are unlikely to cause long-term consequences for individual fish or populations. While serious injury or mortality to individual fish would be expected if they were present in the immediate vicinity of explosive ordnance use, impacts from at-sea explosion from training activities would be temporary and localized since the activities are infrequent and widely dispersed throughout the Study Area, and the distribution of potentially affected fishes also varies.

Underwater explosives, particularly those associated with mine warfare testing that occur in shallow water areas in the SOCAL Range Complex and SSTC, have the possibility to affect steelhead trout. Exposures may result in behavioral responses, hearing loss, physical injury, or death to fish near the activities. However, given the infrequent nature of activities involving underwater explosives in the SOCAL Range Complex and SSTC and the rarity of the species, the likelihood of steelhead trout encountering an explosive activity taking place anywhere within the range complex is remote. Effects to designated steelhead trout critical habitat would not occur as activities do not overlap.

Pursuant to the ESA, the use of impulsive acoustic for training activities under Alternative 2 may affect, but is not likely to adversely affect ESA-listed steelhead trout

The use of impulsive acoustic sources under Alternative 2 during training activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.1.3.6 Alternative 2 – Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Tables 2.8-2 to 2.8-3, and in Section 3.0.5.3.1.2 (Explosives), the number of annual testing activities that use explosions under Alternative 2 would increase over the No Action Alternative. These activities would happen in the same general locations under Alternative 2 as under the No Action Alternative.

Testing activities involving explosives could be conducted throughout the Study Area, although activities do not normally occur within 3 nm of shore except at designated underwater detonation areas (e.g., Puuloa Underwater Range, Barbers Point Underwater Range, Lima Landing, Ewa Training Minefield, Pyramid cove, NW Harbor, Imperial Beach, SSTC). Proposed testing activities under Alternative 2 that involve explosives and other impulsive sources differ in number and location from training activities under the No Action Alternative, however the types and severity of impacts would not be discernable from those described in Section 3.9.3.1.3.1 (No Action Alternative – Training Activities).

As described in Tables 2.8-2 to 2.8-3, testing activities under Alternative 2 include activities that produce in water noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface. Activities are spread throughout the Study Area and could take place within coastal or open ocean area. Proposed testing activities under Alternative 2 that produce in-water noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface differ in number and location from training activities under the No Action Alternative, however the types and severity of impacts would not be discernable from those described in Section 3.9.3.1.3.1 (No Action Alternative – Training Activities).

As discussed for training activities, potential impacts on fish from explosives and impulsive acoustic sources can range from no effect, brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin et al. 1997). Occasional behavioral reactions to intermittent explosions and impulsive acoustic are unlikely to cause long-term consequences for individual fish or populations. While serious injury or mortality to individual fish would be expected if they were present in the immediate vicinity of explosive ordnance use, impacts from at-sea explosives from testing activities would be temporary and localized since activities are infrequent and widely dispersed throughout the Study Area, and the distribution of potentially affected fishes also varies.

Underwater explosives, particularly those associated with mine warfare testing that occur in shallow water areas in the SOCAL Range Complex and SSTC, have the possibility to affect steelhead trout. Exposures may result in behavioral responses, hearing loss, physical injury, or death to fish near the activities. However, given the infrequent nature of activities involving underwater explosives in the SOCAL Range Complex and SSTC and the rarity of the species, the likelihood of steelhead trout encountering an explosive activity taking place anywhere within the range complex is remote. Effects to designated steelhead trout critical habitat would not occur as activities do not overlap.

Pursuant to the ESA, the use of impulsive acoustic sources for testing activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout .

The use of impulsive acoustic sources under Alternative 2 during testing activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.1.3.7 Summary of Effects to Marine Fish from Acoustic Stressors

Under the No Action Alternative, Alternative 1 or Alternative 2, potential impacts on fish from acoustic and explosive stressors can range from no impact brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin et al. 1997). Occasional behavioral reactions to intermittent explosives and impulsive acoustic sources are unlikely to cause long-term consequences for individual fish or populations. While serious injury or mortality to individual fish would be expected if they were present in the immediate vicinity of explosive ordnance use, impacts from acoustic and explosive stressors would be temporary and localized since the activities are infrequent and widely dispersed throughout the Study Area, and the distribution of potentially affected fishes also varies.

Pursuant to the ESA, the use of acoustic stressors under the No Action Alternative, Alternative 1, or Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

Acoustic stressors under the No Action Alternative, Alternative 1, or Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.2 Energy Stressors

This section analyzes the potential impacts of energy stressors that can occur during training and testing activities within the Study Area, and for HSTT only includes potential impacts from electromagnetic devices.

3.9.3.2.1 Impacts from Electromagnetic Devices

Several different electromagnetic devices are used during training and testing activities. A discussion of the type, number, and location of activities using these devices under each alternative is presented in Section 3.0.5.3.2.1 (Electromagnetic Devices).

A comprehensive review of information regarding the sensitivity of marine organisms to electric and magnetic impulses, including fishes comprising the subclass elasmobranchii (sharks, skates, and rays; hereafter referred to as elasmobranchs), as well as other bony fishes, is presented in Normandeau (2011). The synthesis of available data and information contained in this report suggests that while many fish species (particularly elasmobranchs) are sensitive to electromagnetic fields, further investigation is necessary to understand the physiological response and magnitude of the potential effects. Most examinations of electromagnetic fields on marine fishes have focused on buried undersea cables associated with offshore wind farms in European waters (Boehlert and Gill 2010; Gill 2005; Ohman et al. 2007).

Many fish groups including lamprey, elasmobranchs, eels, salmonids, stargazers, and others, have an acute sensitivity to electrical fields, known as electroreception (Bullock et al. 1983; Helfman et al. 2009b). Electroreceptors are thought to aid in navigation, orientation, and migration of sharks and rays (Kalmijn 2000). In elasmobranchs, behavioral and physiological response to electromagnetic stimulus varies by species and age, and appears to be related to foraging behavior (Rigg et al. 2009). Many elasmobranchs respond physiologically to electric fields of 10 nanovolts (nV) per cm and behaviorally at 5 nV per cm (Collin and Whitehead 2004). Electroreceptive marine fishes with ampullary (pouch) organs can detect considerably higher frequencies of 50 hertz (Hz) to more than 2 kilohertz (kHz) (Helfman et al. 2009b). The distribution of electroreceptors on the head of these fishes, especially around the mouth

suggests that these sensory organs may be used in foraging. Additionally, some researchers hypothesize that the electroreceptors aid in social communication (Collin and Whitehead 2004). The ampullae of some fishes are sensitive to low frequencies (< 0.1–25 Hz) of electrical energy (Helfman et al. 2009b), which may be of physical or biological origin, such as muscle contractions. For example, the ampullae of the shovelnose sturgeon (*Scaphirhynchus platorynchus*), were shown to respond to electromagnetic stimuli in a way comparable to the well-studied elasmobranchs, which are sensitive to electric fields as low as 1 microvolt (µV) per cm with a magnetic field of 100 gauss (Bleckmann and Zelick 2009).

While elasmobranchs and other fishes can sense the level of the earth's electromagnetic field, the potential effects on fish resulting from changes in the strength or orientation of the background field are not well understood. When the electromagnetic field is enhanced or altered, sensitive fishes may experience an interruption or disturbance in normal sensory perception. Research on the electrosensitivity of sharks indicates that some species respond to electrical impulses with an apparent avoidance reaction (Helfman et al. 2009b; Kalmijn 2000). This avoidance response has been exploited as a shark deterrent, to repel sharks from areas of overlap with human activity (Marcotte and Lowe 2008).

Experiments with electromagnetic pulses can provide indirect evidence of the range of sensitivity of fishes to similar stimuli. Two studies reported that exposure to electromagnetic pulses do not have any effect on fishes (Hartwell et al. 1991; Nemeth and Hocutt 1990). The observed 48-hour mortality of small estuarine fishes (sheepshead minnow, mummichog, Atlantic menhaden, striped bass, Atlantic silverside, fourspine stickleback, and rainwater killifish) exposed to electromagnetic pulses of 100 to 200 kilovolts (kV) per m (10 nanoseconds per pulse) from distances greater than 164 ft. (50 m) was not statistically different than the control group (Hartwell et al. 1991; Nemeth and Hocutt 1990). During a study of Atlantic menhaden, there were no statistical differences in swimming speed and direction (toward or away from the electromagnetic pulse source), between a group of individuals exposed to electromagnetic pulses and the control group (Hartwell et al. 1991; Nemeth and Hocutt 1990).

Both laboratory and field studies confirm that elasmobranchs (and some teleost [bony] fishes) are sensitive to electromagnetic fields, but the long-term impacts are not well-known. Electromagnetic sensitivity in some marine fishes (e.g., salmonids) is already well-developed at early life stages (Ohman et al. 2007), with sensitivities reported as low as 0.6 millivolt per centimeter (mV/cm) in Atlantic salmon (Formicki et al. 2004); however, most of the limited research that has occurred focuses on adults. Some species appear to be attracted to undersea cables, while others show avoidance (Ohman et al. 2007). Under controlled laboratory conditions, the scalloped hammerhead (*Sphyrna lewini*) and sandbar shark (*Carcharhinus plumbeus*) exhibited altered swimming and feeding behaviors in response to very weak electric fields (less than 1 nV per cm) (Kajiura and Holland 2002). In a test of sensitivity to fixed magnets, five Pacific sharks were shown to react to magnetic field strengths of 25 to 234 gauss at distances ranging between 0.85 and 1.90 ft. (0.26 and 0.58 m) and avoid the area (Rigg et al. 2009). A field trial in the Florida Keys demonstrated that southern stingray (*Dasyatis americana*) and nurse shark (*Ginglymostoma cirratum*) detected and avoided a fixed magnetic field producing a flux of 950 gauss (O'Connell et al. 2010).

Potential impacts of electromagnetic activity on adult fishes may not be relevant to early life stages (eggs, larvae, juveniles) due to ontogenic (lifestage-based) shifts in habitat utilization (Botsford et al. 2009; Sabates et al. 2007). Some skates and rays produce egg cases that occur on the bottom, while many neonate and adult sharks occur in the water column or near the water surface. Other species may have an opposite life history, with egg and larval stages occurring near the water surface, while adults may be demersal.

Based on current literature, only the fish groups identified above as capable of detecting electromagnetic fields (primarily elasmobranchs, salmonids, tuna, eels, and stargazers) will be carried forward in this analysis and the remaining taxonomic groups (from Table 3.9-2) will not be discussed further.

3.9.3.2.1.1 No Action Alternative, Alternative 1, and Alternative 2 – Training Activities

Table 3.0-18 lists the number and location of activities that include the use of electromagnetic devices, which are similar under all Alternatives, with discountable increases under Alternatives 1 and 2. As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), training activities involving electromagnetic devices occur in the Hawaii and SOCAL Range Complexes, and SSTC. Exposure of fishes to electromagnetic stressors is limited to those fish groups identified in Section 3.9.2.4 to 3.9.2.22 (Marine Fish Groups) that are able to detect the electromagnetic properties in the water column (Bullock et al. 1983; Helfman et al. 2009b). Species that do occur within the areas listed above, including the ESA-listed steelhead trout would have the potential to be exposed to the electromagnetic fields.

Electromagnetic devices are used primarily during mine detection/neutralization activities, and in most cases, the devices simply mimics the electromagnetic signature of a vessel passing through the water. None of the devices include any type of electromagnetic "pulse." The towed body used for mine sweeping is designed to simulate a ship's electromagnetic signal in the water, and so would not be experienced by fishes as anything unusual. The static magnetic field generated by the electromagnetic systems is of relatively minute strength, typically 23 gauss at the cable surface and 0.002 gauss at a radius of 656 ft. (199.9 m). The strength of the electromagnetic field decreases quickly away from the cable down to the level of earth's magnetic field (0.5 gauss) at less than 13 ft. (3.9 m) from the source (Department of Navy 2005a). In addition, training activities generally occur offshore in the water column, where fishes with high mobility predominate and fish densities are relatively low, compared with nearshore benthic habitat. Because the towed body is continuously moving, most fishes are expected to move away from it or follow behind it, in ways similar to responses to a vessel.

For any electromagnetically sensitive fishes in close proximity to the source, the generation of electromagnetic fields during training activities has the potential to interfere with prey detection and navigation. They may also experience temporary disturbance of normal sensory perception or could experience avoidance reactions (Kalmijn 2000), resulting in alterations of behavior and avoidance of normal foraging areas or migration routes. Mortality from electromagnetic devices is not expected.

Therefore, the electromagnetic devices used would not cause any potential risk to fishes because (1) the range of impact (i.e., greater than earth's magnetic field) is small (i.e., 13 ft. [3.9 m] from the source); (2) the electromagnetic components of these activities are limited to simulating the electromagnetic signature of a vessel as it passes through the water; and (3) the electromagnetic signal is temporally variable and would cover only a small spatial range during each activity in the Study Area. Some fishes could have a detectable response to electromagnetic exposure, but any impacts would be temporary with no anticipated impact on an individual's growth, survival, annual reproductive success, or lifetime reproductive success (i.e., fitness). Fitness refers to changes in an individual's growth, survival, annual reproductive success, or lifetime reproductive success. Electromagnetic exposure of eggs and larvae of sensitive bony fishes would be low relative to their total ichthyoplankton biomass (Able and Fahay 1998) and; therefore, potential impacts on recruitment would not be expected.

The only ESA-listed fish species capable of detecting electromagnetic energy occurring in the area where electromagnetic training activities are planned is the steelhead trout. Steelhead trout generally occur in

shallow nearshore and coastal waters, and therefore could encounter electromagnetic devices used in training activities in the SOCAL Range Complex and SSTC. Other locations of electromagnetic training activities include offshore areas that do not overlap with the normal distribution of this species. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, none of the electromagnetic stressors would affect steelhead trout critical habitat. If located in the immediate area where electromagnetic devices are being used, steelhead trout could experience temporary disturbance in normal sensory perception during migratory or foraging movements, or avoidance reactions (Kalmijn 2000), but any disturbance would be inconsequential.

Pursuant to the ESA, the use of electromagnetic devices during training activities under the No Action Alternative, Alternative 1, and Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of electromagnetic devices during training activities under the No Action Alternative, Alternative 1, and Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.2.1.2 No Action Alternative– Testing Activities

Table 3.0-18 lists the number and location of activities that include the use of electromagnetic devices. As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), testing activities involving electromagnetic devices occur only in the SOCAL Range Complex.

The electromagnetic devices used in testing activities would not cause any potential risk to fishes for the same reasons stated for training activities above.

Pursuant to the ESA, use of electromagnetic devices during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

Electromagnetic activities under the No Action Alternative would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.2.1.3 Alternative 1 – Testing Activities

Table 3.0-18 lists the number and location of activities that include the use of electromagnetic devices. As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), testing activities involving electromagnetic devices occur only in the SOCAL Range Complex.

Under Alternative 1, a total of 27 electromagnetic testing activities are planned (an increase of 12 activities per year over the No Action Alternative). The increase in number of testing activities under Alternative 1 would not increase the potential for impact on fishes within the Study Area, for reasons described in Section 3.9.3.2.1.1 (No Action Alternative – Training Activities).

Pursuant to the ESA, the use of electromagnetic devices during testing activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

Electromagnetic activities under Alternative 1 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.2.1.4 Alternative 2 - Testing Activities

Table 3.0-18 lists the number and location of activities that include the use of electromagnetic devices. As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 2, testing activities involving electromagnetic devices occur only in the SOCAL Range Complex.

Under Alternative 2, a total of 31 electromagnetic testing activities are planned (an increase of 16 activities per year over the No Action Alternative). The increase in number of testing activities under Alternative 2 would not increase the potential for impact on fishes within the Study Area, for reasons described in Section 3.9.3.2.1.1 (No Action Alternative – Training Activities).

Pursuant to the ESA, the use of electromagnetic devices during testing activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

Electromagnetic activities under Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.2.2 Summary and Conclusions of Energy Impacts

Under the No Action Alternative, Alternative 1 or Alternative 2, disturbance from activities involving the use of electromagnetic devices could be expected to elicit brief behavioral or physiological responses only in those exposed fishes with sensitivities/detection abilities (primarily sharks and rays) within the corresponding portion of the electromagnetic spectrum that these activities use. For electromagnetic devices, the typical reaction would be for the fish to avoid (move away from) the signal upon detection. The impact of electromagnetic signals are expected to be inconsequential on fishes or fish populations because signals are similar to regular vessel traffic, and the electromagnetic signal would be continuously moving and cover only a small spatial area during use.

Pursuant to the ESA, energy stressors under the No Action Alternative, Alternative 1, or Alternative 2 may affect, but are not likely to adversely affect, ESA-listed steelhead trout.

Energy stressors under the No Action Alternative, Alternative 1, or Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3 Physical Disturbance and Strike Stressors

This section evaluates the potential effects of various types of physical disturbance and strike stressors used by Navy during training and testing activities within the Study Area. A list of these activities is presented in Table 3.0-7.

Physical disturbance and strike stressors from vessels and in-water devices, military expended materials, and seafloor devices have the potential to affect all marine fish groups found within the Study Area (Tables 3.9-1 and 3.9-2), although some fish groups are more susceptible to strike potential than others. The potential responses to physical strikes are varied, but include behavioral changes such as avoidance,

altered swimming speed and direction, physiological stress, and physical injury or mortality. Despite their ability to detect approaching vessels using a combination of sensory cues (sight, hearing, lateral line), larger slow-moving fishes (e.g., ocean sunfish, basking sharks, manta rays) cannot avoid all collisions, with some collisions resulting in mortality (Speed et al. 2008).

How a physical strike impacts a fish depends on the relative size of the object potentially striking the fish and the location of the fish in the water column. Before being struck by an object, Atlantic salmon for example, would sense a pressure wave through the water (Hawkins and Johnstone 1978a) and have the ability to swim away from the oncoming object. The movement generated by a large object moving through the water would simply displace small fishes in open water, such as Atlantic herring. Some fish might have time to detect the approaching object and swim away; others could be struck before they become aware of the object. An open-ocean fish that is displaced a small distance by movements from an object falling into the water nearby would likely continue on its original path as if nothing had happened. However, a bottom-dwelling fish near a sinking object would likely be disturbed, and may exhibit a general stress response, as described in Section 3.0.5.7 (Biological Resource Methods). As in all vertebrates, the function of the stress response in fishes is to rapidly raise the blood sugar level to prepare the fish to flee or fight (Helfman et al. 2009b). This generally adaptive physiological response can become a liability to the fish if the stressor persists and the fish is not able to return to its baseline physiological state. When stressors are chronic, the fish may experience reduced growth, health, or survival (Wedemeyer et al. 1990). If the object hits the fish, direct injury (in addition to stress) or death may result.

Many fishes respond to a sudden physical approach or contact by darting quickly away from the stimulus. Some other species may respond by freezing in place and adopting cryptic coloration. Some other species may respond in an unpredictable manner. Regardless of the response, the individual must stop its current activity and divert its physiological and cognitive attention to responding to the stressor (Helfman et al. 2009b). The energy costs of reacting to a stressor depend on the specific situation, but in all cases the caloric requirements of stress reactions reduce the amount of energy available to the fish for other functions, such as predator avoidance, reproduction, growth, and maintenance (Wedemeyer et al. 1990).

The ability of a fish to return to its previous activity following a physical strike (or near-miss resulting in a stress response) is a function of a variety of factors. Some fish species are more tolerant of stressors than others and become re-acclimated more easily. Experiments with species for use in aquaculture have revealed the immense variability among species in their tolerance to physical stressors. Within a species, the rate at which an individual recovers from a physical strike may be influenced by its age, sex, reproductive state, and general condition. A fish that has reacted to a sudden disturbance by swimming at burst speed would tire after only a few minutes; its blood hormone and sugar levels (cortisol and glucose) may not return to normal for up to, or longer than, 24 hours. During its recovery period, the fish would not be able to attain burst speeds and would be more vulnerable to predators (Wardle 1986). If the individual were not able to regain a steady state following exposure to a physical stressor, it may suffer reduced immune function and even death (Wedemeyer et al. 1990).

Potential impacts of physical disturbance or strike to adults may be different than for other life stages (eggs, larvae, juveniles) because these life stages do not necessarily occur together in the same location (Botsford et al. 2009; Sabates et al. 2007), and because they have different response capabilities. The numbers of eggs and larvae exposed to vessel movements would be low relative to total ichthyoplankton biomass (Able and Fahay 1998); therefore, measurable effects on fish recruitment

would not be expected. Also, the early life stages of most marine fishes (excluding sharks and other livebearers) already have extremely high natural mortality rates (10 to 85 percent per day) from predation on these life stages (Helfman et al. 2009b), and therefore, most eggs and larvae are not expected to survive to the next life stage, as demonstrated by equivalent adult modeling (Horst 1977).

3.9.3.3.1 Impacts from Vessels and In-Water Devices

The majority of the activities under all alternatives involve vessels, and a few of the activities involve the use of in-water devices. For a discussion of the types of activities that use vessels and in-water devices, where they are used, and how many activities would occur under each Alternative, see Section 3.0.5.3.3 (Physical Disturbance and Strike Stressors). See Table 3.0-19 for a representative list of Navy vessel sizes and speeds and Table 3.0-31 for the types, sizes, and speeds of Navy in-water devices used in the Study Area. Vessels and in-water devices are covered together in this section because they both present similar potential impacts to fishes.

Vessels and in-water devices do not normally collide with adult fish, most of which can detect and avoid them. One study on fishes' behavioral responses to vessels showed that most adults exhibit avoidance responses to engine noise, sonar, depth finders, and fish finders (Jørgensen et al. 2004), reducing the potential for vessel strikes. Misund (1997b) found that fishes ahead of a ship that showed avoidance reactions did so at ranges of 160 to 490 ft. (48.8 to 149.4 m). When the vessel passed over them, some fishes responded with sudden escape responses that included lateral avoidance or downward compression of the school. Conversely, Rostad (2006) observed that some fishes are attracted to different types of vessels (e.g., research vessels, commercial vessels) of varying sizes, noise levels, and habitat locations. Fish behavior in the vicinity of a vessel is therefore quite variable, depending on the type of fish, its life history stage, behavior, time of day, and the sound propagation characteristics of the water (Schwarz 1985). Early life stages of most fishes could be displaced by vessels and not struck in the same manner as adults of larger species. However, a vessel's propeller movement or propeller wash could entrain early life stages. The low-frequency sounds of large vessels or accelerating small vessels caused avoidance responses among herring (Chapman and Hawkins 1973a), but avoidance ended within 10 seconds (s) after the vessel departed. Because a towed in-water device is continuously moving, most fishes are expected to move away from it or to follow behind it, in a manner similar to their responses to a vessel. When the device is removed, most fishes would simply move to another area.

There are a few notable exceptions to this assessment of potential vessel strike impacts on marine fish groups. Large slow-moving fish such as ocean sunfish, whale sharks, basking sharks, and manta rays occur near the surface in open-ocean and coastal areas, and are more susceptible to ship strikes, causing blunt trauma, lacerations, fin damage, or mortality. Speed et al. (2008) evaluated this specifically for whale sharks, but these other large slow-moving fishes are also likely to be susceptible because of their similar behavior and location in the water column. Increases in the numbers and sizes of shipping vessels in the modern cargo fleets make it difficult to gather mortality data because personnel on large ships are often unaware of whale shark collisions (Stevens 2007), therefore, the occurrence of whale shark strikes is likely much higher than has been documented by the few studies that have been conducted. The results of a whale shark study outside of the Study Area in the Gulf of Tadjoura, Djibouti, revealed that of the 23 whale sharks observed during a five-day period, 65 percent had scarring from boat and propeller strikes (Rowat et al. 2007a). Based on the typical physiological responses described in Section 3.9.3.3, vessel movements are not expected to compromise the general health or condition of individual fishes, except for whale sharks, basking sharks, manta rays, and ocean sunfish.

3.9.3.3.1.1 No Action Alternative, Alternative 1 and Alternative 2 – Training Activities

Exposure of fishes to vessel strike stressors is limited to those fish groups identified in Section 3.9.2.4 to 3.9.2.22 (Marine Fish Groups) that are large, slow-moving, and may occur near the surface, such as ocean sunfish, whale sharks, basking sharks, and manta rays. These species are distributed widely in offshore and nearshore portions of the Study Area. Any isolated cases of a Navy vessel striking an individual could injure that individual, impacting the fitness of an individual fish, but not to the extent that the viability of populations would be impacted. Vessel strikes would not pose a risk to most of the other marine fish groups, because many fish can detect and avoid vessel movements, making strikes rare and allowing the fish to return to their normal behavior after the ship or device passes. As a vessel approaches a fish, they could have a detectable behavioral or physiological response (e.g., swimming away and increased heart rate) as the passing vessel displaces them. However, such reactions are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of these marine fish groups at the population level.

As indicated in Sections 3.0.5.3.3.1 (Vessels) and 3.0.5.3.3.2 (In-Water Devices), training activities involving in-water devices can occur anywhere in the Study Area. Navy vessel activity primarily occurs within the U.S. Exclusive Economic Zone, and certain portions of the Study Area, such as areas near ports or naval installations and training ranges (e.g., San Diego, SSTC, San Clemente Island, Pearl Harbor) are used more heavily by vessels than other portions of the Study Area. These activities do not differ seasonally and could be widely dispersed throughout the Study Area. The differences in the number of in-water device activities between alternatives increases by less than 2 percent under Alternative 1 and Alternative 2 compared to the No Action Alternative. Species that do not occur near the surface within the Study Area would not be exposed to in-water device strike potential. Species that occur near the surface within the Study Area—including the ESA-listed steelhead trout—would have the potential to be exposed to in-water device strikes.

Operational features of in-water devices and their use substantially limit the exposure of fish to potential strikes. First, in-water devices would not pose any strike risk to benthic fishes because the towed equipment is designed to stay off the bottom. Prior to deploying a towed in-water device, there is a standard operating procedure to search the intended path of the device for any floating debris (i.e., driftwood) or other potential obstructions, since they have the potential to cause damage to the device.

The likelihood of strikes by towed mine warfare devices on adult fish, which could result in injury or mortality, would be extremely low because these life stages are highly mobile. The use of in-water devices may result in short-term and local displacement of fishes in the water column. However, these behavioral reactions are not expected to result in substantial changes to an individual's fitness, or species recruitment, and are not expected to result in population-level impacts. Ichthyoplankton (fish eggs and larvae) in the water column could be displaced, injured, or killed by towed mine warfare devices. The numbers of eggs and larvae exposed to vessels or in-water devices would be extremely low relative to total ichthyoplankton biomass (Able and Fahay 1998); therefore, measurable changes on fish recruitment would not occur.

The risk of a strike from vessels and in-water devices used in training activities would be extremely low because: 1) most fish can detect and avoid vessel and in-water device movements, and (2) the types of fish that are likely to be exposed to vessel and in-water device strike are limited and occur in low concentrations where vessels and in-water devices are used. Potential impacts from exposure to vessels and in-water devices are not expected to result in substantial changes to an individual's behavior, fitness, or species recruitment, and are not expected to result in population-level impacts. Since impacts

from strikes would be rare, and although any increase in vessel and in-water device use proposed under Alternatives 1 and 2 could potentially increase the probability of a strike, impacts on fish or fish populations would be negligible.

Based on the primarily nearshore distribution of steelhead trout and overlap of vessel and in-water device use, potential strike risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. Similar to other salmon species, steelhead trout can sense pressure changes in the water column and swim quickly (Baum 1997; Popper and Hastings 2009a), and are likely to escape collision with vessels and in-water devices. However, since vessels and in-water devices could overlap with steelhead trout, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, vessel and in-water device use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of vessels and in-water devices during training activities under the No Action Alternative, Alternative 1, and Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of vessels and in-water devices under the No Action Alternative, Alternative 1, and Alternative 2 during training activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3.1.2 Testing Activities

As indicated in Sections 3.0.5.3.3.1 (Vessel Strikes) and 3.0.5.3.3.2 (In-Water Devices), testing activities involving vessels and in-water devices can occur anywhere in the Study Area.

As discussed for training activities, the risk of a strike from vessels and in-water devices used in testing activities would be extremely low because: (1) most fish can detect and avoid vessel and in-water device movements, and (2) the types of fish that are likely to be exposed to vessel and in-water device strike are limited and occur in low concentrations where vessels and in-water devices are used. Potential impacts of exposure to vessels and in-water devices are not expected to result in substantial changes to an individual's behavior, fitness, or species recruitment, and are not expected to result in population-level impacts. Since impacts from strikes would be rare, and although any increase in vessel and in-water device use proposed under Alternatives 1 and 2 could potentially increase the probability of a strike, for the reasons stated above for the No Action Alternative, impacts on fish or fish populations would be negligible.

Based on the primarily nearshore distribution of steelhead trout and overlap of vessel and in-water device use, potential strike risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. Similar to other salmon species, steelhead trout can sense pressure changes in the water column and swim quickly (Baum 1997; Popper and Hastings 2009a), and are likely to escape collision with vessels and in-water devices. However, since vessels and in-water devices could overlap with steelhead trout, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, vessel and in-water device use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of vessels and in-water devices during testing activities under the No Action Alternative, Alternative 1, and Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of vessels and in-water devices under the No Action Alternative, Alternative 1, and Alternative 2 during testing activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3.2 Impacts from Military Expended Materials

Navy training and testing activities in the Study Area include firing a variety of weapons and employing a variety of explosive and non-explosive rounds including bombs, and small-, medium-, and large-caliber projectiles, or even entire ship hulks during a sinking exercise. During these training and testing activities, various items may be introduced and expended into the marine environment and are referred to as military expended materials.

This section analyzes the strike potential to marine fish of the following categories of military expended materials: (1) non-explosive practice munitions, (2) fragments from high-explosive munitions, and (3) expended materials other than ordnance, such as sonobuoys, vessel hulks, and expendable targets. For a discussion of the types of activities that use military expended materials, where they are used, and how many activities would occur under each alternative, see Section 3.0.5.3.3.3 (Military Expended Materials).

While disturbance or strike from any of these objects as they sink through the water column is possible, it is not very likely for most expended materials because the objects generally sink through the water slowly and can be avoided by most fishes. Therefore, with the exception of sinking exercises, the discussion of military expended materials strikes focuses on strikes at the surface or in the upper water column from fragments (of high-explosives) and projectiles because those items have a greater potential for a fish strike as they hit the water, before slowing down as they move through the water column.

Vessel Hulk. During a sinking exercise, aircraft, ship, and submarine crews deliver ordnance on a seaborne target, usually a clean deactivated ship (Section 3.1, Water and Sediment Quality), which is deliberately sunk using multiple weapon systems. Sinking exercises occur in specific open ocean areas, outside of the coastal range complexes, in waters exceeding 6,000 ft. (1,830 m) in depth. Direct ordnance strikes from the various weapons used in these exercises are a source of potential impact. However, these impacts are discussed for each of those weapons categories in this section and are not repeated here. Therefore, the analysis of sinking exercises as a strike potential for benthic fishes is discussed in terms of the ship hulk landing on the seafloor.

Small-, Medium-, and Large-Caliber Projectiles. Various types of projectiles could cause a temporary (seconds), localized impact when they strike the surface of the water. Current Navy training and testing in the Study Area, such as gunnery exercises, include firing a variety of weapons and using a variety of non-explosive training and testing rounds, including 5 in. (12.7 centimeters [cm]) naval gun shells, torpedoes, and small-, medium-, and large-caliber projectiles. See Table 3.0-65 for information regarding the number and location of activities involving small- and medium-caliber non-explosive practice munitions. The larger-caliber projectiles are primarily used in the open ocean beyond 20 nm. Direct ordnance strikes from firing weapons are potential stressors to fishes. There is a remote possibility that an individual fish at or near the surface may be struck directly if it is at the point of impact at the time of non-explosive ordnance delivery. Expended rounds may strike the water surface with sufficient force to

cause injury or mortality. However, limited fish species swim right at, or near, the surface of the water (e.g., with the exception of pelagic sharks, herring, salmonids, flying fishes, jacks, tuna, mackerels, billfishes, ocean sunfishes, and other similar species.

Various projectiles would fall on soft or hard bottom habitats, where they could either become buried immediately in the sediments, or sit on the bottom for an extended time period (See Figures 3.3-1 through 3.3-6). Except for the 5 in. (12.7 cm) and the 30 mm rounds, which are fired from a helicopter, all projectiles would be aimed at surface targets. These targets would absorb most of the projectiles' energy before they strike the surface of the water and sink. This factor would limit the possibility of high-velocity impacts with fish from the rounds entering the water. Furthermore, fish can quickly and easily leave an area temporarily when vessels or helicopters approach. It is reasonable to assume, therefore, that fish would leave an area prior to, or just after the onset of, projectile firing and would return once tests are completed.

Most ordnance would sink through the water column and come to rest on the seafloor, stirring up sediment and possibly inducing a startle response, displacing, or injuring nearby fishes in extremely rare cases. Particular impacts on a given fish species would depend on the size and speed of the ordnance, the water depth, the number of rounds delivered, the frequency of training and testing, and the sensitivity of the fish.

Bombs, Missiles, and Rockets. Direct ordnance strikes from bombs, missiles, and rockets are potential stressors to fishes. Some individual fish at or near the surface may be struck directly if they are at the point of impact at the time of non-explosive ordnance delivery. However, most missiles hit their target or are disabled before hitting the water. Thus, most of these missiles and aerial targets hit the water as fragments, which quickly dissipates their kinetic energy within a short distance of the surface. A limited number of fishes swim right at, or near, the surface of the water, as described for small-, medium-, and large-caliber projectiles.

As discussed in Appendix I, statistical modeling conducted for the Study Area indicates that the probability of military expended materials striking marine mammals is extremely low. Statistical modeling could not be conducted to estimate the probability of military expended material strikes on fish, because fish density data are not available at the scale of an OPAREA or testing range.

In lieu of strike probability modeling, the number, size, and area of potential impact (or "footprints") of each type of military expended material is presented in Tables 3.3-5 through 3.3-7. The application of this type of footprint analysis to fish follows the notion that a fish occupying the impact area could be susceptible to potential impacts, either at the water surface (e.g., pelagic sharks, salmonids, flying fishes, jacks, tuna, mackerels, billfishes, and ocean sunfishes [Table 3.9-2]) or as military expended material falls through the water column and settles to the bottom (e.g., flounders, skates, and other benthic fishes listed in Table 3.9-2). Furthermore, most of the projectiles fired during training and testing activities are fired at targets, and most projectiles hit those targets, so only a very small portion of those would hit the water with their maximum velocity and force. Of that small portion, a small number of fish at or near the surface (pelagic fishes) or near the bottom (benthic fishes) may be directly impacted if they are in the target area and near the expended item that hits the water surface (or bottom), but population-level effects would not occur.

Propelled fragments are produced by an exploding bomb. Close to the explosion, fishes could potentially sustain injury or death from propelled fragments (Stuhmiller et al. 1990). However, studies of

underwater bomb blasts have shown that fragments are larger than those produced during air blasts and decelerate much more rapidly (O'Keefe and Young 1984; Swisdak Jr. and Montaro 1992), reducing the risk to marine organisms.

Fish disturbance or strike could result from bomb fragments (after explosion) falling through the water column in very small areas compared to the vast expanse of the testing ranges, OPAREAs, range complexes, or the Study Area. The expected reaction of fishes exposed to this stressor would be to immediately leave the area where bombing is occurring, thereby reducing the probability of a fish strike after the initial expended materials hit the water surface. When a disturbance of this type concludes, the area would be repopulated and the fish stock would rebound with inconsequential impacts on the resource (Lundquist et al. 2010).

3.9.3.3.2.1 No Action Alternative – Training Activities

Tables 3.0-65 to 3.0-67 list the number and location of military expended materials, most of which are small- and medium caliber projectiles. As indicated in Section 3.0.5.3.3.3 (Military Expended Materials), under the No Action Alternative, military expended material use can occur throughout the Study Area.

Marine fish groups identified in Section 3.9.2.4 to 3.9.2.22 (Marine Fish Groups) that are particularly susceptible to military expended material strikes are those occurring at the surface, within the offshore and continental shelf portions of the range complexes (where the strike would occur). Those groups include pelagic sharks, salmonids, flying fishes, jacks, tuna, mackerels, billfishes, ocean sunfishes, and other similar species (Table 3.9-2). Additionally, certain deep-sea fishes would be exposed to strike risk as a ship hulk, expended during a sinking exercise, settles to the seafloor. These groups include hagfishes, dragonfishes, lanternfishes, anglerfishes, and oarfishes.

Projectiles, bombs, missiles, rockets, projectiles and associated fragments have the potential to directly strike fish as they hit the water surface and below the surface to the point where the projectile loses its forward momentum. Fish at and just below the surface would be most susceptible to injury from strikes because velocity of these materials would rapidly decrease upon contact with the water and as it travels through the water column. Consequently, most water column fishes would have ample time to detect and avoid approaching munitions or fragments as they fall through the water column. The probability of strike based on the “footprint” analysis included in Table 3.3-5 indicates that even for an extreme case of expending all small-caliber projectiles within a single gunnery box, the probability of any of these items striking a fish (even as large as bluefin tuna or whale sharks) is extremely low. Therefore, since most fishes are smaller than bluefin tuna or whale sharks, and most military expended materials are less abundant than small-caliber projectiles, the risk of strike by these items is exceedingly low for fish overall. A possibility exists that a small number of fish at or near the surface may be directly impacted if they are in the target area and near the point of physical impact at the time of military expended material strike, but population-level impacts would not occur.

Sinking exercises occur in open-ocean areas, outside of the coastal range complexes. While serious injury or mortality to individual fish would be expected if they were present within range of high explosive activities (analyzed in Section 3.9.3.1, Acoustic Stressors), sinking exercises under the No Action Alternative would not result in impacts on pelagic fish populations at the surface based on the low number of fish in the immediate area and the placement of these activities in deep, ocean areas where fish abundance is low or widely dispersed. Disturbances to benthic fishes from sinking exercises would be highly localized. Any deep sea fishes located on the bottom where a ship hulk would settle could experience displacement, injury, or death. However, population level impacts on the deep sea fish

community would not occur because of the limited spatial extent of the impact and the wide dispersal of fishes in deep ocean areas.

The impact of military expended material strikes would be inconsequential due to the (1) limited number of species found directly at the surface where military expended material strikes could occur; (2), the rare chance that a fish might be directly struck at the surface by military expended materials, and; (3) the ability of most fish to detect and avoid an object falling through the water below the surface. The potential impacts of military expended material strikes would be short term and localized disturbances of the water column (and seafloor areas within sinking exercise locations).

Based on the primarily nearshore distribution of steelhead trout and overlap of military expended materials use, potential strike risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. While military expended materials use could overlap with steelhead trout, the likelihood of a strike would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, military expended materials use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of military expended materials during training activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

Military expended material strikes during training activities under the No Action Alternative would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3.2.2 Testing Activities

Tables 3.0-65 to 3.0-67 list the number and location of military expended materials, most of which are small- and medium-caliber projectiles. As indicated in Section 3.0.5.3.3.3 (Military Expended Materials), under the No Action Alternative, military expended material use can occur throughout the Study Area.

The potential impacts of military expended material strikes would be short term and localized disturbances of the water surface and seafloor areas and would be inconsequential for the same reasons stated under the analysis under the No Action Alternative for training activities.

Based on the primarily nearshore distribution of steelhead trout and overlap of military expended materials use, potential strike risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. While military expended materials use could overlap with steelhead trout, the likelihood of a strike would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, military expended materials use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of military expended materials during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

Military expended material strikes during testing activities under the No Action Alternative would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3.2.3 Alternative 1 – Training Activities

Tables 3.0-65 to 3.0-67 list the number and location of military expended materials, most of which are small- and medium-caliber projectiles. As indicated in Section 3.0.5.3.3.3 (Military Expended Materials), under Alternative 1, military expended material use can occur throughout the Study Area.

Compared to the No Action Alternative, the overall increase in military expended materials used under Alternative 1 is due primarily to a large increase in small-caliber projectiles, and a relatively smaller increase in the number of medium-caliber projectiles. These changes would result in increased exposure of fish to military expended materials; however, the probability of strike based on the "footprint" analysis included in Table 3.3-6 indicates that even for an extreme case of expending all small-caliber projectiles within a single gunnery box, the probability of any of these items striking a fish (even as large as bluefin tuna or whale sharks) is extremely low. The potential impacts of military expended material strikes would be short term and localized disturbances of the water surface (and seafloor areas within sinking exercise locations) and would be inconsequential for the same reasons stated under the analysis under the No Action Alternative for training activities.

Based on the primarily nearshore distribution of steelhead trout and overlap of military expended materials use, potential strike risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. While military expended materials use could overlap with steelhead trout, the likelihood of a strike would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, military expended materials use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of military expended materials during training activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

Military expended material strikes during training activities under Alternative 1 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3.2.4 Testing Activities

Tables 3.0-65 to 3.0-67 list the number and location of military expended materials, most of which are small- and medium-caliber projectiles. As indicated in Section 3.0.5.3.3.3 (Military Expended Materials), under Alternative 1, military expended material use can occur throughout the Study Area.

Compared to the No Action Alternative, the overall increase in military expended materials used under Alternative 1 is due primarily to a large increase in small-caliber projectiles, and a relatively smaller increase in the number of medium-caliber projectiles. These changes would result in increased exposure of fish to military expended materials; however, the probability of strike based on the "footprint" analysis included in Table 3.3-6 indicates that even for an extreme case of expending all small-caliber projectiles within a single gunnery box, the probability of any of these items striking a fish (even as large as bluefin tuna or whale sharks) is extremely low. The potential impacts of military expended material

strikes would be short term and localized disturbances of the water surface (and seafloor areas within sinking exercise locations) and would be inconsequential for the same reasons stated under the analysis under the No Action Alternative for training activities.

Based on the primarily nearshore distribution of steelhead trout and overlap of military expended materials use, potential strike risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. While military expended materials use could overlap with steelhead trout, the likelihood of a strike would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, military expended materials use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of military expended materials during testing activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

Military expended material strikes during training activities under Alternative 1 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3.2.5 Alternative 2 – Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative would also be identical as described in Section 3.9.3.3.2.2 (Alternative 1).

Pursuant to the ESA, the use of military expended materials during training activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

Military expended material strikes during training activities under Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3.2.6 Alternative 2 – Testing Activities

Tables 3.0-65 to 3.0-67 list the number and location of military expended materials, most of which are small- and medium-caliber projectiles. As indicated in Section 3.0.5.3.3.3 (Military Expended Materials), under Alternative 2, military expended material use can occur throughout the Study Area.

Compared to the No Action Alternative, the overall increase in military expended materials used under Alternative 2 is due primarily to a large increase in small-caliber projectiles, and a relatively smaller increase in the number of medium-caliber projectiles. These changes would result in increased exposure of fish to military expended materials; however, the probability of strike based on the “footprint” analysis included in Table 3.3-7 indicates that even for an extreme case of expending all small-caliber projectiles within a single gunnery box, the probability of any of these items striking a fish (even as large as bluefin tuna or whale sharks) is extremely low. The potential impacts of military expended material strikes would be short term and localized disturbances of the water surface (and seafloor areas within sinking exercise locations) and would be inconsequential for the same reasons stated under the analysis under the No Action Alternative for training activities.

Based on the primarily nearshore distribution of steelhead trout and overlap of military expended materials use, potential strike risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. While military expended materials use could overlap with steelhead trout, the likelihood of a strike would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, military expended materials use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of military expended materials during testing activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

Military expended material strikes during training activities under Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3.3 Impacts from Seafloor Devices

For a discussion of the types of activities that use seafloor devices, where they are used, and how many activities would occur under each alternative, see Section 3.0.5.3.3.4 (Seafloor Devices). Seafloor devices include items that are placed on, dropped on, or moved along the seafloor such as mine shapes, anchor blocks, anchors, bottom-placed instruments, bottom-crawling unmanned undersea vehicles, and bottom-placed targets that are not expended. As discussed in the military expended materials strike section, objects falling through the water column would slow in velocity as they sink toward the bottom and could be avoided by most fish.

Seafloor devices with a strike potential for fish include those items temporarily deployed on the seafloor. The potential strike impacts of unmanned underwater vehicles, including bottom crawling types, are also included here. Entanglement in seafloor cables is discussed in Section 3.9.3.4 (Entanglement Stressors). Some fishes are attracted to virtually any tethered object in the water column for food or refuge (Dempster and Taquet 2004) and could be attracted to an inert mine assembly. However, while a fish might be attracted to the object, their sensory abilities allow them to avoid colliding with fixed tethered objects in the water column (Bleckmann and Zelick 2009), so the likelihood of a fish striking one of these objects is implausible. Therefore, strike hazards associated with collision into other seafloor devices such as deployed mine shapes or anchored devices are highly unlikely to pose any strike hazard to fishes and are not discussed further.

3.9.3.3.3.1 No Action Alternative – Training Activities

Table 3.0-70 lists the number and location of activities that use seafloor devices. As indicated in Section 3.0.5.3.3.4 (Seafloor Devices), under the No Action Alternative, activities that use seafloor devices occur in the SSTC, Hawaii, and SOCAL Range Complexes.

Seafloor devices have the potential to directly strike fish as they hit the water surface and below the surface to the point where the projectile strikes the bottom. Fish at and just below the surface, as well as those on the bottom would be most susceptible to injury from strikes because velocity of these materials would rapidly decrease upon contact with the water and as it travels through the water column. Consequently, most water column fishes would have ample time to detect and avoid approaching devices as they fall through the water column. A possibility exists that a small number of fish at or near the surface or resting on the bottom may be directly impacted if they are in the target

area and near the point of physical impact at the time of seafloor device strike, but the likelihood of one of these objects striking a fish is implausible and in the rare event that a strike occurred, population-level impacts would not occur.

Based on the primarily nearshore distribution of steelhead trout and overlap of seafloor device use, potential strike risk would be greatest in the coastal areas of the SOCAL Range Complex. While seafloor device use could overlap with steelhead trout, the likelihood of a strike would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, seafloor device use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of seafloor devices during training activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of seafloor devices during training activities under the No Action Alternative would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3.3.2 No Action Alternative – Testing Activities

Table 3.0-70 lists the number and location of activities that use seafloor devices. As indicated in Section 3.0.5.3.3.4 (Seafloor Devices), under the No Action Alternative, testing activities that use seafloor devices occur only in the SOCAL Range Complex.

Seafloor devices have the potential to directly strike fish as they hit the water surface and below the surface to the point where the projectile strikes the bottom. Fish at and just below the surface, as well as those on the bottom would be most susceptible to injury from strikes because velocity of these materials would rapidly decrease upon contact with the water and as it travels through the water column. Consequently, most water column fishes would have ample time to detect and avoid approaching devices as they fall through the water column. A possibility exists that a small number of fish at or near the surface or resting on the bottom may be directly impacted if they are in the target area and near the point of physical impact at the time of seafloor device strike, but the likelihood of one of these objects striking a fish is implausible and in the rare event that a strike occurred, population-level impacts would not occur.

Based on the primarily nearshore distribution of steelhead trout and overlap of seafloor device use, potential strike risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. While seafloor device use could overlap with steelhead trout, the likelihood of a strike would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, seafloor device use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of seafloor devices during testing activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of seafloor devices during testing activities under the No Action Alternative would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3.3.3 Alternative 1 – Training Activities

Training activities that deploy seafloor devices under Alternative 1 would occur in the same geographic areas as under the No Action Alternative, Section 3.9.3.3.3.1 (No Action Alternative), and are expected to decrease by approximately 7 percent.

Similar to the No Action Alternative, a possibility exists that a small number of fish at or near the surface or resting on the bottom may be directly impacted if they are in the target area and near the point of physical impact at the time of seafloor device strike, but the likelihood of one of these objects striking a fish is implausible and in the rare event that a strike occurred, population-level impacts would not occur.

Based on the primarily nearshore distribution of steelhead trout and overlap of seafloor device use, potential strike risk would be greatest in the coastal areas of the SOCAL Range Complex. While seafloor device use could overlap with steelhead trout, the likelihood of a strike would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, seafloor device use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of seafloor devices during training activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of seafloor devices during training activities under Alternative 1 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3.3.4 Alternative 1 – Testing Activities

Table 3.0-70 lists the number and location of activities that use seafloor devices. As indicated in Section 3.0.5.3.3.4 (Seafloor Devices), under Alternative 1, the number of activities using seafloor devices is approximately twice that of the No Action Alternative. The activities using seafloor devices under Alternative 1 would occur in the same geographic location as the No Action Alternative. In addition, seafloor devices would be used in the Hawaii Range Complex. As discussed in Section 3.9.3.3.2 (Impacts from Military Expended Materials Strike), and similar to the No Action Alternative, a possibility exists that a small number of fish at or near the surface or resting on the bottom may be directly impacted if they are in the target area and near the point of physical impact at the time of seafloor device strike, but the likelihood of one of these objects striking a fish is implausible and in the rare event that a strike occurred, population-level impacts would not occur.

Based on the primarily nearshore distribution of steelhead trout and overlap of seafloor device use, potential strike risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. While seafloor device use could overlap with steelhead trout, the likelihood of a strike would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites,

and migration corridors), and are outside the Study Area. Therefore, seafloor device use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of seafloor devices during testing activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of seafloor devices during testing activities under Alternative 1 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3.3.5 Alternative 2 – Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative would also be identical as described in Section 3.9.3.3.3.2, Alternative 1.

Pursuant to the ESA, the use of seafloor devices during training activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of seafloor devices during training activities under Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3.3.6 Alternative 2 – Testing Activities

Table 3.0-70 lists the number and location where seafloor devices are used. As indicated in Section 3.0.5.3.3.4 (Seafloor Devices), under Alternative 2, the number of activities using seafloor devices is approximately twice that of the No Action Alternative. The activities using seafloor devices under Alternative 2 would occur in the same geographic location as the No Action Alternative. In addition, seafloor devices would be used in the Hawaii Range Complex. As discussed in Section 3.9.3.3.2 (Impacts from Military Expended Materials Strike), and similar to the No Action Alternative and Alternative 1, a possibility exists that a small number of fish at or near the surface or resting on the bottom may be directly impacted if they are in the target area and near the point of physical impact at the time of seafloor device strike, but the likelihood of one of these objects striking a fish is implausible and in the rare event that a strike occurred, population-level impacts would not occur.

Based on the primarily nearshore distribution of steelhead trout and overlap of seafloor device use, potential strike risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. While seafloor device use could overlap with steelhead trout, the likelihood of a strike would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, seafloor device use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of seafloor devices during testing activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of seafloor devices during testing activities under Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.3.4 Summary and Conclusions of Physical Disturbance and Strike Impacts

The greatest potential for combined impacts of physical disturbance and strike stressors under the Proposed Action, would occur for sinking exercises because of multiple opportunities for potential strike by vessel, ordnance, or other military expended material. Under the Proposed Action, no more than eight sinking exercises would occur per year. Sinking exercises were specifically chosen to evaluate impacts on military expended material strike because sinking exercises represent the activity with the greatest amount of military expended materials by weight. During each sinking exercise, approximately 725 objects would be expended, including large bombs, missiles, large projectiles, torpedoes, and one target vessel. Therefore, during each sinking exercise, approximately 105 objects per km^2 would sink to the ocean floor. These items, combined with the mass and size of the ship hulk itself, are representative of an extreme case for military expended materials of all types striking benthic fishes. However, the overlap of these activities would only occur during a limited number of activities and only within the open ocean areas where the sinking exercises areas are located.

A less intensive example of potential impacts of combined strike stressors would be for cases where a fish could be displaced by a vessel in the water column during any number of activities utilizing bombs, missiles, rockets, or projectiles. As the vessel maneuvers during the exercise, any fishes displaced by that vessel movement could potentially be struck by munitions expended by that vessel during that same exercise. This would be more likely to occur in concentrated areas of this type of activity (e.g., a gunnery exercise inside a gunnery box). However, the likelihood of this occurring is probably quite low anywhere else, because most activities do not expend their munitions towards, or in proximity to, a training or testing vessel for safety reasons. While small-caliber projectiles are expended away from but often close to the vessel from which the projectiles are fired, this does not necessarily increase the risk of strike. During the initial displacement of the fish from vessel activity, or after the first several projectiles are fired, most fishes would disperse widely and the probability of strike may actually be reduced in most cases. Also, the combination of these stressors would cease immediately when the activity ends; therefore, combination is possible but not reasonably foreseeable.

3.9.3.3.5 Summary of Physical Disturbance and Strike Stressors and General Conclusions

Exposures to physical disturbance and strike stressors occur primarily within the range complexes and operating areas associated with the Study Area. Research suggests that only a limited number of marine fish species are susceptible to being struck by a vessel. Most fishes would not respond to vessel disturbance beyond a temporary displacement from their normal activity, which would be inconsequential and not detectable. The Navy identified and analyzed three physical disturbance or strike substressors that have potential to impact fishes: vessel and in-water device strikes, military expended material strikes, and seafloor device strikes. While the potential for vessel strikes on fish can occur anywhere vessels are operated, most fishes are highly mobile and capable of avoiding vessels, expended materials, or objects in the water column. For the larger slower-moving species (e.g., basking shark, manta ray, and ocean sunfish) the potential for a vessel or military expended material strike increases, as discussed in the analysis. The potential for a seafloor device striking a fish is very low because the sensory capabilities of most fishes allow them to detect and avoid underwater objects.

Pursuant to the ESA, physical disturbance and strikes under the No Action Alternative, Alternative 1, or Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

Physical disturbance and strikes under the No Action Alternative, Alternative 1, or Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.4 Entanglement Stressors

This section evaluates potential entanglement impacts of various types of expended materials used by the Navy during training and testing activities within the Study Area. The likelihood of fish being affected by an entanglement stressor is a function of the physical properties, location, and buoyancy of the object and the behavior of the fish as described in Section 3.0.5.7.4 (Conceptual Framework for Assessing Effects from Entanglement). Two types of military expended materials are considered here: (1) fiber optic cables and guidance wires, and (2) parachutes.

Most entanglement observations involve abandoned or discarded nets, lines, and other materials that form loops or incorporate rings (Derraik 2002; Keller et al. 2010; Laist 1987; Macfadyen et al. 2009). A 25-year dataset assembled by the Ocean Conservancy reported that fishing line, rope, and fishing nets accounted for approximately 68 percent of fish entanglements, with the remainder due to encounters with various items such as bottles, cans, and plastic bags (Ocean Conservancy 2010). No occurrences involving military expended materials were documented.

Fish entanglement occurs most frequently at or just below the surface or in the water column where objects are suspended. A smaller number involve objects on the seafloor, particularly abandoned fishing gear designed to catch bottom fish or invertebrates (Ocean Conservancy 2010). More fish species are entangled in coastal waters and the continental shelf than elsewhere in the marine environment because of higher concentrations of human activity (e.g., fishing, sources of entangling debris), higher fish abundances, and greater species diversity (Helfman et al. 2009b; Macfadyen et al. 2009). The consequences of entanglement range from temporary and inconsequential to major physiological stress or mortality.

Some fish are more susceptible to entanglement in derelict fishing gear and other marine debris, compared to other fish groups. Physical features, such as rigid or protruding snouts of some elasmobranchs (e.g., the wide heads of hammerhead sharks), increase the risk of entanglement compared to fish with smoother, more streamlined bodies (e.g., lamprey and eels). Most other fish, except for jawless fish and eels that are too smooth and slippery to become entangled, are susceptible to entanglement gear specifically designed for that purpose (e.g., gillnets); however, the Navy does not expend any items that are designed to function as entanglement objects.

The overall effects of entanglement are highly variable, ranging from temporary disorientation to mortality due to predation or physical injury. The evaluation of a species' entanglement potential should consider the size, location, and buoyancy of an object as well as the behavior of the fish species.

The following sections seek to identify entanglement potential due to military expended material. Where appropriate, specific geographic areas (open ocean areas, range complexes, testing ranges, and bays and inland waters) of potential impact are identified.

3.9.3.4.1 Impacts from Fiber Optic Cables and Guidance Wires

Fiber optic cables and guidance wires are used during training and testing activities. A discussion of the types of activities, physical characteristics, location of use, and the number of items expended under each alternative is presented in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires).

Marine fish groups identified in Sections 3.9.2 (Affected Environment), that could be susceptible to entanglement in expended cables and wires are those with elongated snouts lined with tooth-like structures that easily snag on other similar marine debris, such as derelict fishing gear (Macfadyen et al. 2009). Some elasmobranchs (hammerhead sharks) and billfish occurring within the offshore and continental shelf portions of the range complexes (where the potential for entanglement would occur) could be susceptible to entanglement in cables and wires. Species occurring outside the specified areas within these range complexes would not be exposed to fiber optic cables or guidance wires.

Once a guidance wire is released, it is likely to sink immediately and remain on the seafloor. In some cases, the wire may snag on a hard structure near the bottom and remain partially or completely suspended. The types of fish that encounter any given wire would depend, in part, on its geographic location and vertical location in the water column. In any situation, the most likely mechanism for entanglement would involve fish swimming through loops in the wire that tighten around it; however, loops are unlikely to form in guidance wire (Environmental Sciences Group 2005).

Because of their physical characteristics, guidance wires and fiber optic cables pose a potential, though unlikely, entanglement risk to susceptible fish. Potential entanglement scenarios are based on fish behavior in abandoned monofilament, nylon, and polypropylene lines used in commercial nets. Such derelict fishing gear is abundant in the ocean (Macfadyen et al. 2009) and pose a greater hazard to fish than the very thin wire expended by the Navy. Fishing gear materials often have breaking strengths that can be up to orders of magnitude greater than that of guidance wire and fiber optic cables (Environmental Sciences Group 2005), and are far more prone to tangling, as discussed in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires). Fiber optic cables do not easily form loops, are brittle, and break easily if bent, so they pose a negligible entanglement risk. Additionally, the encounter rate and probability of impact from guidance wires and fiber optic cables are low, as few are expended.

3.9.3.4.1.1 No Action Alternative – Training Activities

Tables 3.0-80 and 3.0-83 list the number and locations of activities that expend fiber optic cables and guidance wires. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under the No Action Alternative, activities that expend fiber optic cables occur in the SOCAL Range Complex and the SSTC, while expended guidance wires would occur in the Hawaii and SOCAL Range Complexes. While individual fish susceptible to entanglement could encounter guidance wires and cables, the long-term consequences of entanglement are unlikely for either individuals or populations because: (1) the encounter rate is low given the low number of items expended, (2) the types of fish that are susceptible to these items is limited, (3) the restricted overlap with susceptible fish, and (4) the properties of guidance wires and fiber optic cables reduce entanglement risk to fish. Potential impacts from exposure to guidance wires and fiber optic cables are not expected to result in substantial changes to an individual's behavior, fitness, or species recruitment, and are not expected to result in population-level impacts.

Expended torpedo guidance wire would not co-occur with the distribution and habitat of steelhead trout. The sink rates of these guidance wires would rule out the possibility of it drifting great distances

into nearshore and coastal areas where steelhead trout are found, or into designated river or estuarine critical habitat.

Pursuant to the ESA, the use of fiber optic cables and guidance wires for training activities under the No Action Alternative would have no effect on ESA-listed steelhead trout.

The use of fiber optic cables and guidance wires for training activities under the No Action Alternative would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.4.1.2 No Action Alternative - Testing Activities

Tables 3.0-80 and 3.0-83 list the number and locations of activities that expend fiber optic cables and guidance wires. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under the No Action Alternative, activities that expend fiber optic cables occur only in the SOCAL Range Complex, while expended guidance wires would occur in the Hawaii and SOCAL Range Complexes. Risk of entanglement resulting from proposed testing activities would be low as described in the analysis for the No Action Alternative – Training Activities; therefore, testing activities are not expected to result in substantial changes to an individual's behavior, fitness, or species recruitment, and are not expected to result in population-level impacts.

Pursuant to the ESA, the use of fiber optic cables and guidance wires for testing activities under the No Action Alternative would have no effect on ESA-listed steelhead trout.

The use of fiber optic cables and guidance wires for testing activities under the No Action Alternative would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.4.1.3 Alternative 1 – Training Activities

Tables 3.0-80 and 3.0-83 list the number and locations of activities that expend fiber optic cables and guidance wires. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under Alternative 1, activities that expend fiber optic cables occur in the SOCAL Range Complex and the SSTC, while expended guidance wires would occur in the Hawaii and SOCAL Range Complexes. Despite the slight increase from the No Action Alternative, the risk of entanglement resulting from proposed training activities would be low as described in the analysis for the No Action Alternative – Training Activities; therefore, training activities are not expected to result in substantial changes to an individual's behavior, fitness, or species recruitment, and are not expected to result in population-level impacts.

Pursuant to the ESA, the use of fiber optic cables and guidance wires for training activities under Alternative 1 would have no effect on ESA-listed steelhead trout.

The use of fiber optic cables and guidance wires for training activities under Alternative 1 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.4.1.4 Alternative 1 – Testing Activities

Tables 3.0-80 and 3.0-83 list the number and locations of activities that expend fiber optic cables and guidance wires. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under Alternative 1, activities that expend fiber optic cables occur only in the SOCAL Range Complex, while

expended guidance wires would occur in the Hawaii and SOCAL Range Complexes. Despite the approximately 20 percent increase from the No Action Alternative, the risk of entanglement resulting from proposed testing activities would be low as described in the analysis for the No Action Alternative – Training Activities; therefore, testing activities are not expected to result in substantial changes to an individual's behavior, fitness, or species recruitment, and are not expected to result in population-level impacts.

Pursuant to the ESA, the use of fiber optic cables and guidance wires for testing activities under Alternative 1 would have no effect on ESA-listed steelhead trout.

The use of fiber optic cables and guidance wires for testing activities under Alternative 1 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.4.1.5 Alternative 2 – Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative would also be identical as described in Section 3.9.3.4.1.2 (Alternative 1 – Training). Despite the slight increase from the No Action Alternative, the risk of entanglement resulting from proposed training activities would be low as described in the analysis for the No Action Alternative – Training Activities; therefore, training activities are not expected to result in substantial changes to an individual's behavior, fitness, or species recruitment, and are not expected to result in population-level impacts.

Pursuant to the ESA, the use of fiber optic cables and guidance wires for training activities under Alternative 2 would have no effect on ESA-listed steelhead trout.

The use of fiber optic cables and guidance wires for training activities under Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.4.1.6 Alternative 2 – Testing Activities

Tables 3.0-80 and 3.0-83 list the number and locations of activities that expend fiber optic cables and guidance wires. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under Alternative 2, activities that expend fiber optic cables occur only in the SOCAL Range Complex, while expended guidance wires would occur in the Hawaii and SOCAL Range Complexes. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires) under Alternative 2, the number of activities that expend fiber optic cables is nearly the same as that of the No Action Alternative. The activities using fiber optic cables under Alternative 2 would occur in the same geographic locations as the No Action Alternative. The number of torpedo activities that expend guidance wire is nearly two times that of the No Action Alternative. These activities under Alternative 2 would occur in the same geographic locations as the No Action Alternative. Despite the increase from the No Action Alternative, the risk of entanglement resulting from proposed testing activities would be low as described in the analysis for the No Action Alternative – Training Activities; therefore, testing activities are not expected to result in substantial changes to an individual's behavior, fitness, or species recruitment, and are not expected to result in population-level impacts.

Pursuant to the ESA, the use of fiber optic cables and guidance wires for testing activities under Alternative 2 would have no effect on ESA-listed steelhead trout.

The use of fiber optic cables and guidance wires for testing activities under Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.4.2 Impacts from Parachutes

Parachutes of varying sizes are used during training and testing activities. The types of activities that use parachutes, physical characteristics and size of parachutes, locations where parachutes are used, and the number of parachute activities proposed under each alternative are presented in Section 3.0.5.3.4.2 (Parachutes).

Fish face many potential entanglement scenarios in abandoned monofilament, nylon, polypropylene line, and other derelict fishing gear in the nearshore and offshore marine habitats of the Study Area (Macfadyen et al. 2009; Ocean Conservancy 2010). Abandoned fishing gear is dangerous to fish because it is abundant, essentially invisible, strong, and easily tangled. In contrast, parachutes are rare, highly visible, and not designed to capture fish. The combination of low encounter rates and weak entangling features reduce the risk that steelhead trout would be adversely impacted by parachutes.

Once a parachute has been released to the water, it poses a potential entanglement risk to fish. The Naval Ocean Systems Center identified the potential impacts of torpedo air launch accessories, including parachutes, on fish (U.S. Department of the Navy 1996). Unlike other materials in which fish become entangled (such as gill nets and nylon fishing line), the parachute is relatively large and visible, reducing the chance that visually oriented fish would accidentally become entangled in it. No cases of fish entanglement have been reported for parachutes (Ocean Conservancy 2010,U.S. Department of the Navy 2001a). Entanglement in a newly-expended parachute while it is in the water column is unlikely because fish generally react to sound and motion at the surface with a behavioral reaction by swimming away from the source (see Section 3.9.3.3.2, Impacts from Military Expended Material Strikes) and would detect the oncoming parachute in time to avoid contact. While the parachute is sinking, fish would have ample opportunity to swim away from the large moving object. Even if the parachute landed directly on a fish, it would likely be able to swim away faster than the parachute would sink because the resistance of the water would slow the parachute's downward motion.

Once the parachute is on the bottom, however, it is feasible that a fish could become entangled in the parachute or its suspension lines while diving and feeding, especially in deeper waters where it is dark. If the parachute dropped in an area of strong bottom currents, it could billow open and pose a short-term entanglement threat to large fish feeding on the bottom. Benthic fish with elongated spines could become caught on the parachute or lines. Most sharks and other smooth-bodied fish are not expected to become entangled because their soft, streamlined bodies can more easily slip through potential snares. A fish with spines or protrusions (e.g., some sharks, billfish, sturgeon, or sawfish) on its body that swam into the parachute or a loop in the lines, and then struggled, could become bound tightly enough to prevent escape. Although this scenario is possible based on the structure of the materials and the shape and behavior of fish, it is not considered a likely event.

Aerial-launched sonobuoys are deployed with a parachute. The sonobuoy itself is not considered an entanglement hazard for upon deployment (Environmental Sciences Group 2005), but their components may pose an entanglement hazard once released into the ocean. Sonobuoys contain cords, electronic components, and plastic mesh that may entangle fish (Environmental Sciences Group 2005). Open-ocean filter feeding species, such as basking sharks, whale sharks, and manta rays could become entangled in these items, whereas smaller species could become entangled in the plastic mesh in the

same manner as a small gillnet. Since most sonobuoys are expended in offshore areas, many coastal fish would not encounter or have any opportunity to become entangled in materials associated with sonobuoys, apart from the risk of entanglement in parachutes described above.

3.9.3.4.2.1 No Action Alternative – Training Activities

Table 3.0-84 lists the number and locations of activities that expend parachutes. The number and footprint of parachutes are detailed in Table 3.3-5 (Marine Habitats). As indicated in Section 3.0.5.3.4.2 (Parachutes) under the No Action Alternative, activities involving parachute use would occur in the open ocean portions of the Study Area. Given the size of the range complexes and the resulting widely scattered parachutes (0.12 per nm^2), it would be very unlikely that fishes would encounter and become entangled in any parachutes or sonobuoy accessories. If a fish were to encounter and become entangled in any of these items, the growth, survival, annual reproductive success, or lifetime reproductive success of populations would not be impacted directly or indirectly.

Expended parachutes generally would not co-occur with the distribution and critical habitat of steelhead trout. However, if an expended parachute were encountered, the steelhead trout, like all salmonids, is a strong swimmer with a streamlined body that is unlikely to become entangled in parachutes or lines, but there would be the potential for effect.

Pursuant to the ESA, the use of parachutes for training activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of parachutes for training activities under the No Action Alternative would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.4.2.2 No Action Alternative – Testing Activities

Table 3.0-84 lists the number and locations of activities that expend parachutes. The number and footprint of parachutes are detailed in Table 3.3-5. As indicated in Section 3.0.5.3.4.2 (Parachutes) under the No Action Alternative, activities involving parachute use would occur in the open ocean portions of the Hawaii and SOCAL Range Complexes. Given the size of the range complexes and the resulting widely scattered parachutes (0.02 per nm^2), it would be very unlikely that fishes would encounter and become entangled in any parachutes or sonobuoy accessories. If a fish were to encounter and become entangled in any of these items, the growth, survival, annual reproductive success, or lifetime reproductive success of populations would not be impacted directly or indirectly.

Expended parachutes generally would not co-occur with the distribution and critical habitat of steelhead trout. However, if an expended parachute were encountered, the steelhead trout, like all salmonids, is a strong swimmer with a streamlined body that is unlikely to become entangled in parachutes or lines, but there would be the potential for effect.

Pursuant to the ESA, the use of parachutes for testing activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of parachutes for testing activities under the No Action Alternative would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.4.2.3 Alternative 1 – Training Activities

Table 3.0-84 lists the number and locations of activities that expend parachutes. The number and footprint of parachutes are detailed in Table 3.3-6. As indicated in Section 3.0.5.3.4.2 (Parachutes) under Alternative 1, activities involving parachute use would occur in the open ocean portions of the Study Area. Given the size of the range complexes and the resulting widely scattered parachutes (0.14 per nm^2), it would be very unlikely that fishes would encounter and become entangled in any parachutes or sonobuoy accessories. If a fish were to encounter and become entangled in any of these items, the growth, survival, annual reproductive success, or lifetime reproductive success of populations would not be impacted directly or indirectly.

Expended parachutes generally would not co-occur with the distribution and critical habitat of steelhead trout. However, if an expended parachute were encountered, the steelhead trout, like all salmonids, is a strong swimmer with a streamlined body that is unlikely to become entangled in parachutes or lines, but there would be the potential for effect.

Pursuant to the ESA, the use of parachutes for training activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of parachutes for training activities under Alternative 1 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.4.2.4 Alternative 1 – Testing Activities

Table 3.0-84 lists the number and locations of activities that expend parachutes. The number and footprint of parachutes are detailed in Table 3.3-6. As indicated in Section 3.0.5.3.4.2, (Parachutes) under Alternative 1, activities involving parachute use would occur in the open ocean portions of the Hawaii and SOCAL Range Complexes, with the number of activities involving the use of parachutes being approximately two times that of the No Action Alternative. The activities using parachutes under Alternative 1 would occur in the same geographic locations as the No Action Alternative. Given the size of the range complexes and the resulting widely scattered parachutes (0.03 per nm^2), it would be very unlikely that fishes would encounter and become entangled in any parachutes or sonobuoy accessories. If a fish were to encounter and become entangled in any of these items, the growth, survival, annual reproductive success, or lifetime reproductive success of populations would not be impacted directly or indirectly.

Expended parachutes generally would not co-occur with the distribution and critical habitat of steelhead trout. However, if an expended parachute were encountered, the steelhead trout, like all salmonids, is a strong swimmer with a streamlined body that is unlikely to become entangled in parachutes or lines, but there would be the potential for effect.

Pursuant to the ESA, the use of parachutes for testing activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of parachutes for testing activities under Alternative 1 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.4.2.5 Alternative 2 – Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative would also be identical as described in Section 3.9.3.4.2.2, Alternative 1.

Pursuant to the ESA, the use of parachutes for training activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of parachutes for training activities under Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.4.2.6 Alternative 2 – Testing Activities

Table 3.0-84 lists the number and locations of activities that expend parachutes. The number and footprint of parachutes are detailed in Table 3.3-7. As indicated in Section 3.0.5.3.4.2 (Parachutes) under Alternative 2, activities involving parachute use would occur in the open ocean portions of the Hawaii and SOCAL Range Complexes, with the number of activities involving the use of parachutes being approximately two times that of the No Action Alternative. The activities using parachutes under Alternative 2 would occur in the same geographic locations as the No Action Alternative. Given the size of the range complexes and the resulting widely scattered parachutes (0.03 per nm^2), it would be very unlikely that fishes would encounter and become entangled in any parachutes or sonobuoy accessories. If a fish were to encounter and become entangled in any of these items, the growth, survival, annual reproductive success, or lifetime reproductive success of populations would not be impacted directly or indirectly.

Expended parachutes generally would not co-occur with the distribution and critical habitat of steelhead trout. However, if an expended parachute were encountered, the steelhead trout, like all salmonids, is a strong swimmer with a streamlined body that is unlikely to become entangled in parachutes or lines, but there would be the potential for effect.

Pursuant to the ESA, the use of parachutes for testing activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of parachutes for testing activities under Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.4.3 Summary and Conclusions of Entanglement Impacts

While most fish species are susceptible to entanglement in fishing gear that is designed to entangle a fish by trapping a fish by its gills or spines (e.g., gill nets), only a limited number of fish species that possess certain features such as an irregular shaped or rigid rostrum (snout) (e.g., billfish) are susceptible to entanglement by military expended materials. A survey of marine debris entanglements found no fish entanglements in military expended materials in a 25-year dataset (Ocean Conservancy 2010).

3.9.3.4.3.1 Combined Entanglement Stressors

An individual fish could experience the following consequences of entanglement stressors: displacement, stress, avoidance response, behavioral changes, entanglement causing injury, and

entanglement causing mortality. If entanglement results in mortality, it cannot act in combination because mortal injuries occur with the first instance. Therefore, there is no possibility for the occurrence of this consequence to increase if sub-stressors are combined.

Sub-lethal consequences may result in delayed mortality because they cause irrecoverable injury or alter the individual's ability to feed or detect and avoid predation. Sub-lethal effects resulting in mortality could be more likely if the activities occurred in essentially the same location and occurred within the individual's recovery time from the first disturbance. This circumstance is only likely to arise during training and testing activities that cause frequent and recurring entanglement stressors to essentially the same location (e.g., torpedoes expended at the same location as sonobuoys). In these specific circumstances the potential consequences to fishes from combinations of entanglement stressors may be greater than the sum of their individual consequences.

These specific circumstances that could multiply the consequences of entanglement stressors are highly unlikely to occur for two reasons. First, it is highly unlikely that torpedo guidance wires and sonobuoy parachutes would impact essentially the same space because most of these sub-stressors are widely dispersed in time and space. Because the risk of injury or mortality is extremely low for each sub-stressor independently, the combined impact of these sub-stressors does not increase the risk in a meaningful way. Furthermore, while it is conceivable that interaction between sub-stressors could magnify their combined risks, the necessary circumstances are highly unlikely to overlap.

Interaction between entanglement sub-stressors is likely to have neutral consequences for fishes. There is no potential for these entangling objects to combine in a way that would multiply their impact, as is the case with derelict (abandoned or discarded) fishing nets that commonly occur in the Study Area (Macfadyen et al. 2009) and entangle fish by design. Fish entangled in derelict nets attract scavengers and predators that may themselves become entangled in an ongoing cycle (Morgan and Chuenpagdee 2003). Guidance wires and parachutes are used relatively infrequently over a wide area, and are mobile for only a short time. Therefore, unlike discarded fishing gear, it is extremely unlikely that guidance wires and parachutes could interact.

3.9.3.4.3.2 Summary of Entanglement Stressors

The Navy identified and analyzed three military expended materials types that have potential to entangle fishes: fiber-optic cables, guidance wires, and parachutes. Other military expended materials types such as bomb or missile fragments do not have the physical characteristics to entangle fishes in the marine environment and were not analyzed. Even for fishes that might encounter and become entangled in an expended guidance wire, the breaking strength of that wire is low enough that the impact would be only temporary and not likely to impact the individual.

Pursuant to the ESA, entanglement stressors used under the No Action Alternative, Alternative 1, and Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

Entanglement stressors used under the No Action Alternative, Alternative 1, and Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.5 Ingestion Stressors

This section analyzes the potential ingestion impacts of the various types of munitions and military expended materials other than munitions used by the Navy during training and testing activities within

the Study Area. Aspects of ingestion stressors that are applicable to marine organisms in general are presented in Section 3.0.5.7.5 (Conceptual Framework for Assessing Effects from Ingestion). Ingestion of expended materials by fishes could occur in coastal and open ocean areas, and can occur at the surface, in the water column, or at the seafloor depending on the size and buoyancy of the expended object and the feeding behavior of the fish. Floating material is more likely to be eaten by fishes that feed at or near the water surface (e.g., ocean sunfishes, basking sharks, manta rays, etc.), while materials that sink to the seafloor present a higher risk to bottom-feeding fishes (e.g., rockfish, hammerhead sharks, skates/rays, flounders).

It is reasonable to assume that any item of a size that can be swallowed by a fish could be eaten at some time; this analysis focuses on ingestion of materials in two locations: (1) at the surface or water column, and (2) at the seafloor. Open-ocean predators and open-ocean planktivores are most likely to ingest materials in the water column. Coastal bottom-dwelling predators and estuarine bottom-dwelling predators could ingest materials from the seafloor. The potential for fish, including the ESA-listed fish species, to encounter and ingest expended materials is evaluated with respect to their feeding group and geographic range, which influence the probability that they would eat military expended materials.

The Navy expends the following types of materials during training and testing in the Study Area that could become ingestion stressors: non-explosive practice munitions (small- and medium-caliber), fragments from high-explosives, fragments from targets, chaff, flare casings (including plastic end caps and pistons), and small parachutes. The activities that expend these items and their general distribution are detailed in Section 3.0.5.3.5 (Ingestion Stressors). Metal items eaten by marine fish are generally small (such as fishhooks, bottle caps, and metal springs), suggesting that small- and medium-caliber projectiles, pistons, or end caps (from chaff canisters or flares) are more likely to be ingested. Both physical and toxicological impacts could occur as a result of consuming metal or plastic materials. Items of concern are those of ingestible size that either drift at or just below the surface (or in the water column) for a time or sink immediately to the seafloor. The likelihood that expended items would cause a potential impact on a given fish species depends on the size and feeding habits of the fish and the rate at which the fish encounters the item and the composition of the item. In this analysis only small- and medium-caliber munitions (or small fragments from larger munitions), chaff, small parachutes, and end caps and pistons from flares and chaff cartridges are considered to be of ingestible size for a fish.

The analysis of ingestion impacts on fish is structured around the following feeding strategies:

Feeding at or Just Below the Surface or Within the Water Column

- **Open-Ocean Predators.** Large, migratory, open-ocean fishes, such as tuna, dorado, sharks, and billfishes, feed on fast-swimming prey in the water column of the Study Area. These fishes range widely in search of unevenly distributed food patches. Smaller military expended materials could be mistaken for prey items and ingested purposefully or incidentally as the fish is swimming. Prey fishes sometimes dive deeper to avoid an approaching predator (Pitcher 1986). A few of these predatory fishes (e.g., tiger sharks) are known to ingest any type of marine debris that fit into its mouth, even items such as tires.
- **Open-Ocean Planktivores.** Plankton eating fish in the open-ocean portion of the Study Area include anchovies, sardines, flying fishes, ocean sunfish, manta rays, whale sharks, and basking sharks. These fishes feed by either filtering plankton from the water column or by selectively ingesting larger zooplankton. These planktivores could encounter, and incidentally feed on smaller types of military expended materials (e.g., chaff, end caps, pistons) at the surface or in the water column. None of the species listed under the ESA in the Study Area are open ocean

planktivores, but some species in this group of fishes (e.g., anchovies) constitute a major prey base for many important predators.

Military expended materials that could potentially impact these types of fish at or just below the surface or in the water column include those items that float or are suspended in the water column for some period of time (e.g., parachutes and end caps and pistons from chaff cartridges or flares).

Fishes Feeding at the Seafloor

- **Coastal Bottom Dwelling Predators/Scavengers.** Large predatory fishes near the seafloor are represented by rockfishes, groupers, and jacks, which are typical seafloor predators in coastal and deeper nearshore waters of the Study Area (See Table 3.9-7). These species feed opportunistically on or near the bottom, taking fish and invertebrates from the water column and from the bottom (e.g., crabs, octopus). Bottom-dwelling fishes in the nearshore coasts (See Table 3.9-7) may feed by seeking prey and by scavenging on dead fishes and invertebrates (e.g., skates, rays, flatfish, rat fish).

Military expended materials that could be ingested by fish at the seafloor include items that sink (e.g., small-caliber projectiles and casings, fragments from high-explosive munitions).

Potential impacts of ingestion to adults are different than for other lifestages (eggs, larvae, juveniles) because early lifestages are too small to ingest any military expended materials except for chaff, which has been shown to have no impact on fishes. Therefore, no ingestion potential impacts on early lifestages would occur with the exception of later stage larvae and juveniles.

Within the context of fish location in the water column and feeding strategies, the analysis is divided into (1) munitions (small- and medium-caliber projectiles, and small fragments from larger munitions); and (2) military expended material other than munitions (chaff, chaff end caps, pistons, parachutes, flares, and target fragments).

Table 3.9-7: Summary of Ingestion Stressors on Fishes Based on Location

Feeding Guild	Representative Species	ESA-Protected Species	Overall Potential for Impact
Open-ocean Predators	Dorado, most shark species, tuna, billfish	None	These fishes may ingest floating or sinking expended materials, but the encounter rate would be extremely low.
Open-ocean plankton eaters	Basking shark	None	These fishes may ingest floating expended materials incidentally as they feed in the water column, but the encounter rate would be extremely low.
Coastal bottom-dwelling predators	Rockfishes, groupers, jacks	None	These fishes may ingest expended materials on the seafloor, but the encounter rate would be extremely low.
Coastal/estuarine bottom-dwelling predators and scavengers	Skates and rays, flounders	None	These fishes could incidentally ingest some expended materials while foraging, especially in muddy waters with limited visibility. However, encounter frequency would be extremely low.

Note: ESA = Endangered Species Act

3.9.3.5.1 Impacts from Munitions and Military Expended Materials other than Munitions

The potential impacts of ingesting foreign objects on a given fish depend on the species and size of the fish. Fish that normally eat spiny, hard-bodied invertebrates could be expected to have tougher mouths and digestive systems than fish that normally feed on softer prey. Materials that are similar to the normal diet of a fish would be more likely to be ingested and more easily handled once ingested—for example, by fish that feed on invertebrates with sharp appendages. These items could include fragments from high-explosives that a fish could encounter on the seafloor. Relatively small or smooth objects, such as small caliber projectiles or their casings, might pass through the digestive tract without causing harm. A small sharp-edged item could cause a fish immediate physical distress by tearing or cutting the mouth, throat, or stomach. If the object is rigid and large (relative to the fish's mouth and throat), it may block the throat or obstruct the flow of waste through the digestive system. An object may be enclosed by a cyst in the gut lining (Danner et al. 2009; Hoss and Settle 1990). Ingestion of large foreign objects could lead to disruption of a fish's normal feeding behavior, which could be sublethal or lethal.

Munitions are heavy and would sink immediately to the seafloor, so exposure would be limited to those fish identified as bottom-dwelling predators and scavengers. It is possible that expended small caliber projectiles on the seafloor could be colonized by seafloor organisms and mistaken for prey or that expended small caliber projectiles could be accidentally or intentionally eaten during foraging. Over time, the metal may corrode or become covered by sediment in some habitats, reducing the likelihood of a fish encountering the small caliber, non-explosive practice munitions.

Fish feeding on the seafloor in the offshore locations where these items are expended (e.g., gunnery boxes) would be more likely to encounter and ingest them than fish in other locations. A particularly large item (relative to the fish ingesting it) could become permanently encapsulated by the stomach lining, with the rare chance that this could impede the fish's ability to feed or take in nutrients. However, in most cases, a fish would pass a round, smooth item through its digestive tract and expel it, with no long-term measurable reduction in the individual's fitness.

If high-explosive ordnance does not explode, it would sink to the bottom. In the unlikely event that explosive material, high-melting-point explosive (known as HMX) or royal demolition explosive (known as RDX), is exposed on the ocean floor it would break down in a few hours (U.S. Department of the Navy 2001b). HMX or RDX would not accumulate in the tissues of fish (Lotufo et al. 2010; Price et al. 1998). Fish may take up trinitrotoluene (TNT) from the water when it is present at high concentrations but not from sediments (Lotufo et al. 2010). The rapid dispersal and dilution of TNT expected in the marine water column reduces the likelihood of a fish encountering high concentrations of TNT to near zero.

3.9.3.5.1.1 No Action Alternative – Training Activities

Projectiles

Table 3.0-65 lists the number and location of small- and medium-caliber projectiles. As indicated in Section 3.0.5.3.5.1 (Non-explosive Practice Munitions) under the No Action Alternative, small- and medium-caliber projectile use would occur in the Hawaii and SOCAL Range Complexes. Species that occur in these areas would have the potential to be exposed to small- and medium-caliber projectiles.

Table 3.0-66 lists the number and location of activities that expend fragments from high-explosive ordnance and munitions (e.g., demolition charges, grenades, bombs, missiles, and rockets). The number and footprint of high-explosive ordnance and munitions are detailed in Table 3.3-5; however, the fragment size cannot be quantified. As indicated in Section 3.0.5.3.5.2 (Fragments from High-explosive

Munitions), under the No Action Alternative, high-explosive ordnance and munitions use would occur in the Hawaii and SOCAL Range Complexes. Species that occur in these areas would have the potential to be exposed to fragments from high explosive ordnance and munitions. These items are heavy and would sink immediately to the seafloor, so exposure to fishes would be limited to those groups identified as bottom-dwelling predators and scavengers. It is possible that expended small-caliber projectiles on the seafloor could be colonized by seafloor organisms and mistaken for prey or that expended small-caliber projectiles could be accidentally or intentionally eaten during foraging. Over time, the metal corrodes slowly or may become covered by sediment in some habitats, reducing the likelihood of a fish encountering the small-caliber non explosive practice munitions. High explosive munitions are typically fused to detonate within 5 ft. (1.5 m) of the water surface, with steel fragments breaking off in all directions and rapidly decelerating in the water and settling to the seafloor. The analysis generally assumes that most explosive expended materials sink to the seafloor and become incorporated into the seafloor, with no substantial accumulations in any particular area (see Section 3.1, Sediments and Water Quality).

Encounter rates in locations with concentrated small-caliber projectiles would be assumed to be greater than in less concentrated areas. Fishes feeding on the seafloor in the offshore locations where these items are expended (e.g., focused in gunnery boxes) would be more likely to encounter these items and at risk for potential ingestion impacts than in other locations. If ingested, and swallowed, these items could potentially disrupt an individual's feeding behavior or digestive processes. If the item is particularly large for the fish ingesting it, the projectile could become permanently encapsulated by the stomach lining, with the rare chance that this could impede the fish's ability to feed or take in nutrients. However, in most cases a fish would pass the round and smooth item through their digestive tract and expel the item with full recovery expected without impacting the individual's growth, survival, annual reproductive success, or lifetime reproductive success. There are no ESA-listed species that occur at the offshore locations where small-caliber projectile use is concentrated.

Unexploded high-explosive munitions would sink to the bottom. The residual explosive material would not be exposed to the marine environment, as it is encased in a non-buoyant cylindrical package. Should the High Melting point Explosive or Royal Demolition Explosive be exposed on the ocean floor, they would break down within a few hours (Department of the Navy 2001b) and would not accumulate in the tissues of fishes (Lotufo, Gibson, et al. 2010; Price et al. 1998). Trinitrotoluene (TNT) would bioaccumulate in fish tissues if present at high concentrations in the water, but not from fish exposure to TNT in sediments since it is rapidly degraded (Lotufo, Blackburn, et al. 2010). Given the rapid dispersal and dilution expected in the marine water column, the likelihood of a fish encountering high concentrations of TNT is very low. Over time, Royal Demolition Explosive residue would be covered by ocean sediments in most habitats or diluted by ocean water.

It is not possible to predict the size or shape of fragments resulting from high explosives. High explosives used in the Study Area range in size from medium-caliber projectiles to large bombs, rockets, and missiles. When these items explode, they partially break apart or remain largely intact with irregular shaped pieces—some of which may be small enough for a fish to ingest. Fishes would not be expected to ingest most fragments from high explosives because most pieces would be too large to ingest. Also, since fragment size cannot be quantified, it is assumed that fragments from larger munitions are similarly sized as larger munitions, but more fragments would result from larger munitions than smaller munitions. Small-caliber projectiles far outnumber the larger-caliber high explosive projectiles/bombs/missiles/rockets expended as fragments in the Study Area. Although it is possible that the number of fragments resulting from a high explosive could exceed this number, this cannot be

quantified. Therefore, small-caliber projectiles would be more prevalent throughout the Study Area, and more likely to be encountered by bottom-dwelling fishes, and potentially ingested than fragments from any type of high explosive munitions.

Chaff and Flares

Tables 3.0-85 and 3.0-86 lists the number and location of expended chaff and flares. As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions) under the No Action Alternative, activities that expend chaff and flares occur in the open ocean areas of the Hawaii and SOCAL Range Complexes. Species that occur in these areas would have the potential to be exposed to chaff and flares. Under all Alternatives, a total of 20,950 chaff cartridges would be expended from aircraft during training activities. No potential impacts would occur from the chaff itself, as discussed in Section 3.0.5.3.5.3, but there is some potential for the end caps or pistons associated with the chaff cartridges to be ingested. Under all Alternatives, a total of 10,050 flares would be expended during training flare exercises. The flare device consists of a cylindrical cartridge approximately 1.4 in (3.6 cm) in diameter and 5.8 in (14.7 cm) in length. Items that could be potentially ingested from flares include plastic end caps and pistons. An extensive literature review and controlled experiments conducted by the U.S. Air Force revealed that self-protection flare use poses little risk to the environment (U.S. Air Force 1997). The light generated by flares in the air (designed to burn out completely prior to entering the water) would have no impact on fish based on short burn time, relatively high altitudes where they are used, and the wide-spread and infrequent use. The potential exists for large, open-ocean predators (e.g., tunas, billfishes, pelagic sharks) to ingest self-protection flare end caps or pistons as they float on the water column for some time. A variety of plastic and other solid materials have been recovered from the stomachs of billfishes, dorado (South Atlantic Fishery Management Council 2011) and tuna (Hoss and Settle 1990).

End caps and pistons sink in saltwater (Spargo 1999), which reduces the likelihood of ingestion by surface-feeding fishes. However, some of the material could remain at or near the surface, and predatory fishes may incidentally ingest these items. The highest density of chaff and flare end caps/pistons would be expended in the SOCAL Range Complex. Assuming that all end-caps and pistons would be evenly dispersed in the SOCAL Range Complex, the annual relative end-cap and piston concentration would be very low (0.07 nm^2).

Based on the low environmental concentration (Table 3.3-5), it is unlikely that a larger number of fish would ingest an end cap or piston, much less a harmful quantity. Furthermore, a fish might expel the item before swallowing it. The number of fish potentially impacted by ingestion of end caps or pistons would be low based on the low environmental concentration and population-level impacts are not expected to occur.

Summary of Training Activities

Overall, the potential impacts of ingesting small-caliber projectiles, high explosive fragments, parachutes, or end caps/pistons would be limited to individual cases where a fish might suffer a negative response, for example, ingesting an item too large to be digested. While ingestion of ordnance-related materials, or the other military expended materials identified here, could result in sublethal or lethal impacts, the likelihood of ingestion is low based on the dispersed nature of the materials and the limited exposure of those items at the surface/water column or seafloor where certain fishes could be at risk of ingesting those items. Furthermore, a fish might taste an item then expel it before swallowing it (Felix et al. 1995), in the same manner that fish would temporarily take a lure into its mouth, then spit it out. Based on these factors, the number of fish potentially impacted by

ingestion of ordnance-related materials would be low and population-level impacts are not likely to occur.

Based on the primarily nearshore distribution of steelhead trout and overlap of munitions use, potential ingestion risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. While munitions use could overlap with steelhead trout, the likelihood of ingestion would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, munitions use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of munitions or military expended materials of ingestible size for training activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of munitions or military expended materials of ingestible size for training activities under the No Action Alternative would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.5.1.2 No Action Alternative – Testing Activities

Table 3.0-65 lists the number and location of small- and medium-caliber projectiles. As indicated in Section 3.0.5.3.5.1 (Non-explosive Practice Munitions) under the No Action Alternative, only medium caliber projectile use would occur in the SOCAL Range Complex. Species that occur in these areas would have the potential to be exposed to small- and medium-caliber projectiles.

Table 3.0-66 lists the number and location of activities that expend fragments from high-explosive ordnance and munitions (e.g., demolition charges, grenades, bombs, missiles, and rockets). The number and footprint of high-explosive ordnance and munitions are detailed in Table 3.3-5; however, the fragment size cannot be quantified. As indicated in Section 3.0.5.3.5.2 (Fragments from High-explosive Munitions), under the No Action Alternative, high-explosive ordnance and munitions use would occur in the Hawaii and SOCAL Range Complexes. Species that occur in these areas would have the potential to be exposed to fragments from high explosive ordnance and munitions.

Under the No Action Alternative, no testing activities use chaff or flares (Tables 3.0-85 and 3.0-86).

Overall, the potential impacts of ingesting small-caliber projectiles, high-explosive fragments, parachutes, or flare end caps/pistons would be limited to individual cases where a fish might suffer a negative response, for example, ingesting an item too large to be digested. While ingestion of ordnance-related materials, or the other military expended materials identified here, could result in sublethal or lethal impacts, the likelihood of ingestion is low based on the dispersed nature of the materials and the limited exposure of those items at the surface/water column or seafloor where certain fishes could be at risk of ingesting those items. Furthermore, a fish might expel the item before swallowing it. Based on these factors, the number of fish potentially impacted by ingestion of ordnance-related materials would be low and population-level impacts are not likely to occur.

Based on the primarily nearshore distribution of steelhead trout and overlap of munitions use, potential ingestion risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. While

munitions use could overlap with steelhead trout, the likelihood of ingestion would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, munitions use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of munitions or military expended materials of ingestible size for testing activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of munitions or military expended materials of ingestible size for testing activities under the No Action Alternative would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.5.1.3 Alternative 1 – Training Activities

Projectiles

Table 3.0-65 lists the number and location of small- and medium- caliber projectiles. As indicated in Section 3.0.5.3.5.1 (Non-explosive Practice Munitions) under Alternative 1, small- and medium-caliber projectile use would occur in the open ocean portions of the Study Area. Species that occur in these areas would have the potential to be exposed to small- and medium-caliber projectiles.

Table 3.0-66 lists the number and location of activities that expend fragments from high-explosive ordnance and munitions (e.g., demolition charges, grenades, bombs, missiles, and rockets). The number and footprint of high-explosive ordnance and munitions are detailed in Table 3.3-6; however, the fragment size cannot be quantified. As indicated in Section 3.0.5.3.5.2 (Fragments from High-explosive Munitions), under Alternative 1, high-explosive ordnance and munitions use would occur in the open ocean portions of the Study Area. Species that occur in these areas would have the potential to be exposed to fragments from high explosive ordnance and munitions.

Chaff and Flares

Tables 3.0-85 and 3.0-86 lists the number and location of expended chaff and flares. As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions) under Alternative 1, activities that expend chaff and flares occur in the open ocean areas of the Hawaii and SOCAL Range Complexes. Species that occur in these areas would have the potential to be exposed to chaff and flares. Although the number and location of training activities under Alternative 1 are slightly higher than training activities under the No Action Alternative,. the impacts and comparisons to the No Action Alternative would be similar to those as described in Section 3.9.3.5.1.1 (No Action Alternative – Summary of Training Activities).

The increase in expended materials under Alternative 1 would increase the probability of ingestion risk; however, as discussed under the No Action Alternative, the likelihood of ingestion would still be low based on the dispersed nature of the materials and the limited exposure of those items at the surface/water column or seafloor where certain fishes could be at risk of ingesting those items. Therefore, the number of fish potentially impacted by ingestion of expended materials would be low and population-level impacts are not likely to occur.

Based on the primarily nearshore distribution of steelhead trout and overlap of munitions use, potential ingestion risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. While munitions use could overlap with steelhead trout, the likelihood of ingestion would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, munitions use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of munitions or military expended materials of ingestible size for training activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of munitions or military expended materials of ingestible size for training activities under Alternative 1 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.5.1.4 Alternative 1 – Testing Activities

Table 3.0-65 lists the number and location of small- and medium-caliber projectiles. As indicated in Section 3.0.5.3.5.1 (Non-explosive Practice Munitions) under Alternative 1, small- and medium-caliber projectile use would occur in the entre Study Area. Species that occur in these areas would have the potential to be exposed to small- and medium-caliber projectiles.

Table 3.0-66 lists the number and location of activities that expend fragments from high-explosive ordnance and munitions (e.g., demolition charges, grenades, bombs, missiles, and rockets). The number and footprint of high-explosive ordnance and munitions are detailed in Table 3.3-6; however, the fragment size cannot be quantified. As indicated in Section 3.0.5.3.5.2 (Fragments from High-explosive Munitions), under Alternative 1, high-explosive ordnance and munitions use would occur in the open ocean portions of the Study Area. Species that occur in these areas would have the potential to be exposed to fragments from high explosive ordnance and munitions.

Tables 3.0-85 and 3.0-86 lists the number and location of expended chaff and flares. As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions) under Alternative 1, activities that expend chaff and flares occur in the open ocean areas of the Hawaii and SOCAL Range Complexes. Species that occur in these areas would have the potential to be exposed to chaff and flares. Although the number and location of testing activities under Alternative 1 are slightly higher than testing activities under the No Action Alternative, the impacts and comparisons to the No Action Alternative would be similar to those described in Section 3.9.3.5.1.1 (No Action Alternative).

Given the reasons stated under the training activities, the number of fish potentially impacted by ingestion of ordnance-related materials would be low and population-level impacts are not likely to occur.

Based on the primarily nearshore distribution of steelhead trout and overlap of munitions use, potential ingestion risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. While munitions use could overlap with steelhead trout, the likelihood of ingestion would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites,

and migration corridors), and are outside the Study Area. Therefore, munitions use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of munitions or military expended materials of ingestible size for testing activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of munitions or military expended materials of ingestible size for testing activities under Alternative 1 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.5.1.5 Alternative 2 – Training Activities

Under Alternative 2, the number of military expended materials would be the same as under Alternative 1 (Tables 3.0-65 and 3.0-66). Therefore, the impact of military expended materials would be the same as under Alternative 1.

Based on the primarily nearshore distribution of steelhead trout and overlap of munitions use, potential ingestion risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. While munitions use could overlap with steelhead trout, the likelihood of ingestion would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, munitions use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of munitions or military expended materials of ingestible size for training activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of munitions or military expended materials of ingestible size for training activities under Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.5.1.6 Alternative 2 – Testing Activities

Under Alternative 2, the number of military expended materials would increase slightly compared to the No Action Alternative (Tables 3.0-65 and 3.0-66). Given the reasons stated under the training activities under Alternative 1 and despite the slight increase, the number of fish potentially impacted by ingestion from munitions use would be low and population-level impacts are not likely to occur.

Based on the primarily nearshore distribution of steelhead trout and overlap of munitions use, potential ingestion risk would be greatest in the coastal areas of the SOCAL Range Complex and SSTC. While munitions use could overlap with steelhead trout, the likelihood of ingestion would be extremely low given the low abundance of steelhead trout in the Study Area and the dispersed nature of the activity. However, there would be the potential for effect. The majority of the primary constituent elements required by steelhead trout are applicable to freshwater and estuaries (i.e., spawning sites, rearing sites, and migration corridors), and are outside the Study Area. Therefore, munitions use would not affect steelhead trout critical habitat.

Pursuant to the ESA, the use of munitions or military expended materials of ingestible size for testing activities Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of munitions or military expended materials of ingestible size for testing activities under Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.5.2 Summary and Conclusions of Ingestion Impacts

3.9.3.5.2.1 Combined Ingestion Stressors

An individual fish could experience the following consequences of ingestion stressors: stress, behavioral changes, ingestion causing injury, and ingestion causing mortality. Ingestion causing mortality cannot act in combination because mortal injuries occur with the first instance. Therefore, there is no possibility for the occurrence of this consequence to increase if sub-stressors are combined.

Sub-lethal consequences may result in delayed mortality because they cause irrecoverable injury or alter the individual's ability to feed or detect and avoid predation. Normally, for fish large enough to ingest it, most small-caliber projectiles would pass through a fish's digestive system without injury. However, in this scenario it is possible that a fish's digestive system could already be compromised or blocked in such a manner that the small-caliber projectiles can no longer easily pass through without harm. It is conceivable that a fish could first ingest a small bomb fragment that might damage or block its digestive tract, then ingest a small-caliber projectile, with magnified combined impacts. Sub-lethal effects resulting in mortality could be more likely if the activities occurred in essentially the same location and occurred within the individual's recovery time from the first disturbance. This circumstance is likely to arise only during training and testing activities that cause frequent and recurring ingestion stressors to essentially the same location (e.g., chaff cartridge end caps/flares expended at the same location as small-caliber projectiles). In these specific circumstances the potential consequences to fishes from combinations of ingestion stressors may be greater than the sum of their individual consequences.

These specific circumstances that could magnify the consequences of ingestion stressors are highly unlikely to occur because, with the exception of a sinking exercise, it is highly unlikely that chaff cartridge end caps/flares and small-caliber projectiles would impact essentially the same location because most of these sub-stressors are widely dispersed in time and space.

The combined impact of these sub-stressors does not increase the risk in a meaningful way because the risk of injury or mortality is extremely low for each sub-stressor independently. While it is conceivable that interaction between sub-stressors could magnify their combined risks, the necessary circumstances are highly unlikely to overlap. Interaction between ingestion sub-stressors is likely to have neutral consequences for fishes.

Pursuant to the ESA, the use of munitions or military expended materials of ingestible size for training activities under the No Action Alternative, Alternative 1, or Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of munitions or military expended materials of ingestible size for training activities under the No Action Alternative, Alternative 1, or Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.5.2.2 Summary and Conclusions of Ingestion Impacts

The Navy identified and analyzed three military expended materials types that have ingestion potential for fishes: non-explosive practice munitions, military expended materials from high explosives, and

military expended materials from non-ordnance items (e.g., end caps, canisters, chaff, and accessory materials). The probability of fishes ingesting military expended materials depends on factors such as the size, location, composition, and the buoyancy of the expended material. These factors, combined with the location and feeding behavior of fishes were used to analyze the likelihood the expended material would be mistaken for prey and what the potential impacts would be if ingested. Most expended materials, such as large- and medium-caliber ordnance, would be too large to be ingested by a fish, but other materials, such as small-caliber munitions or some fragments of larger items, may be small enough to be swallowed by some fishes. During normal feeding behavior, many fishes ingest nonfood items and often reject (spit out) nonfood items prior to swallowing. Other fishes may ingest and swallow both food and nonfood items indiscriminately. There are concentrated areas where bombing, missile, and gunnery activities that generate materials that could be ingested. However, even within those areas, the overall impact on fishes would be inconsequential.

The potential impacts of military expended material ingestion would be limited to individual cases where a fish might suffer a negative response, for example, ingesting an item too large, sharp, or pointed to pass through the digestive tract without causing damage. Based on available information, it is not possible to accurately estimate actual ingestion rates or responses of individual fishes. Nonetheless, the number of military expended materials ingested by fishes is expected to be very low and only an extremely small percentage of the total would be potentially encountered by fishes. Certain feeding behavior such as “suction feeding” along the seafloor exhibited by sturgeon may increase the probability of ingesting military expended materials relative to other fishes; however, encounter rates would still remain low.

Pursuant to the ESA, the use of munitions or military expended materials of ingestible size under the No Action Alternative, Alternative 1, or Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The use of munitions or military expended materials of ingestible size under the No Action Alternative, Alternative 1, or Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.3.6 Secondary Stressors

This section analyzes potential impacts on fishes exposed to stressors indirectly through impacts on habitat, sediment, or water quality. These are also primary elements of marine fish habitat and firm distinctions between indirect impacts and habitat impacts are difficult to maintain. For the purposes of this analysis, indirect impacts on fishes via sediment or water which do not require trophic transfer (e.g., bioaccumulation) in order to be observed are considered here. It is important to note that the terms "indirect" and "secondary" do not imply reduced severity of environmental consequences, but instead describe how the impact may occur in an organism or its ecosystem.

Stressors from Navy training and testing activities could pose secondary or indirect impacts on fishes via habitat, sediment, and water quality. These include: (1) explosives and by-products; (2) metals; (3) chemicals; (4) other materials such as targets, chaff, and plastics, and (5) impacts on fish habitat. Activities associated with these stressors are detailed in Tables 2.8-1 to 2.8-5 and analyses of their potential impacts are discussed in Section 3.1 (Sediments and Water Quality) and Section 3.3 (Marine Habitats).

3.9.3.6.1 Explosives

In addition to directly impacting fish and fish habitat, underwater explosions could impact other species in the food web including plankton and other prey species that fish feed upon. The impacts of underwater explosions would differ depending upon the type of prey species in the area of the blast. As discussed in Section 3.9.4.1, fish with swim bladders are more susceptible to blast injuries than fish without swim bladders.

In addition to physical impacts of an underwater blast, prey might have behavioral reactions to underwater sound. For instance, prey species might exhibit a strong startle reaction to detonations that might include swimming to the surface or scattering away from the source. This startle and flight response is the most common secondary defense among animals (Hanlon and Messenger 1996). The sound from underwater explosions might induce startle reactions and temporary dispersal of schooling fishes if they are within close proximity. The abundances of fish and invertebrate prey species near the detonation point could be diminished for a short period of time before being repopulated by animals from adjacent waters. Alternatively, any prey species that would be directly injured or killed by the blast could draw in scavengers from the surrounding waters that would feed on those organisms, and in turn could be susceptible to becoming directly injured or killed by subsequent explosions. Any of these scenarios would be temporary, only occurring during activities involving explosives, and no lasting impact on prey availability or the pelagic food web would be expected. Indirect impacts of underwater detonations and high explosive ordnance use under the Proposed Action would not result in a decrease in the quantity or quality of fish populations or fish habitats in the Study Area.

3.9.3.6.2 Explosion By-Products, and Unexploded Ordnance

Deposition of undetonated explosive materials into the marine environment can be reasonably well estimated by the known failure and low-order detonation rates of high explosives. Undetonated explosives associated with mine neutralization activities are collected after training is complete; therefore, potential impacts are assumed to be inconsequential for these training and testing activities, but other activities could result in unexploded ordnance and unconsumed explosives on the seafloor. Fishes may be exposed by contact with the explosive, contact with contaminants in the sediment or water, and ingestion of contaminated sediments.

High-order explosions consume most of the explosive material, creating typical combustion products. In the case of Royal Demolition Explosive, 98 percent of the products are common seawater constituents and the remainder are rapidly diluted below threshold impact level. Explosion by-products associated with high order detonations present no indirect stressors to fishes through sediment or water. However, low order detonations and unexploded ordnance present elevated likelihood of impacts on fishes.

Indirect impacts of explosives and unexploded ordnance to fishes via sediment is possible in the immediate vicinity of the ordnance. Degradation of explosives proceeds via several pathways discussed in Section 3.1. Degradation products of Royal Demolition Explosive are not toxic to marine organisms at realistic exposure levels (Rosen and Lotufo 2010). TNT and its degradation products impact developmental processes in fishes and are acutely toxic to adults at concentrations similar to real-world exposures (Halpern et al. 2008; Rosen and Lotufo 2010). Relatively low solubility of most explosives and their degradation products means that concentrations of these contaminants in the marine environment are relatively low and readily diluted. Furthermore, while explosives and their degradation products were detectable in marine sediment approximately 6 to 12 in (15.2 to 30.5 m) away from degrading ordnance, the concentrations of these compounds were not statistically distinguishable from background beyond 3 to 6 ft. (0.9 to 1.8 m) from the degrading ordnance (Section 3.1). Taken together,

it is likely that various lifestages of fishes could be impacted by the indirect impacts of degrading explosives within a very small radius of the explosive 1 to 6 ft. (0.3 to 1.8 m).

3.9.3.6.3 Metals

Certain metals are harmful to fishes at concentrations above background levels (e.g., cadmium, chromium, lead, mercury, zinc, copper, manganese, and many others) (Wang and Rainbow 2008). Metals are introduced into seawater and sediments as a result of Navy training and testing activities involving vessel hulks, targets, ordnance, munitions, and other military expended materials (Section 3.1). Some metals bioaccumulate and physiological impacts begin to occur only after bioaccumulation concentrate the metals (see Section 3.3, Marine Habitats, and Chapter 4, Cumulative Impacts). Indirect impacts of metals to fishes via sediment and water involve concentrations several orders of magnitude lower than concentrations achieved via bioaccumulation. Fishes may be exposed by contact with the metal, contact with contaminants in the sediment or water, and ingestion of contaminated sediments. Concentrations of metals in sea water are orders of magnitude lower than concentrations in marine sediments. It is extremely unlikely that fishes would be indirectly impacted by toxic metals via the water.

3.9.3.6.4 Chemicals

Several Navy training and testing activities introduce potentially harmful chemicals into the marine environment; principally, flares and propellants for rockets, missiles, and torpedoes. Polychlorinated biphenyls (PCBs) are discussed in Section 3.1. Properly functioning flares missiles, rockets, and torpedoes combust most of their propellants; leaving benign or readily diluted soluble combustion by-products (e.g., hydrogen cyanide). Operational failures allow propellants and their degradation products to be released into the marine environment.

The greatest risk to fishes from flares, missile, and rocket propellants is perchlorate which is highly soluble in water, persistent, and impacts metabolic processes in many plants and animals. Fishes may be exposed by contact with contaminated water or ingestion of contaminated sediments. Since perchlorate is highly soluble, it does not readily absorb to sediments. Therefore, missile and rocket fuel poses no risk of indirect impact on fishes via sediment. In contrast, the principal toxic components of torpedo fuel, propylene glycol dinitrate and nitrodiphenylamine, adsorbs to sediments, has relatively low toxicity, and is readily degraded by biological processes (Section 3.1). It is conceivable that various lifestages of fishes could be indirectly impacted by propellants via sediment in the immediate vicinity of the object (e.g., within a few inches), but these potential impacts would diminish rapidly as the propellant degrades.

3.9.3.6.5 Other Materials

Some military expended materials (e.g., parachutes) could become remobilized after their initial contact with the sea floor (e.g., by waves or currents) and could be reintroduced as an entanglement or ingestion hazard for fishes. In some bottom types (without strong currents, hard-packed sediments, and low biological productivity), items such as projectiles might remain intact for some time before becoming degraded or broken down by natural processes. While these items remain intact sitting on the bottom, they could potentially remain ingestion hazards. These potential impacts may cease only (1) when the military expended materials are too massive to be mobilized by typical oceanographic processes, (2) if the military expended materials become encrusted by natural processes and incorporated into the seafloor, or (3) when the military expended materials become permanently buried. In this scenario, a parachute could initially sink to the seafloor, but then be transported laterally through the water column or along the seafloor, increasing the opportunity for entanglement. In the

unlikely event that a fish would become entangled, injury or mortality could result. The entanglement stressor would eventually cease to pose an entanglement risk as it becomes encrusted or buried.

3.9.3.6.6 Impacts on Fish Habitat

The Proposed Action could result in localized and temporary changes to the benthic community during activities that impact fish habitat. Fish habitat could become degraded during activities that would strike the seafloor or introduce military expended materials, bombs, projectiles, missiles, rockets, or fragments to the seafloor. During, or following activities that impact benthic habitats, fish species may experience loss of available benthic prey at locations in the Study Area where these items might be expended on essential fish habitat or habitat areas of particular concern. Additionally, plankton and zooplankton that are eaten by fish may also be negatively impacted by these same expended materials. The spatial area of Essential Fish Habitat and habitat areas of particular concern impacted by the Proposed Action would be relatively small compared to the available habitat in the HSTT Study Area. Potentially a maximum area of 0.3 nm^2 of essential fish habitat and habitat areas of particular concern may have decreased habitat value resulting from the Proposed Action, based on the footprint of expended materials. However, there would still be vast expanses of essential fish habitat and habitat areas of particular concern adjacent to the areas of habitat impact that would remain undisturbed by the Proposed Action.

Impacts of physical disturbance and strikes by small, medium, and large projectiles would be concentrated within designated gunnery box areas, resulting in localized disturbances of hard bottom areas, but could occur anywhere in the range complexes or the Study Area. Hard bottom is important habitat for many different species of fish, including those fishes managed by various fishery management plans.

When a projectile hits a biogenic habitat, the substrate immediately below the projectile is not available at that habitat type on a long-term basis, until the material corrodes. The substrate surrounding the projectile would be disturbed, possibly resulting in short-term localized increased turbidity. Given the large spatial area of the range complexes compared to the small percentage covered by biogenic habitat, it is unlikely that most of the small, medium, and large projectiles expended in the Study Area would fall onto this habitat type. Furthermore, these activities are distributed within discrete locations within the Study Area, and the overall footprint of these areas is quite small with respect to the spatial extent of this biogenic habitat within the Study Area.

Sinking exercises could also provide secondary impacts on deep sea populations. These activities occur in open-ocean areas, outside of the coastal range complexes, with potential direct disturbance or strike impacts on deep sea fishes, covered in Sections 3.9.2.4 through 3.9.2.22. Secondary impacts on these fishes could occur after the ship hulks sink to the seafloor. Over time, the ship hulk would be colonized by marine organisms that attach to hard surfaces. For fishes that feed on these types of organisms, or whose abundances are limited by available hard structural habitat, the ships that are sunk during sinking exercises could provide an incidental beneficial impact on the fish community (Love and York 2005).

Designated critical habitat of steelhead trout includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek, and is outside the Study Area. Therefore, would be no impacts associated with secondary stressors.

Pursuant to the ESA, secondary stressors resulting under the No Action Alternative, Alternative 1, or Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

Secondary stressors under the No Action Alternative, Alternative 1, or Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.4 Summary of Potential Impacts (Combined Impacts from All Stressors) on Fish

As described in Section 3.0.5.5 (Resource-Specific Impacts Analysis for Multiple Stressors), this section evaluates the potential for combined impacts of all the stressors from the Proposed Action. The analysis and conclusions for the potential impacts from each individual stressor are discussed in the analyses of each stressor in the sections above and summarized in Sections 3.9.4.2 (Endangered Species Act Determinations).

There are generally two ways that a fish could be exposed to multiple stressors. The first would be if a fish were exposed to multiple sources of stress from a single activity (e.g., a mine warfare activity may include the use of a sound source and a vessel). The potential for a combination of these impacts from a single activity would depend on the range of effects of each stressor and the response or lack of response to that stressor. Most of the activities as described in the Proposed Action involve multiple stressors; therefore, it is likely that if a fish were within the potential impact range of those activities, they may be impacted by multiple stressors simultaneously. This would be even more likely to occur during large-scale exercises or activities that span a period of days or weeks (such as a sinking exercises or composite training unit exercise).

Fish could be exposed to a combination of stressors from multiple activities over the course of its life. This is most likely to occur in areas where training and testing activities are more concentrated (e.g., near naval ports, testing ranges, and routine activity locations outlined in Table 3.0-3 and in areas that individual fish frequent because it is within the animal's home range, migratory corridor, spawning or feeding area. Except for in the few concentration areas mentioned above, combinations are unlikely to occur because training and testing activities are generally separated in space and time in such a way that it would be very unlikely that any individual fish would be exposed to stressors from multiple activities. However, animals with a home range intersecting an area of concentrated Navy activity have elevated exposure risks relative to animals that simply transit the area through a migratory corridor. The majority of the proposed training and testing activities occur over a small spatial scale relative to the entire Study Area, have few participants, and are of a short duration (the order of a few hours or less).

Multiple stressors may also have synergistic effects. For example, fish that experience temporary hearing loss or injury from acoustic stressors could be more susceptible to physical strike and disturbance stressors via a decreased ability to detect and avoid threats. Fish that experience behavioral and physiological consequences of ingestion stressors could be more susceptible to entanglement and physical strike stressors via malnourishment and disorientation. These interactions are speculative, and without data on the combination of multiple Navy stressors, the synergistic impacts from the combination of Navy stressors are difficult to predict in any meaningful way. Navy research and monitoring efforts include data collection through conducting long-term studies in areas of Navy activity, occurrence surveys over large geographic areas, biopsy of animals occurring in areas of Navy activity, and tagging studies where animals are exposed to Navy stressors. These efforts are intended to contribute to the overall understanding of what impacts may be occurring overall to animals in these areas.

Although potential impacts to certain fish species from the Proposed Action may include injury or mortality, impacts are not expected to decrease the overall fitness of any given population. Mitigation

measures designed to reduce the potential impacts are discussed in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring. The potential impacts anticipated from the Proposed Action are summarized in Sections 3.9.4.2, Endangered Species Act Determinations, with respect to each regulation applicable to fish.

Pursuant to the ESA, the combined impacts of all the stressors under the No Action Alternative, Alternative 1, or Alternative 2 may affect, but is not likely to adversely affect, ESA-listed steelhead trout.

The combined impacts of all the stressors under the No Action Alternative, Alternative 1, or Alternative 2 would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

3.9.5 ENDANGERED SPECIES ACT DETERMINATIONS

Table 3.9-8 summarizes the ESA determinations for each substressor analyzed. For all substressors, training and testing activities would have no effect on steelhead trout critical habitat, which includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek.

Table 3.9-8: Summary of Endangered Species Act Determinations for Training and Testing Activities for the Preferred Alternative

Stressor		Steelhead Trout
Acoustic Stressors		
Non-Impulsive Sources	Training Activities	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect
Explosives and other non-impulsive sources	Training Activities	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect
Energy Stressors		
Electromagnetic devices	Training Activities	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect
Physical Disturbance and Strike Stressors		
Vessels and in-water devices	Training Activities	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect
Military expended materials	Training Activities	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect
Seafloor devices	Training Activities	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect
Entanglement Stressors		
Cables and wires	Training Activities	No effect
	Testing Activities	No effect
Parachutes	Training Activities	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect
Ingestion Stressors		
Munitions	Training Activities	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect
Military expended materials other than munitions	Training Activities	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect
Secondary Stressors		
Secondary Stressors	Training Activities	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect

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REFERENCES

Abbott, R., Bing-Sawyer, E. & Blizard, R. (2002). Assessment of pile driving impacts on the Sacramento blackfish (*Orthodon microlepidotus*). (pp. 17 pp.). Oakland, California: Caltrans District 4.

Abbott, R. & Reyff, J. (2004). Fisheries and Hydroacoustic Monitoring Program Compliance Report I. Edmonds-Hess and M. Melandry (Eds.), *San Francisco-Oakland Bay Bridge East Span Seismic Safety Project*. (pp. 148).

Abbott, R., Reyff, J. & Marty, G. (2005). Monitoring the effects of conventional pile driving on three species of fish. (pp. 131 pp). Richmond, California: Strategic Environmental Consulting, Inc. for Manson Construction Company.

Able, K. W. & Fahay, M. P. (1998). The first year in the life of estuarine fishes in the Middle Atlantic Bight: Rutgers University Press.

Adams, P. B., Grimes, C. B., Hightower, J. E., Lindley, S. T. & Moser, M. L. (2002). *Status Review for North American Green Sturgeon,* Acipenser medirostris. (pp. 49) National Marine Fisheries Service, North Carolina Cooperative Fish and Wildlife Research Unit.

Allen, L. G., Pondella, D. J., II & Horn, M. H. (Eds.). (2006). *The Ecology of Marine Fishes: California and Adjacent Waters* (pp. 660). Berkeley, CA: University of California Press.

Amoser, S. & Ladich, F. (2003). Diversity in noise-induced temporary hearing loss in otophysine fishes. *Journal of the Acoustical Society of America, 113*(4), 2170-2179.

Amoser, S. & Ladich, F. (2005). Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats? *Journal of Experimental Biology, 208*, 3533-3542.

Astrup, J. (1999). Ultrasound detection in fish - a parallel to the sonar-mediated detection of bats by ultrasound-sensitive insects? *Comparative Biochemistry and Physiology, Part A, 124*, 19-27.

Astrup, J. & MØHL, B. (1993). Detection of intense ultrasound by the cod *Gadus morhua*. *Journal of Experimental Biology, 182*, 71-80.

Atema, J., Kingsford, M. J. & Gerlach, G. (2002). Larval reef fish could use odour for detection, retention and orientation to reefs. *Marine Ecology Progress Series, 241*, 151-160.

Bakun, A., Babcock, E. A., Lluch-Cota, S. E., Santora, C. & Salvadeo, C. J. (2010). Issues of ecosystem-based management of forage fisheries in ‘‘open’’ non-stationary ecosystems: The example of the sardine fishery in the Gulf of California. *Reviews in Fish Biology and Fisheries, 20*, 9-29. doi:10.1007/s11160-009-9118-1

Baum, E. (1997). *Maine Atlantic Salmon: A National Treasure* (pp. 224). Hermon, ME: Atlantic Salmon Unlimited.

Beamish, R.J., G.A. McFarlane, & J.R. King. (2005). Migratory patterns of pelagic fishes and possible linkages between open ocean and coastal ecosystems off the Pacific coast of North America. Deep Sea Research II. 52(2005) 739-755Beauchamp, D. A., Shepard, M. F. & Pauley, G. B. (1983). Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Northwest). Chinook Salmon. (pp. 15) U.S. Fish and Wildlife Service Division of Biological Services

Bester, C. (1999, last updated 17 December 2003). Biological profiles: Scalloped hammerhead shark. [Internet] Florida Museum of Natural History. Retrieved from

http://www.flmnh.ufl.edu/fish/Gallery/Descript/ScHammer/ScallopedHammerhead.html as accessed

Bethea, D. M., Carlson, J. K., Hollensead, L. D., Papastamatiou, Y. P. & Graham, B. S. (2011). A Comparison of the Foraging Ecology and Bioenergetics of the Early Life-Stages of Two Sympatric Hammerhead Sharks. *Bulletin of Marine Science*, 87(4), 873-889. 10.5343/bms.2010.1047

Bleckmann, H. & Zelick, R. (2009). Lateral line system of fish. *Integrative Zoology, 4*(1), 13-25. doi: 10.1111/j.1749-4877.2008.00131.x

Boehlert, G. W. & Gill, A. B. (2010). Environmental and Ecological Effects of Ocean Renewable Energy Development; A Current Synthesis. *Oceanography, 23*(2), 68-81.

Booman, C., Dalen, H., Heivestad, H., Levsen, A., van der Meeren, T. & Toklum, K. (1996). (Seismic-fish) Effekter av luftkanonskyting pa egg, larver og ynell. *Havforskningsinstituttet*.

Botsford, L. W., Brumbaugh, D. R., Grimes, C., Kellner, J. B., Largier, J., O'Farrell, M. R., Wespestad, V. (2009). Connectivity, Sustainability, and Yield: Bridging the Gap Between Conventional Fisheries Management and Marine Protected Areas. [Review]. *Reviews in Fish Biology and Fisheries, 19*(1), 69-95. 10.1007/s11160-008-9092-z

Brander, K. (2010). Impact of climate change on fisheries. *Journal of Marine Systems, 79*, 389-402. 10.1016/j.jmarsys.2008.12.015

Brander, K. M. (2007). Global fish production and climate change. *Proceedings of the National Academy of Sciences of the United States of America, 104*(50), 19709-19714. 10.1073/pnas.0702059104

Buerkle, U. (1968). Relation of pure tone thresholds to background noise level in the Atlantic cod (*Gadus morhua*). *Journal of the Fisheries Research Board of Canada, 25*, 1155 1160.

Buerkle, U. (1969). Auditory masking and the critical band in Atlantic cod (*Gadus morhua*). *Journal of the Fisheries Research Board of Canada, 26*, 1113-1119.

Bullock, T. H., Bodznick, D. A. & Northcutt, R. G. (1983). The Phylogenetic Distribution of Electroreception - Evidence for Convergent Evolution of a Primitive Vertebrate Sense Modality. *Brain Research Reviews, 6*(1), 25-46. 10.1016/0165-0173(83)90003-6

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

California Department of Transportation. (2001). Pile Installation Demonstration Project Marine Mammal Impact Assessment *San Francisco - Oakland Bay Bridge East Span Seismic Safety Project*.

Caltrans. (2001). Pile installation demonstration project: Fisheries impact assessment. (pp. 59) San Francisco - Oakland Bay Bridge East Span Seismic Safety Project.

Carlson, T., Hastings, M. & Popper, A. N. (2007). Memorandum: Update on Recommendations for Revised Interim Sound Exposure Criteria for Fish during Pile Driving Activities. (pp. 8). Prepared for California Department of Transportation.

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

Casper, B. & Mann, D. (2006a). Evoked potential audiograms of the nurse shark (*Ginglymostoma cirratum*) and the yellow stingray (*Urabatis jamaicensis*). *Environmental Biology of Fishes, 76*, 101-108. 10.1007/s10641-006-9012-9

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

Casper, B. M. & Mann, D. A. (2006b). Evoked potential audiograms of the nurse shark (*Ginglymostoma cirratum*) and the yellow stingray (*Urobatis jamaicensis*). *Environmental Biology of Fishes, 76*, 101-108.

Casper, B. M. & Mann, D. A. (2009). Field hearing measurements of the Atlantic sharpnose shark *Rhizoprionodon terraenovae*. *Journal of Fish Biology, 75*, 2768-2776. doi:10.1111/j.1095-8649.2009.02477.x

Castro, J. I. (1983). The sharks of North American waters (pp. 179). College Station, Texas: Texas A&M University Press.

Cato, D. H. (1978). Marine biological choruses observed in tropical waters near Australia. *Journal of the Acoustical Society of America, 64*(3), 736-743.

Chapman, C. J. & Hawkins, A. D. (1973a). Field study of hearing in cod, gadus-morhua-l. *Journal of Comparative Physiology, 85*(2), 147-167. 10.1007/bf00696473

Chapman, C. J. & Hawkins, A. D. (1973b). A field study of hearing in the cod, *Gadus morhua*. *Journal of Comparative Physiology, 85*, 147-167.

Cheung, W. W. L., Watson, R., Morato, T., Pitcher, T. J. & Pauly, D. (2007). Intrinsic vulnerability in the global fish catch. *Marine Ecology-Progress Series, 333*, 1-12.

Codarin, A., Wysocki, L. E., Ladich, F. & Picciulin, M. (2009). Effects of ambient and boat noise on hearing and communication in three fish species living in a marine protected area (Miramare, Italy). *Marine Pollution Bulletin, 58*(12), 1880-1887. doi:10.1016/j.marpolbul.2009.07.011

Collin, S. P. & Whitehead, D. (2004). The functional roles of passive electroreception in non-electric fishes. *Animal Biology, 54*(1), 1-25.

Compagno, L. J. V. (1984). FAO species catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of sharks species known to date. Part 2: Carcharhiniformes. (pp. 406). Available from ftp://ftp.fao.org/docrep/fao/009/ad123e/ad123e00.pdf

Continental Shelf Associates (CSA) Inc. (2004). Explosive removal of offshore structures - information synthesis report U.S. Department of the Interior (Ed.). New Orleans, LA: Minerals Management Service, Gulf of Mexico OCS Region.

Coombs, S. & Popper, A. (1979a). Hearing Differences Among Hawaiian Squirrelfish (Family *Holocentridae*) Related to Differences in the Peripheral Auditory System. *Journal of Comparative Physiology, 132*, 203-307.

Coombs, S. & Popper, A. N. (1979b). Hearing differences among Hawaiian squirrelfish (family Holicentridae) related to differences in the peripheral auditory system. *Journal of Comparative Physiology A, 132*, 203-207.

Crain, C. M., Halpern, B. S., Beck, M. W. & Kappel, C. V. (2009). Understanding and Managing Human Threats to the Coastal Marine Environment. In R. S. Ostfeld and W. H. Schlesinger (Eds.), *The Year in Ecology and Conservation Biology, 2009* (pp. 39-62). Oxford, UK: Blackwell Publishing. doi: 10.1111/j.1749-6632.2009.04496.x

Cross, J. N. & Allen, L. G. (1993). Fishes. In M. D. Dailey, D. J. Reish and J. W. Anderson (Eds.), *Ecology of the Southern California Bight: A Synthesis and Interpretation* (pp. 459-540). Berkeley, California: University of California Press.

Culik, B. M., Koschinski, S., Tregenza, N. & Ellis, G. M. (2001). Reactions of harbor porpoises *Phocoena phocoena* and herring Clupea harengus to acoustic alarms. *Marine Ecology Progress Series, 211*, 255-260.

Daly-Engel, T. S., Seraphin, K. D., Holland, K. N., Coffey, J. P., Nance, H. A., Toonen, R. J. & Bowen, B. W. (2012). Global phylogeography with mixed-marker analysis reveals male-mediated dispersal in the endangered scalloped hammerhead shark (*Sphyrna lewini*). PLoS One, 7(1), 279-289. DOI:10.1371/journal.pone.0029986

Danner, G. R., Chacko, J. & Brautigam, F. (2009). Voluntary ingestion of soft plastic fishing lures affects brook trout growth in the laboratory. *North American Journal of Fisheries Management, 29*(2), 352-360. doi: 10.1577/M08-085.1

Dempster, T. & Taquet, M. (2004). Fish aggregation device (FAD) research: gaps in current knowledge and future directions for ecological studies. *Reviews in Fish Biology and Fisheries, 14*(1), 21-42.

Deng, X., Wagner, H.-J. & Popper, A. N. (2011). The inner ear and its coupling to the swim bladder in the deep-sea fish *Antimora rostrata* (Teleostei: Moridae). *Deep-Sea Research I, 58*, 27-37. doi:10.1016/j.dsr.2010.11.001

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

Doksaeter, L., Godo, O. R., Handegard, N. O., Kvadsheim, P. H., Lam, F.-P. A., Donovan, C. & Miller, P. J. O. (2009). Behavioral responses of herring (*Clupea harengus*) to 1-2 and 6-7 kHz sonar signals and killer whale feeding sounds. *The Journal of the Acoustical Society of America, 125*(1), 554-564. Retrieved from http://link.aip.org/link/?JAS/125/554/1

Drazen, J. C. and B. A. Seibel. (2007). "Depth-related trends in metabolism of benthic and benthopelagic deep-sea fishes." Limnology and Oceanography 52(5): 2306-2316.

Dufour, F., Arrizabalaga, H., Irigoien, X. & Santiago, J. (2010). Climate impacts on albacore and bluefin tunas migrations phenology and spatial distribution. *Progress In Oceanography, 86*(1-2), 283-290. 10.1016/j.pocean.2010.04.007

Dulvy, N. K., Sadovy, Y. & Reynolds, J. D. (2003). Extinction vulnerability in marine populations. *Fish and Fisheries, 4*(1), 25-64.

Duncan, K. M. & Holland, K. N. (2006). Habitat use, growth rates and dispersal patterns of juvenile scalloped hammerhead sharks *Sphyrna lewini* in a nursery habitat. *Marine Ecology-Progress Series*, 312, 211-221. 10.3354/meps312211

Dunning, D., Ross, Q., Geoghegan, P., Reichle, J., Menezes, J. & Watson, J. (1992). Alewives Avoid High-Frequency Sound. *North American Journal of Fisheries Management, 12*(3), 407-416.

Dzwilewski, P. T. & Fenton, G. (2002). Shock wave / sound propagation modeling results for calculating marine protected species impact zones during explosive removal of offshore structures. (ARA PROJECT 5604, pp. 1-37). New Orleans, LA: Applied Research Associates Inc., for Minerals Management Service.

Edds-Walton, P. L. & Finneran, J. J. (2006). Evaluation of Evidence for Altered Behavior and Auditory Deficits in Fishes Due to Human-Generated Noise Sources. (Vol. TR 1939, pp. 47). San Diego, CA: SSC San Diego.

Egner, S. & Mann, D. (2005a, January 19). Auditory sensitivity of sergeant major damselfish *Abudefduf saxatilis* from post-settlement juvenile to adult. *Marine Ecology Progess Series, 285*, 213-222. Retrieved from www.int-res.com

Egner, S. A. & Mann, D. A. (2005b). Auditory sensitivity of sergeant major damselfish *Abudefduf saxatilis* from post-settlement juvenile to adult. *Marine Ecology Progress Series, 285*, 213-222.

Emmett, R. L., Hinton, S. A., Stone, S. L. & Monaco, M. E. (1991). *Distribution and Abundance of Fishes and Invertebrates in West Coast Estuaries*. (Vol. II: Species Life History Summaries, ELMR Report Number 8, pp. 329). Rockville, MD: NOAA/NOS Strategic Environmental Assessments Division.

Engås, A., S. Løkkeborg, et al. (1996). "Effects of seismic shooting on local abundance and catch rates of cod (Gadus morhua) and haddock (Melanogrammus aeglefinus)." Canadian Journal of Fisheries and Aquatic Sciences 53: 2238-2249

Engås, A. and S. Løkkeborg. (2002). "Effects of seismic shooting and vessel-generated noise on fish behaviour and catch rates." Bioacoustics 12: 313-315.

Enger, P. S. (1981). Frequency discrimination in teleosts-central or peripheral? W. N. Tavolga, A. N. Popper and R. R. Fay (Eds.), *Hearing and Sound Communication in Fishes* (pp. 243-255). New York: Springer-Verlag.

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

Estrada, J. A., A. N. Rice, et al. (2003). "Predicting trophic position in sharks of the north-west Atlantic Ocean using stable isotope analysis." Journal of the Marine Biological Association of the United Kingdom 83: 1347-1350.

Fay, R. R. (1988). Hearing in vertebrates: A psychophysics handbook (pp. 621). Winnetka, Illinois: Hill-Fay Associates.

Fay, R. R. & Megela-Simmons, A. (1999). The sense of hearing in fishes and amphibians R. R. Fay and A. N. Popper (Eds.), *Comparative Hearing: Fish and Amphibians* (pp. 269-318). New York: Springer-Verlag.

Feist, B.E. (1991). Potential impacts of pile driving on juvenile pink (Oncorhynchus gorbuscha) and chum (O. keta) salmon behavior and distribution. Masters of Science thesis, University of Washington, Seattle, Washington.

Feist, B. E., Anderson, J. J. & Miyamoto, R. (1992). *Potential Impacts of Pile Driving on Juvenile Pink (*Oncorhynchus gorbuscha*) and Chum (*O. keta*) Salmon Behavior and Distribution*. (pp. 66) University of Washington.

Felix, A., Stevens, M. E. & Wallace, R. L. (1995). Unpalatability of a Colonial Rotifer, Sinantherina socialis to Small Zooplanktivorous Fishes. Invertebrate Biology, 114(2), 139-144. 10.2307/3226885

Fisheries Hydroacoustic Working Group. (2008). Memorandum of agreement in principle for interim criteria for injury to fish from pile driving. California Department of Transportation in coordination with the Federal Highway Administration.

Fitch, J. E. and P. H. Young. (1948). Use and effect of explosives in California coastal waters. California Division Fish and Game.

Food and Agriculture Organization of the United Nations. (2005). Review of the state of world marine fishery resources. (FAO Fisheries Technical Paper No. 457, pp. 235). Rome, Italy: FAO. Available from http://www.fao.org/docrep/009/y5852e/y5852e00.htm

Food and Agriculture Organization of the United Nations. (2012). Species Fact Sheets, *Sphyrna lewini* FAO. Retrieved from http://www.fao.org/fishery/species/2028/en as accessed

Formicki, K., Tanski, A., Sadowski, M. & Winnicki, A. (2004). Effects of magnetic fields on fyke net performance. *Journal of Applied Ichthyology, 20*(5), 402-406. 10.1111/j.1439-0426.2004.00568.x

Froese, R. and D. Pauly. (2010). FishBase. 2010: World Wide Web electronic publication.

Gannon, D. P., Barros, N. B., Nowacek, D. P., Read, A. J., Waples, D. M. & Wells, R. S. (2005). Prey detection by bottlenose dolphins (*Tursiops truncatus*): an experimental test of the passive listening hypothesis. *Animal Behaviour, 69*, 709-720.

Gearin, P. J., Gosho, M. E., Laake, J. L., Cooke, L., DeLong, R. L. & Hughes, K. M. (2000). Experimental testing of acoustic alarms (pingers) to reduce bycatch of harbour porpoise, *Phoceona phocoena*, in the state of Washington. *2*(1), 1-9.

Gill, A. B. (2005). Offshore renewable energy: ecological implications of generating electricity in the coastal zone. *Journal of Applied Ecology, 42*(4), 605-615. 10.1111/j.1365-2664.2005.01060.x

Gitschlag, G. R., Schirripa, M. J. & Powers, J. E. (2001). Estimation of fisheries impacts due to underwater explosives used to sever and salvage oil and gas platforms in the U.S. Gulf of Mexico Final Report. Prepared by U.S. Department of the Interior.

Glover, A. G. & Smith, C. R. (2003). The deep-sea floor ecosystem: current status and prospects of anthropogenic change by the year 2025. *Environmental Conservation, 30*(3), 219-241. doi: 10.1017/S0376892903000225

Goatley, C. H. R. and D. R. Bellwood. (2009). "Morphological structure in a reef fish assemblage." Coral Reefs 28: 449-457.

Goertner, J.F. (1982). Prediction of Underwater Explosion Safe Ranges for Sea Mammals. Research and Technology Department. NSWC TR 82-188.

Goertner, J. F., Wiley, M. L., Young, G. A. & McDonald, W. W. (1994). Effects of underwater explosions on fish without swimbladders. (NSWC TR 88-114). Silver Spring, MD: Naval Surface Warfare Center.

Goncalves, R., Scholze, M., Ferreira, A. M., Martins, M. & Correia, A. D. (2008). The joint effect of polycyclic aromatic hydrocarbons on fish behavior. *Environmental Research, 108*(2), 204-213. 10.1016/j.envres.2008.07.008

Good, T. P., Waples, R. S. & Adams, P. (2005). *Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead*. (NOAA Technical Memorandum NMFS-NWFSC-66, pp. 598) U.S. Department of Commerce.

Govoni, J. J., L. R. L.R. Settle, et al. (2003). "Trauma to juvenile pinfish and spot inflicted by submarine detonations." Journal of Aquatic Animal Health 15: 111-119.

Gregory, J. & Clabburn, P. (2003). Avoidance behaviour of *Alosa fallax fallax* to pulsed ultrasound and its potential as a technique for monitoring clupeid spawning migration in a shallow river. *Aquatic Living Resources, 16*, 313-316. 10.1016/S0990-7440(03)00024-X. Retrieved from www.sciencedirect.com

Haedrich, R. L. (1996). "Deep-water fishes: Evolution and adaptation in the earth's largest living spaces." Journal of Fish Biology 49: 40-53.

Halpern, B. S., McLeod, K. L., Rosenberg, A. A. & Crowder, L. B. (2008). Managing for cumulative impacts in ecosystem-based management through ocean zoning. *Ocean & Coastal Management, 51*(3), 203-211. doi: 10.1016/j.ocecoaman.2007.08.002

Halvorsen, M. B., Casper, B. M., Woodley, C. M., Carlson, T. J. & Popper, A. N. (2011). Predicting and mitigating hydroacoustic impacts on fish from pile installations *Research Results Digest*. (Vol. 363, pp. Project 25-28). Washington, D.C.: National Cooperative Highway Research Program, Transportation Research Board, National Academy of Sciences.

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

Hansen, L. P. & Windsor, M. L. (2006). Interactions between aquaculture and wild stocks of Atlantic salmon and other diadromous fish species: Science and management, challenges and solutions. *ICES Journal of Marine Science, 63*(7), 1159-1161. 10.1016/J.ICEJMS.2006.05.003

Hartwell, S. I., Hocutt, C. H. & van Heukelem, W. F. (1991). Swimming response of menhaden (*Brevoortia tyrannus*) to electromagnetic pulses. *Journal of Applied Ichthyology, 7*(2), 90-94.

Hastings, M. C. (1990). Effects of Underwater Sound on Fish. Document No. 46254-900206-01IM, Project No. 401775-1600, AT&T Bell Laboratories.

Hastings, M. C. (1995). Physical effects of noise on fishes. Presented at the Proceedings of INTER-NOISE 95, The 1995 International Congress on Noise Control Engineering.

Hastings, M. C. & Popper, A. N. (2005a). Effects of Sound on Fish. (Contract No. 43A0139, Task Order 1). 2600 V Street Sacramento, CA 9581: California Department of Transportation. Prepared by P. C. Jones & Stokes.

Hastings, M. C. & Popper, A. N. (15701). (2005b). Effects of sound on fish. (Vol. Report to Cal Trans, pp. 1-82).

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

Hastings, M. C., Reid, C. A., Grebe, C. C., Hearn, R. L. & Colman, J. G. (2008). The effects of seismic airgun noise on the hearing sensitivity of tropical reef fishes at Scott Reef, Western Australia. *Proceedings of the Institute of Acoustics, 30*(5), 8 pp.

Hawkins, A. D. & Johnstone, A. D. F. (1978a). The hearing of the Atlantic salmon, *Salmo salar*. *Journal of Fish Biology, 13*, 655-673.

Hawkins, A. D. & Johnstone, A. D. F. (1978b). The hearing of the Atlantic salmon, *Salmo solar*. *Journal of Fish Biology, 13*, 655-673.

Helfman, G. S., Collette, B. B. & Facey, D. E. (1997). *The Diversity of Fishes* (pp. 528). Malden, MA: Blackwell Science.

Helfman, G. S., Collette, B. B., Facey, D. E. & Bowen, B. W. (2009a). The Diversity of Fishes. In Wiley-Blackwell (Ed.) (Second ed.).

Helfman, G. S., Collette, B. B., Facey, D. E. & Bowen, B. W. (2009b). *The Diversity of Fishes: Biology, Evolution, and Ecology* (2nd ed., pp. 528). Malden, MA: Wiley-Blackwell.

Higgs, D., Plachta, D., Rollo, A., Singheiser, M., Hastings, M. & Popper, A. (2004). Development of ultrasound detection in American shad (*Alosa sapidissima*). *The Journal of Experimental Biology, 207*, 155-163. 10.1242/jeb.00735

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

Holland, K. N., Wetherbee, B. M., Peterson, J. D. & Lowe, C. G. (1993). Movements and Distribution of Hammerhead Shark Pups on their Natal Grounds. *Copeia*(2), 495-502. 10.2307/1447150

Horn, M. H. & Allen, L. G. (1978). A distributional analysis of California coastal marine fishes. *Journal of Biogeography, 5*(1), 23-42. Retrieved from http://www.jstor.org/stable/3038105

Horst, T. J. (1977). Use of Leslie Matrix for assessing environmental-impact with an example for a fish population. *Transactions of the American Fisheries Society, 106*(3), 253-257.

Hoss, D. E. & Settle, L. R. (1990). Ingestion of plastics by teleost fishes. In S. Shomura and M. L. Godfrey (Eds.), *Proceedings of the Second International Conference on Marine Debris* [Technical Memorandum]. (NFMS-SWFSC-154, pp. 693-709). Honolulu, HI: US Department of Commerce, National Oceanic and Atmospheric Administration.

International Union for Conservation of Nature and Natural Resources. (2009). Indo-Pacific bottlenose dolphin assessment workshop report: Solomon Islands case study of *Tursiops aduncus*. R. R. Reeves and R. L. Brownell (Eds.), *Occasional Paper of the Species Survival Commission*. Gland, Switzerland: International Union for Conservation of Nature and Natural Resources.

International Union for Conservation of Nature. (2010). Red List of Threatened Species. Version 2009.2. Barcelona, International Union for Conservation of Nature and Natural Resources. 2010.

Iversen, R. T. B. (1967). Response of the yellowfin tuna (Thunnus albacares) to underwater sound. In W. N. Tavolga (Ed.), *Marine Bio-Acoustics II*. New York: Pergamon Press.

Iversen, R. T. B. (1969). Auditory thresholds of the scombrid fish *Euthynnus affinis*, with comments on the use of sound in tuna fishing, *FAO Conference on Fish Behaviour in Relation to Fishing Techniques and Tactics*.

Jonsson, B., Waples, R. S. & Friedland, K. D. (1999). Extinction considerations for diadromous fishes. *ICES Journal of Marine Science, 56*(4), 405-409.

Jørgensen, R., Handegard, N. O., Gjøsæter, H. & Slotte, A. (2004). Possible vessel avoidance behaviour of capelin in a feeding area and on a spawning ground. *Fisheries Research, 69*(2), 251-261. doi: 10.1016/j.fishres.2004.04.012

Jorgensen, R., Olsen, K., Petersen, I. & Kanapthipplai, P. (2005). Investigations of potential effects of low frequency sonar signals on survival, development and behaviour of fish larvae and juveniles. (pp. 51) The Norwegian College of Fishery Science, University of Tromso, Norway.

Kajiura, S. M. & Holland, K. N. (2002). Electroreception in Juvenile Scalloped Hammerhead and Sandbar Sharks. *The Journal of Experimental Biology, 205*, 3609-3621.

Kalmijn, A. J. (2000). Detection and processing of electromagnetic and near-field acoustic signals in elasmobranch fishes. *Philosophical Transactions of the Royal Society of London Series B-Biological Sciences, 355*(1401), 1135-1141. doi: 10.1098/rstb.2000.0654

Kane, A. S., Song, J., Halvorsen, M. B., Miller, D. L., Salierno, J. D., Wysocki, L. E., Popper, A. N. (2010). Exposure of fish to high intensity sonar does not induce acute pathology. [Uncorrected Proof]. *Journal of Fish Biology*.

Kappel, C. V. (2005). Losing pieces of the puzzle; threats to marine, estuarine, and diadromous species. *Frontiers in Ecology and the Environment, 3*(5), 275-282.

Kauparinen, A. & Merila, J. (2007). Detecting and managing fisheries-induced evolution. *Trends in Ecology & Evolution, 22*(12), 652-659. 10.1016/j.tree.2007.08.11

Keevin, T. M. & Hempen, G. (1997). The environmental effects of underwater explosions with methods to mitigate impacts (pp. 1-102). U.S. Army Corps of Engineers St. Louis, Missouri.

Keller, A. A., Fruh, E. L., Johnson, M. M., Simon, V. & McGourty, C. (2010, May). Distribution and abundance of anthropogenic marine debris along the shelf and slope of the US West Coast. [Research Support, U.S. Gov't, Non-P.H.S.]. *Marine Pollution Bulletin, 60*(5), 692-700. 10.1016/j.marpolbul.2009.12.006 Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/20092858

Kenyon, T. (1996a). Ontogenetic changes in the auditory sensitivity of damselfishes (pomacentridae). *Journal of Comparative Physiology, 179*, 553-561.

Kenyon, T. N. (1996b). Ontogenetic changes in the auditory sensitivity of damselfishes (pomacentridae). *Journal of Comparative Physiology A, 179*, 553-561.

Ketten, D. R. (1998, September). Marine Mammal Auditory Systems: A Summary of Audiometric and Anatomical Data and Its Implications for Underwater Acoustic Impacts. Dolphin-Safe Research Program, Southwest Fisheries Science Center, LA Jolla, CA.

Klimley, A. P. & Nelson, D. R. (1984). Diel Movement Patterns of the Scalloped Hammerhead Shark (*Sphyrna-Lewini*) in Relation to El-Bajo-Espiritu-Santo - A Refuging Central-Position Social System. Behavioral Ecology and Sociobiology, 15(1), 45-54. 10.1007/bf00310214

Koslow, J. A. (1996). "Energetic and life-history patterns of deep-sea benthic, benthopelagic and seamount-associated fish." Journal of Fish Biology 49: 54-74.

Kvadsheim, P. H. and E. M. Sevaldsen. (2005). The potential impact of 1-8 kHz active sonar on stocks of juvenile fish during sonar exercises, Forsvarets Forskningsinstitutt

Ladich, F. (2008). Sound communication in fishes and the influence of ambient and anthropogenic noise. [Journal Article]. *Bioacoustics, 17*, 35-37.

Ladich, F. and A. N. Popper. (2004). Parallel Evolution in Fish Hearing Organs. Evolution of the Vertebrate Auditory System, Springer Handbook of Auditory Research. G. A. Manley, A. N. Popper and R. R. Fay. New York, Springer-Verlag.

Laist, D. W. (1987). Overview of the biological effects of lost and discarded plastic debris in the marine environment. *Marine Pollution Bulletin, 18*(6B), 319-326.

Leet, W. S., Dewees, C. M., Klingbeil, R. & Larson, E. J. (Eds.). (2001). *California's Living Marine Resources: A Status Report*. (SG 01-11, pp. 593) California Department of Fish and Game. Available from www.dfg.ca.gov/mrd

Limburg, K. E. & Waldman, J. R. (2009). Dramatic declines in North Atlantic diadromous fishes. *BioScience, 59*(11), 955-965. 10.1525/bio.2009.59.11.7

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

Lombarte, A., Yan, H. Y., Popper, A. N., Chang, J. C., and Platt, C. (1993). "Damage and regeneration of hair cell ciliary bundles in a fish ear following treatment with gentamicin." Hear. Res. 66, 166-174.

Lotufo, G. R., Blackburn, W., Marlborough, S. J. & Fleeger, J. W. (2010). Toxicity and bioaccumulation of TNT in marine fish in sediment exposures. *Ecotoxicology and Environmental Safety, 73*(7), 1720-1727. doi: 10.1016/j.ecoenv.2010.02.009

Love, M. S. & York, A. (2005). A comparison of the fish assemblages associated with an oil/gas pipeline and adjacent seafloor in the Santa Barbara Channel, southern California bight. Bulletin of Marine Science, 77(1), 101-117.

Lovell, J., Findlay, M., Moate, R. & Yan, H. (2005). The hearing abilities of the prawn *Palaemon serratus*. *Comparative Biochemistry and Physiology, Part A, 140*, 89-100. Retrieved from www.elsevier.com/locate/cbpa

Luczkovich, J. J., Daniel III, H. J., Hutchinson, M., Jenkins, T., Johnson, S. E., Pullinger, R. C. & Sprague, M. W. (2000). Sounds of sex and death in the sea: bottlenose dolphin whistles suppress mating choruses of silver perch. *Bioacoustics, 10*(4), 323-334.

Lundquist, C. J., Thrush, S. F., Coco, G. & Hewitt, J. E. (2010). Interactions between disturbance and dispersal reduce persistence thresholds in a benthic community. *Marine Ecology-Progress Series, 413*, 217-228. doi: 10.3354/meps08578

Macfadyen, G., Huntington, T. & Cappell, R. (2009). *Abandoned, Lost or Otherwise Discarded Fishing Gear*. (UNEP Regional Seas Report and Studies 185, or FAO Fisheries and Aquaculture Technical Paper 523, pp. 115). Rome, Italy: United Nations Environment Programme, Food and Agriculture Organization of the United Nations. Available from http://www.fao.org/docrep/011/i0620e/i0620e00.HTM

Madsen, P., Johnson, M., Miller, P., Soto, N., Lynch, J. & Tyack, P. (2006, October). Quantitative measures of air-gun pulses recorded on sperm whales (*Physeter macrocephalus*) using acoustic tags during controlled exposure experiments. *Journal of the Acoustical Society of America, 120*(4), 2366-2379.

Mahon, R., S. K. Brown, et al. (1998). "Assemblages and biogeography of demersal fishes of the east coast of North America." Canadian Journal of Fisheries and Aquatic Sciences 55: 1704-1738.

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

Mann, D. A., Higgs, D. M., Tavolga, W. N., Souza, M. J. & Popper, A. N. (2001b). Ultrasound detection by clupeiform fishes. *Journal of the Acoustical Society of America, 109*(6), 3048-3054.

Mann, D. A. & Lobel, P. S. (1997, June). Propagation of damselfish (*Pomacentridae*) courtship sounds. *Journal of Acoustical Society of America, 101*(6), 3783-3791.

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

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

Mann, D., Popper, A. & Wilson, B. (2005a, May 20). Pacific herring hearing does not include ultrasound. *Biology Letters, 1*, 158-161. 10.1098/rsbl.2004.0241

Mann, D. A., Popper, A. N. & Wilson, B. (2005b). Pacific herring hearing does not include ultrasound. *Biology Letters, 1*, 158-161.

Marcotte, M. M. & Lowe, C. G. (2008). Behavioral responses of two species of sharks to pulsed, direct current electrical fields: Testing a potential shark deterrent. *Marine Technology Society Journal, 42*(2), 53-61.

Marshall, N. J. (1996). "Vision and sensory physiology - The lateral line systems of three deep-sea fish." Journal of Fish Biology 49: 239-258.

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

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

McCauley, R. D., J. Fewtrell, et al. (2003). "High intensity anthropogenic sound damages fish ears." Journal of the Acoustical Society of America 113(1): 638-642.

McEwan, D. & Jackson, T. A. (1996). *Steelhead Restoration and Management Plan for California*. (pp. 234). Sacramento, CA: California Department of Fish and Game.

McLennan, M. W. (1997). A simple model for water impact peak pressure and pulse width: a technical memorandum. Goleta, CA: Greeneridge Sciences Inc.

Meyer, M., Fay, R. R. & Popper, A. N. (2010). Frequency tuning and intensity coding of sound in the auditory periphery of the lake sturgeon, Acipenser fulvescens. Journal of Experimental Biology, 213, 1567-1578. doi:10.1242/jeb.031757Miller, J. D. (1974, April, 1974). Effects of noise on people. *Journal of the Acoustical Society of America, 56*(3), 729-764.

Miller, M.H., Carlson, J., Cooper, P., Kobayashi, D., Nammack, M., and J. Wilson. (2013). Status review report: scalloped hammerhead shark (*Sphyrna lewini*). Report to National Marine Fisheries Service, Office of Protected Resources. March 2013.131 pp.

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

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

Moore, C. J. (2008). Synthetic polymers in the marine environment: A rapidly increasing, long-term threat. *Environmental Research, 108*(2), 131-139. 10.1016/j.envres.1008.07.025

Morgan, L. & Chuenpagdee, R. (2003) Shifting Gears addressing the collateral impacts of fishing methods in U.S. waters. Island Press, Washington, D.C

Mueller-Blenkle, C., McGregor, P. K., Gill, A. B., Andersson, M. H., Metcalfe, J., Bendall, V., Thomsen, F. (2010a). *Effects of Pile-Driving Noise on the Behaviour of Marine Fish*. (COWRIE Ref: Fish 06-08 / CEFAS Ref: C3371, Technical Report, pp. 57) COWRIE Ltd.

Mueller-Blenkle, C., McGregor, P. K., Gill, A. B., Andersson, M. H., Metcalfe, J., Bendall, V., Thomsen, F. (2010b). *Effects of Pile-Driving Noise on the Behaviour of Marine Fish*. (COWRIE Ref: Fish 06-08 / CEFAS Ref: C3371, Technical Report, pp. 62) COWRIE Ltd.

Musick, J. A., Harbin, M. M., Berkeley, S. A., Burgess, G. H., Eklund, A. M., Findley, L. & Wright, S. G. (2000). Marine, estuarine, and diadromous fish stocks at risk of extinction in North America (exclusive of Pacific salmonids). *25*(11), 6-30.

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

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

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

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

Myrberg, J., A.A. (1980). Ocean noise and the behavior of marine animals: relationships and implications F. P. Diemer, F. J. Vernberg and D. Z. Mirkes (Eds.), *Advanced concepts in ocean measurements for marine biology* (pp. 461-491). Univ.SouthCar.Press, 572pp.

National Marine Fisheries Service. (1997). Endangered and threatened species: Listing of several evolutionary significant units (ESUs) of west coast steelhead. [Final rule]. *Federal Register, 62*(159), 43937-43954.

National Marine Fisheries Service. (2001). *Final Environmental Impact Statement: Fishery Management Plan, Pelagic Fisheries of the Western Pacific Region*. (Vol. 1). Prepared by URS Corporation. Available from http://www.fpir.noaa.gov/Library/PUBDOCs/environmental_impact_statements/FEIS_Wstrn_Pcf_Plgc_Fshrs/feis_wstrn_pcf_plgc_fshrs.html

National Marine Fisheries Service. (2002). Magnuson-Stevens Act provisions; Essential Fish Habitat (EFH). [Final rule]. Federal Register, 67(12), 2343-2383.

National Marine Fisheries Service. (2005). Appendix G: Non-fishing impacts to essential fish habitat and recommended conservation measures. In Final Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska. (pp. 94). Juneau, AK: NOAA, NMFS Alaska Regional Office.

National Marine Fisheries Service. (2009). Annual Report to Congress on the status of U.S. fisheries - 2008. Silver Spring, Maryland: National Oceanic and Atmospheric Administration Available from http://www.nmfs.noaa.gov/sfa/statusoffisheries/booklet_status_of_us_fisheries08.pdf

National Marine Fisheries Service. (2010). Steelhead Trout (*Oncorhynchus mykiss*): NOAA Fisheries Office of Protected Resources.

National Marine Fisheries Service. (2011). Endangered and Threatened Wildlife and Plants; 90-Day Finding on a Petition To List the Scalloped Hammerhead Shark as Threatened or Endangered Under the Endangered Species Act National Marine Fisheries Service. Retrieved from http://www.nmfs.noaa.gov/pr/pdfs/fr/fr76-72891.pdf as accessed

National Oceanic and Atmospheric Administration. (1996). Magnuson Act provisions; Consolidation and

update of regulations. [Proposed rule; request for comments]. Federal Register, 61(85), 19390-19429.

National Oceanic and Atmospheric Administration. (2011). Draft Aquaculture Policy. Available from http://www.nmfs.noaa.gov/aquaculture/docs/noaadraftaqpolicy.pdf

National Research Council (NRC). (1994). Low-frequency sound and marine mammals: Current knowledge and research needs. Washington, DC, National Academy Press.

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

Nedwell, J., Turnpenny, A., Langworthy, J. & Edwards, B. (2003a). *Measurements of Underwater Noise during Piling at the Red Funnel Terminal, Southampton, and Observations of its Effect on Caged Fish*. (Report Reference 558 R 0207, pp. 33) Subacoustech Ltd. Prepared for Red Funnel.

Nedwell, J., Turnpenny, A., Langworthy, J. & Edwards, B. (2003b). Measurements of underwater noise during piling at the Red Funnel Terminal, Southampton, and observations of its effect on caged fish. (Report 558 R 0207, pp. 33 pp.). Hants, UK: Subacoustech Ltd.

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

Nemeth, D. J. & Hocutt, C. H. (1990). Acute effects of electromagnetic pulses (EMP) on fish. *Journal of Applied Ichthyology, 6*(1), 59-64.

Nelson, J. S. (2006). Fishes of the World. Hoboken, NJ, John Wiley & Sons: 601.

Nestler, J. M., Goodwin, R. A., Cole, T. M., Degan, D. & Dennerline, D. (2002). Simulating Movement Patterns of Bluback Herring in a Stratified Southern Impoundment. *Transations of the American Fisheries Society, 131*, 55-69.

Newman, M. C. (1998). Uptake, biotransformation, detoxification, elimination, and accumulation. *Fundamentals of ecotoxicology*, 25.

Nix, P. and P. Chapman. (1985). Monitoring of underwater blasting operations in False Creek, British Columbia Proceedings of the workshop on effects of explosive use in the marine environment, Ottawa, Ontario, Environmental Protection Branch Technical Report No. 5, Canada Oil and Gas Lands Administration.

Normandeau, Exponent, T., T. & Gill, A. (2011). Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species. Camarillo, CA: U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region. Available from http://www.gomr.boemre.gov/PI/PDFImages/ESPIS/4/5115.pdf

O'Connell, C. P., Abel, D. C., Rice, P. H., Stroud, E. M. & Simuro, N. C. (2010). Responses of the southern stingray (*Dasyatis americana*) and the nurse shark (*Ginglymostoma cirratum*) to permanent magnets. *Marine and Freshwater Behaviour and Physiology, 43*(1), 63-73. doi: 10.1080/10236241003672230

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

O'Keeffe, D. J. (1984). Guidelines for predicting the effects of underwater explosions on swimbladder fish (pp. 1-28). Dahlgren,Virginia: Naval Surface Weapons Center.

O'Keeffe, D. J. & Young, G. A. (1984). Handbook on the Environmental Effects of Underwater Explosions (pp. 1-207). Silver Spring, Maryland: Naval Surface Weapons Center.

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

Ohman, M. C., Sigray, P. & Westerberg, H. (2007). Offshore windmills and the effects electromagnetic fields on fish. *Ambio, 36*(8), 630-633. doi: 10.1579/0044-7447(2007)36[630:OWATEO]2.0.CO;2

Ormerod, S. J. (2003). Current issues with fish and fisheries: Editor's overview and introduction. *Journal of Applied Ecology, 40*(2), 204-213.

Pacific Fishery Management Council. (2000). *Amendment 14 to the Pacific Coast Salmon Plan (1997) Incorporating the Regulatory Impact Review/Initial Regulatory Flexibility Analysis and Final Supplemental Environmental Impact Statement*. Portland, OR.

Pacific Fishery Management Council. (2008). Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery. July 2008.

Pauly, D. and M. L. Palomares. (2005). "Fishing down marine food web: It is far more pervasive than we thought." Bulletin of Marine Science 76(2): 197-211.Paxton, J. R. and W. N. Eschmeyer (1994). Encyclodpedia of Fishes. San Diego, California, Academic Press.

Pearson, W. H., Skalski, J. R. & Malme, C. I. (1987). Effects of sounds from a geophysical survey device on fishing success. Battelle/Marine Research Laboratory for the Marine Minerals Service, United States Department of the Interior.

Pearson, W. H., Skalski, J. R. & Malme, C. I. (1992). Effects of sounds from a geophysical survey device on behavior of captive Rockfish (*Sebastes spp.*). *Canadian Journal of Fisheries and Aquatic Sciences, 49*, 1343-1356.

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

Pews Oceans Commission. (2003). *America's Living Oceans: Charting a Course for Sea Change*. (pp. 166). Arlington, VA: Pew Oceans Commission.

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

Pitcher, T. J. (1986). Functions of shoaling behaviour in teleosts. In. The Behavior of Teleost Fishes. T. J. Pitcher. Baltimore, MD, The Johns Hopkins University Press: 294-337.

Pitcher, T. J. (1995). "The impact of pelagic fish behaviour on fisheries." Scientia Marina 59(3-4): 295-306.

Popper, A. N. (1977). A scanning electron microscopic study of the sacculus and lagena in the ears of fifteen species of teleost fishes. *Journal of Morphology, 153*, 397-418.

Popper, A. N. (1980). Scanning electron microscopic studies of the sacculus and lagena in several deep sea fishes. *American Journal of Anatatomy, 157*, 115 136.

Popper, A. N. (2003a, October). Effects of Anthropogenic Sounds on Fishes. *Fisheries, 28*(10), 24-31. Retrieved from www.fisheries.org

Popper, A. N. (2003b). Effects of anthropogenic sounds on fishes. *Fisheries, 28*(10), 24-31.

Popper, A. N. (2008). Effects of mid- and High-Frequency Sonars on Fish. (pp. 52). Newport, Rhode Island: Naval Undersea Warfare Center Division. Prepared by L. Environmental BioAcoustics.

Popper, A. N. & Carlson, T. J. (1998, September). Application of Sound and Other Stimuli to Control Fish Behavior. *Transactions of the American Fisheries Society, 127*(5), 673-707.

Popper, A. N., Carlson, T. J., Hawkins, A. D., Southall, B. L. & Gentry, R. L. (2006). *Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper*. (pp. 15).

Popper, A. N. & Fay, R. R. (2010). Rethinking sound detection by fishes. *Hearing Research*. doi: DOI: 10.1016/j.heares.2009.12.023 Retrieved from http://www.sciencedirect.com/science/article/B6T73-4Y0KWGD-1/2/7a2c622709c6199f8a4051cbbbffbd8c

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

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

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

Popper, A. N. & Hastings, M. C. (2009a). The effects of anthropogenic sources of sound on fishes. *Journal of Fish Biology, 75*(3), 455-489. 10.1111/j.1095-8649.2009.02319.x

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

Popper, A. N. & Hastings, M. C. (2009c). Review Paper: The effects of anthropogenic sources of sound on fishes. [Review Paper]. *Journal of Fish Biology, 75*, 455-489. 10.1111/j.1095-8649.2009.02319.x

Popper, A. N. and B. Hoxter (1984). "Growth of a fish ear: 1. Quantitative analysis of sensory hair cell and ganglion cell proliferation." Hearing Research 15: 133-142.

Popper, A. N. & Hoxter, B. (1987). Sensory and nonsensory ciliated cells in the ear of the sea lamprey, *Petromyzon marinus*. *Brain, Behavior and Evolution, 30*, 43-61.

Popper, A. N., Smith, M. E., Cott, P. A., Hanna, B. W., MacGillivray, A. O., Austin, M. E. & Mann, D. A. (2005). Effects of exposure to seismic airgun use on hearing of three fish species. *Journal of the Acoustical Society of America, 117*(6), 3958-3971. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=16018498

Popper, A. N., D. T. T. Plachta, et al. (2004). "Response of clupeid fish to ultrasound: a review." ICES Journal of Marine Science 61: 1057-1061.

Popper, A. N. & Tavolga, W. N. (1981). Structure and Function of the Ear in the Marine Catfish, *Arius felis*. *Journal of Comparative Physiology, 144*, 27-34.

Price, C. B., Brannon, J. M. & Yost, S. L. (1998). *Transformation of RDX and HMX Under Controlled Eh/pH Conditions* [Final Report]. (Technical Report IRRP-98-2, pp. 34). Washington, DC: U.S. Army Corps of Engineers, Waterways Experiment Station.

Quinn, T.P. & K.W. Meyers. (2004). Anadromy and the marine migrations of Pacific salmon and trout: Rounsefell revisited. Reviews in Fish Biology and Fisheries (2004) 14:421-442.

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

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

Ramcharitar, J. & Popper, A. N. (2004b, September). Masked auditory thresholds in sciaenid fishes: A comparative study. *Journal of Acoustical Society of America, 116*(3), 1687-1691.

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

Ramcharitar, J. U., Deng, X., Ketten, D. & Popper, A. N. (2004). Form and function in the unique inner ear of a teleost: The silver perch (*Bairdiella chrysoura*). *Journal of Comparative Neurology, 475*(4), 531-539.

Ramcharitar, J., Higgs, D. & Popper, A. N. (2006a, January). Audition in sciaenid fishes with different swim bladder-inner ear configurations. *Journal of the Acoustical Society of America, 119*(1), 439-443.

Ramcharitar, J. U., Higgs, D. M. & Popper, A. N. (2006b). Audition in sciaenid fishes with different swim bladder-inner ear configurations. *Journal of the Acoustical Society of America, 119*(1), 439-443.

Randall, J. E. (1998). Zoogeography of shore fishes of the Indo-Pacific region. *Zoological Studies, 37*(4), 227-268.

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

Remage-Healey, L., Nowacek, D. P. & Bass, A. H. (2006b). Dolphin foraging sounds suppress calling and elevate stress hormone levels in a prey species, the Gulf toadfish. *The Journal of Experimental Biology, 209*, 4444-4451. 10.1242/jeb.02525

Rex, M. A. and R. J. Etter. (1998). "Bathymetric patterns of body size: implications for deep-sea biodiversity." Deep-Sea Research II 45(1-3): 103-127.

Reynolds, J. D., Dulvy, N. K., Goodwin, N. B. & Hutchings, J. A. (2005). Biology of extinction risk in marine fishes. *Proceedings of the Roayal Society B-Biological Sciences, 272*(1579), 2337-2344. 10.1098/rspb.2005.3281

Rigg, D. P., Peverell, S. C., Hearndon, M. & Seymour, J. E. (2009). Do elasmobranch reactions to magnetic fields in water show promise for bycatch mitigation? *Marine and Freshwater Research, 60*(9), 942-948. doi: 10.1071/mf08180

Rickel, S. and A. Genin. (2005). "Twilight transitions in coral reef fish: The input of light-induced changes in foraging behaviour." Animal Behaviour 70(1): 133-144.

Rosen, G. & Lotufo, G. R. (2010). Fate and effects of composition B in multispecies marine exposures. Environmental Toxicology and Chemistry, 9999(12), 1-8. doi: 10.1002/etc.153

Ross, Q. E., D. J. Dunning, et al. (1996). "Reducing impingement of alewives with high-frequency sound at a power plant intake on Lake Ontario." North American Journal of Fisheries Management 16: 548-559.Rostad, A., Kaartvedt, S., Klevjer, T. A. & Melle, W. (2006). Fish are attracted to vessels. *ICES Journal of Marine Science, 63*(8), 1431-1437. 10.1016/j.icejms.2006.03.026

Rowat, D., Meekan, M., Engelhardt, U., Pardigon, B. & Vely, M. (2007a). Aggregations of juvenile whale sharks (*Rhincodon typus*) in the Gulf of Tadjoura, Djibouti. *Environmental Biology of Fishes, 80*(4), 465-472. doi: 10.1007/s10641-006-9148-7

Rowat, D., Meekan, M. G., Engelhardt, U., Pardigon, B. & Vely, M. (2007b). Aggregations of juvenile whale sharks (Rhincodon typus) in the Gulf of Tadjoura, Djibouti. *Environmental Biology of Fishes, 80*(4), 465-472. 10.1007/s10641-006-9148-7

Ruggerone, G.T., S.E. Goodman, and R. Miner. (2008). Behavioral response and survival of juvenile coho salmon to pile driving sounds. Natural Resources Consultants, Inc., and Robert Miner Dynamic Testing, Inc.

Sabarros, P. S., Menard, F., Levenez, J. J., Tew-Kai, E. & Ternon, J. F. (2009). Mesoscale eddies influence distribution and aggregation patterns of micronekton in the Mozambique Channel. *Marine Ecology Progess Series, 395*, 101-107. doi:10.3354/meps08087

Sabates, A., Olivar, M. P., Salat, J., Palomera, I. & Alemany, F. (2007). Physical and Biological Processes Controlling the Distribution of Fish Larvae in the NW Mediterranean. *Progress in Oceanography, 74*(2-3), 355-376. 10.1016/j.pocean.2007.04.017

Saele, O., J. S. Solbakken, et al. (2004). "Staging of Atlantic halibut (Hippoglossus hippoglossus L.) from first feeding through metamorphosis, including cranial ossification independent of eye migration." Aquaculture 239: 445-465.

Sancho, G. (2000). "Predatory behaviors of Caranx melampygus (Carangidae) feeding on spawning reef fishes: A novel ambushing strategy." Bulletin of Marine Science 66(2): 487-496.

Scholik, A. R. & Yan, H. Y. (2001, Feb). Effects of underwater noise on auditory sensitivity of a cyprinid fish. *Hearing Research, 152*(1-2), 17-24. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=11223278

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

Schwartz, A. L. (1985). The behavior of fishes in their acoustsic environment. *Environmental Biology of Fishes, 13*(1), 3-15.

Schwarz, A. L. (1985). The behavior of fishes in their acoustic environment. *Environmental Biology of Fishes, 13*(1), 3-15.

Scripps Institution of Oceanography & Foundation., N. S. (2008). Environmental Assessment of a marine geophysical survey by the R/V Melville in the Santa Barbara Channel. Scripps Institution of Oceanography, La Jolla, CA and National Science Foundation, Arlington, VA.

Scripps Institution of Oceanography & Foundation., N. S. (2005). Environmental Assessment of a Planned Low-Energy Marine Seismic Survey by the Scripps Institution of Oceanography on the Louisville Ridge in the Southwest Pacific Ocean, January–February 2006. Scripps Institution of Oceanography, La Jolla, CA and National Science Foundation, Arlington, VA.

Settle, L. R., J. J. Govoni, et al. (2002). Investigation of impacts of underwater explosions on larval and early juvenile fishes.

Sibert, J., J. Hampton, et al. (2006). "Biomass, size, and trophic status of top predators in the Pacific Ocean." Science 314: 1773-1776.

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

Sisneros, J. A. & Bass, A. H. (2003b, February 1). Seasonal Plasticity of Peripheral Auditory Frequency Sensitivity. *The Journal of Neuroscience, 23*(3), 1049-1058.

Skalski, J. R., Pearson, W. H. & Malme, C. I. (1992). Effects of sounds from a geophysical survey device on catch-per unit-effort in a hook-and-line fishery for rockfish (*Sebastes* spp.). *Canadian Journal of Fisheries and Aquatic Sciences, 49*, 1357-1365.

Slabbekoorn, H., Bouton, N., van Opzeeland, I., Coers, A., ten Cate, C. & Popper, A. N. (2010a). A noisy spring: the impact of globally rising underwater sound levels on fish. [Review]. *Trends in Ecology and Evolution, 25*(7).

Slabbekoorn, H., Bouton, N., van Opzeeland, I., Coers, A., ten Cate, C. & Popper, A. N. (2010b). A noisy spring: The impact of globally rising underwater sound levels on fish. *Trends in Ecology and Evolution, 25*(7), 419-427. doi:10.1016/j.tree.2010.04.005

Slotte, A., K. Kansen, et al. (2004). "Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast." Fisheries Research 67: 143-150.

Smith, M. E., Coffin, A. B., Miller, D. L. & Popper, A. N. (2006). Anatomical and functional recovery of the goldfish (*Carassius auratus*) ear following noise exposure. *Journal of Experimental Biology, 209*, 4193-4202. doi:10.1242/jeb.02490

Smith, M. E., Kane, A. S. & Popper, A. N. (2004a, Sep). Acoustical stress and hearing sensitivity in fishes: does the linear threshold shift hypothesis hold water? *Journal of Experimental Biology, 207*(Pt 20), 3591-3602. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=15339955

Smith, M. E., Kane, A. S. & Popper, A. N. (2004b, Jan). Noise-induced stress response and hearing loss in goldfish (Carassius auratus). *Journal of Experimental Biology, 207*(Pt 3), 427-435. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=14691090

Song, J., Mann, D. A., Cott, P. A., Hanna, B. W. & Popper, A. N. (2008). The inner ears of northern Canadian freshwater fishes following exposure to seismic air gun sounds. *Journal of the Acoustical Society of America, 124*(2), 1360-1366. Retrieved from http://link.aip.org/link/?JAS/124/1360/1

Song, J., Mathieu, A., Soper, R. F. & Popper, A. N. (2006). Structure of the inner ear of bluefin tuna Thunnus thynnus. *Journal of Fish Biology, 68*, 1767-1781. 10.1111/j.1095-8649.2006.01057.x Retrieved from http://www.blackwell-synergy.com

South Atlantic Fishery Management Council. (2011). Dolphin Fish. [Web page] South Atlantic Fishery Management Council. Retrieved from http://www.safmc.net/FishIDandRegs/FishGallery/DolphinFish/tabid/284/Default.aspx

Spargo, B. J. (1999). Environmental Effects of RF Chaff: A Select Panel Report to the Undersecretary of Defense for Environmental Security. Washington, DC, U.S. Department of the Navy, Naval Research Laboratory: 85.

Speed, C. W., Meekan, M. G., Rowat, D., Pierce, S. J., Marshall, A. D. & Bradshaw, C. J. A. (2008). Scarring patterns and relative mortality rates of Indian Ocean whale sharks. *Journal of Fish Biology, 72*(6), 1488-1503. doi: 10.1111/j.1095-8649.2008.01810.x

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

Stadler, J. H. & Woodbury, D. P. (2009). Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria, *Inter-Noise 2009: Innovations in Practical Noise Control*. Ottawa, Canada.

Stenseth, N. C., Mysterud, A., Ottersen, G., Hurrell, J. W., Chan, K. S. & Lima, M. (2002). Ecological effects of climate fluctuations. *Science, 297*, 1292-1296.

Stevens, J. D. (2007). Whale shark (*Rhincodon typus*) biology and ecology: A review of the primary literature. *Fisheries Research, 84*(1), 4-9. doi: 10.1016/j.fishres.2006.11.008

Stuhmiller, J. H., Phillips, Y. Y. & Richmong, D. R. (1990). The Physics and Mechanisms of Primary Blast Injury R. Zatchuck, D. P. Jenkins, R. F. Bellamy and C. M. Quick (Eds.), *Textbook of Military Medicine. Part I. Warfare, Weapons, and the Casualty* (Vol. 5, pp. 241-270). Washington. D.C.: TMMM Publications.

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

Tavolga, W. N. (1974a). Sensory parameters in communication among coral reef fishes. *The Mount Sinai Journal of Medicine, 41*(2), 324-340.

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

The Hawaii Association for Marine Education and Research Inc. (2005). Manta Rays. Retrieved from http://www.hamerhawaii.com/Main%20Web%20Pages/Education/Marine$10Life/Rays/manta_rays.htm, November 18, 2010.

Torres-Rojas, Y. E., Hernandez-Herrera, A., Galvan-Magana, F. & Alatorre-Ramirez, V. G. (2010). Stomach content analysis of juvenile, scalloped hammerhead shark *Sphyrna lewini* captured off the coast of Mazatlan, Mexico. *Aquatic Ecology*, 44(1), 301-308. 10.1007/s10452-009-9245-8

U.S. Department of the Navy. (1996). *Environmental Assessment of the Use of Selected Navy Test Sites for Development Tests and Fleet Training Exercises of the MK-46 and MK 50 Torpedoes* [Draft report]. Program Executive Office Undersea Warfare, Program Manager for Undersea Weapons.

U.S. Department of the Navy. (1998). Shock Testing the Seawolf Submarine Final Environmental Impact Statement.

U.S. Department of the Navy. (2001a). *Airborne Mine Neutralization System (AMNS) Inert Target Tests: Environmental Assessment and Overseas Environmental Assessment*. (pp. 83). Panama City, FL: Coastal Systems Station. Prepared by Science Applications International Corporation.

U.S. Department of the Navy. (2001b). *Overseas Environmental Assessment (OEA) for Cape Cod TORPEDO EXERCISE (TORPEX) in Fall 2001*. (pp. 62). Arlington, VA: Undersea Weapons Program Office. Prepared by Naval Undersea Warfare Center Division Newport.

U.S. Department of the Navy. (2006). Archival Search Report for Certain Northeast Range Complex Training/Testing Ranges: Small Point Mining Range, Ex-Salmon Site and the Tomahawk Missile Recovery Site at Ralph Odom Survival Training Facility [Final Report]. (Contract No. N62470-02-D-3054, D0 0009, Mod 3, pp. 87). Norfolk, VA: U.S. Department of the Navy.

U.S. Navy Office of Naval Research. (2001). *Final Environmental Impact Statement for the North Pacific Acoustic Laboratory*. (Vol. I and II). Arlington, VA.

U.S. Air Force, Headquarters Air Combat Command. (1997). Environmental Effects of Self-Protection Chaff and Flares. Langley Air Force Base, VA, U.S. Air Force: 241.

U.S. Army Corps of Engineers, Waterways Experiment Station, Environmental Laboratory. (1998). Toxicity of Military Unique Compounds in Aquatic Organisms: An Annotated Bibliography (Studies Published Through 1996) [Final Report]. (Technical Report IRRP-98-4, pp. 93). Vicksburg, MS: U.S. Army Corps of Engineers.

U.S. Environmental Protection Agency. (2004). Regional Analysis Document for Cooling Water Intake Structures-CWA 316(b), Phase II-Large existing electric generating plants. In Cooling Water Intake Structures-CWA 316(b). [Electronic Data] EPA. Retrieved from http://www.epa.gov/waterscience/316b/phase2/casestudy/final.htm, 13 April 2010.

van der Oost, R., Beyer, J. & Vermeulen, N. P. E. (2003). Fish bioaccumulation and biomarkers in environmental risk assessment: a review. *Environmental Toxicology and Pharmacology, 13*(2), 57-149.

Vaske, T., Vooren, C. M. & Lessa, R. P. (2009). Feeding Strategy of the Night Shark (*Carcharhinus signatus*) and Scalloped Hammerhead Shark (*Sphyrna lewini*) Near Seamounts off Northeastern Brazil. *Brazilian Journal of Oceanography*, 57(2), 97-104.

Wang, W. X. & Rainbow, P. S. (2008). Comparative approaches to understand metal bioaccumulation in aquatic animals. Comparative Biochemistry and Physiology C-Toxicology & Pharmacology, 148(4), 315-323. doi: 10.1016/j.cbpc.2008.04.003

Wainwright, P. C. and B. A. Richard. (1995). "Predicting patterns of prey use from morphology of fishes." Environmental Biology of Fishes 44: 97-113.

Wardle, C. S. (1986). Fish behaviour and fishing gear. In T. J. Pitcher (Ed.), *The Behavior of Teleost Fishes* (pp. 463-495). Baltimore, MD: The Johns Hopkins University Press.

Wardle, C. S., T. J. Carter, et al. (2001). "Effects of seismic air guns on marine fish." Continental Shelf Research 21: 1005-1027.

Warrant, E. J. and N. A. Locket. (2004). "Vision in the deep sea." Biological Reviews 79(3): 671-712.

Wedemeyer, G. A., Barton, B. A. & McLeay, D. J. (1990). Stress and acclimation. In C. B. Schreck and P. B. Moyle (Eds.), *Methods for Fish Biology* (pp. 451-489). Bethesda, MD: American Fisheries Society.

Wegner, N. C., C. A. Sepulveda, et al. (2006). "Gill specializations in high-performance pelagic teleosts, with reference to striped marlin (Tetrapturus audax) and wahoo (Acanthocybium solandri)." Bulletin of Marine Science 79(3): 747-759.

West Coast Salmon Biological Review Team, Northwest Fisheries Science Center & Southwest Fisheries Science Center. (2003). *Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead*. Available from http://www.nwfsc.noaa.gov/trt/brtrpt.htm

Wiley, M. L., Gaspin, J. B. & Goertner, J. F. (1981). Effects of underwater explosions on fish with a dynamical model to predict fishkill. *Ocean Science and Engineering, 6*, 223-284.

Wilson, S. K., Adjeroud, M., Bellwood, D. R., Berumen, M. L., Booth, D., Bozec, Y. M., Syms, C. (2010, Mar). Crucial knowledge gaps in current understanding of climate change impacts on coral reef

fishes. [Article]. *Journal of Experimental Biology, 213*(6), 894-900. 10.1242/jeb.037895 Retrieved from <Go to ISI>://WOS:000275002600011

Wright, A., Soto, N., Baldwin, A., Bateson, M., Beale, C., Clark, C., Martin, V. (2007). Anthropogenic Noise as a Stressor in Animals: A Multidisciplinary Perspective. *International Journal of Comparative Psychology*. Retrieved from http://escholarship.org/uc/item/46m4q10x

Wright, D. G. (1982). A Discussion Paper on the Effects of Explosives on Fish and Marine Mammals in the Waters of the Northwest Territories *Canadian Technical Report of Fisheries and Aquatic Sciences*. (pp. 1-16). Winnipeg, Manitoba: Western Region Department of Fisheries and Oceans.

Wright, D. G. & Hopky, G. E. (1998). Guidelines for the use of explosives in or near Canadian fisheries waters *Canadian Technical Report of Fisheries and Aquatic Sciences 2107*.

Wright, K., Higgs, D., Belanger, A. & Leis, J. (2005a, June). Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces: Pomacentridae). *Marine Biology, 147*, 1425-1434.

Wright, K. J., Higgs, D. M., Belanger, A. J. & Leis, J. M. (2005b). Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces: Pomacentridae). *Marine Biology, 147*, 1425-1434.

Wright, K. J., Higgs, D. M., Belanger, A. J. & Leis, J. M. (2007). Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces: Pomacentridae). [Erratum to Mar Biol 147:1425–1434 DOI 10.1007/s00227-005-0028-z]. *Marine Biology, 150*, 1049-1050.

Wright, K. J., Higgs, D. M., Cato, D. H. & Leis, J. M. (2010). Auditory sensitivity in settlement-stage larvae of coral reef fishes. *Coral Reefs, 29*, 235-243. doi:10.1007/s00338-009-0572-y

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

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

Wysocki, L. E. & Ladich, F. (2005, Mar). Hearing in fishes under noise conditions. *Journal of the Association for Research in Otolaryngology, 6*(1), 28-36. 10.1007/s10162-004-2427-0 Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=15735936

Yelverton, J. T., Richmond, D. R., Hicks, W., Saunders, K. & Fletcher, E. R. (1975). The relationship between fish size and their response to underwater blast. (Defense Nuclear Agency Topical Report DNA 3677T, pp. 39 pp.). Washington, DC: Lovelace Foundation for Medical Education and Research, Defense Nuclear Agency.

Young, G. A. (1991). Concise Methods for Predicting the Effects of Underwater Explosions on Marine Life. (NAVSWC MP 91-220, pp. 19). Dahlgren, VA: U.S. Department of the Navy, Naval Surface Warfare Center.

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

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3.10 Cultural Resources

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3.10 CULTURAL RESOURCES

CULTURAL RESOURCES SYNOPSIS

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

- Acoustic (underwater explosives and pile-driving)
- Physical disturbance (in-water devices, military expended materials, sea floor devices)

Preferred Alternative

- Acoustics and Physical Disturbance: Acoustic and physical stressors, as indicated above, would not affect submerged cultural resources within United States (U.S.) territorial waters in accordance with Section 106 of the National Historic Preservation Act because measures were previously implemented to protect these resources. A Finding of No Effects on historic properties within the Area of Potential Effect has been determined by the U.S. Department of the Navy, and the California State Historic Preservation Officer (California State Historic Preservation Office 2012) concurs with this finding.

3.10.1 INTRODUCTION AND METHODS

3.10.1.1 Introduction

Cultural resources are found throughout the Hawaii-Southern California Training and Testing (HSTT) Study Area (Study Area). The approach to assessing cultural resources includes defining the resource; presenting the regulatory requirements for identifying, evaluating, and treating the resource within established jurisdictional parameters; establishing the specific resource subtypes in the Study Area; identifying the data used to define the current conditions; and describing the method of impact analysis.

Cultural resources are defined as districts, landscapes, sites, structures, objects, and ethnographic resources, as well as other physical evidence of human activity, that are considered to be important to a culture, subculture, or community for scientific, traditional, religious, or other reasons. Cultural resources include archaeological resources, historic architectural resources, and traditional cultural properties related to prehistoric/pre-contact (prior to European contact) and historic/post-contact periods.

Archaeological resources include prehistoric and historic sites and artifacts. Archaeological resources can have a surface component, a subsurface component, or both. Prehistoric resources are physical properties resulting from human activities that predate written records, and include village sites, temporary camps, lithic scatters, roasting pits, hearths, milling features, petroglyphs, rock features, and burials. Historic resources postdate the advent of written records in a region, and include building foundations, refuse scatters, wells, cisterns, and privies. Submerged cultural resources include historic shipwrecks and other submerged historic materials, such as sunken airplanes and prehistoric cultural remains. Architectural resources are elements of the built environment consisting of standing buildings or structures from the historic period. These resources include existing buildings, dams, bridges, lighthouses, and forts. Traditional cultural resources are resources associated with beliefs or cultural practices of a living culture, subculture, or community. These beliefs and practices must be rooted in the group's history and must be important in maintaining the cultural identity of the group. Prehistoric archaeological sites and artifacts, historic and contemporary locations of traditional events, sacred

places, landscapes, and resource collection areas, including fishing, hunting and gathering areas, may be traditional cultural resources.

3.10.1.2 Identification, Evaluation, and Treatment of Cultural Resources

Procedures for identifying, evaluating, and treating cultural resources within state territorial waters (within 3 nautical miles [nm] of the coast) and United States (U.S.) territorial waters (within 12 nm of the coast) are contained in a series of federal and state laws and regulations, and agency guidelines. Archaeological, historical architectural, and cultural (including Native American and Native Hawaiian) resources are protected by a variety of laws and their implementing regulations: the National Historic Preservation Act of 1966 as amended in 2006, the Archeological and Historic Preservation Act of 1974, the Archaeological Resources Protection Act of 1979, the American Indian Religious Freedom Act of 1978, the Native American Graves Protection and Repatriation Act of 1990, the Submerged Lands Act of 1953, the Abandoned Shipwreck Act of 1987, and the Sunken Military Craft Act of 2004. The Advisory Council on Historic Preservation (Advisory Council) further guides treatment of archaeological and architectural resources through the regulations, *Protection of Historic Properties* (36 Code of Federal Regulations [C.F.R.] Part 800). The category of "historic properties" is a subset of cultural resources that is defined in the National Historic Preservation Act (16 United States Code [U.S.C.] § 470w(5)) as any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places (National Register), including artifacts, records, and material remains related to such a property or resource.

Section 106 of the National Historic Preservation Act requires federal agencies to consider the effects of their actions on cultural resources listed in or eligible for inclusion in the National Register. The regulations implementing Section 106 (36 C.F.R. Part 800) specify a consultation process to assist in satisfying this requirement. Consultation with the appropriate State Historic Preservation Offices, the Advisory Council, Native American tribes and Native Hawaiian organizations, the public, and state and federal agencies is required by Section 106 of the National Historic Preservation Act. Government-to-government consultation required by Executive Order (EO) 13007 will be accomplished concurrently with the preparation of this Environmental Impact Statement (EIS)/Overseas EIS (OEIS) for the portion of the Proposed Action within state territorial waters (within 3 nm). Section 106 consultation letters for the undertaking described under this EIS/OEIS were delivered to California and Hawaii State Historic Preservation Officers and to the appropriate federally recognized Native American tribes or Native Hawaiian organizations. In a letter dated 5 June 2012, the California State Historic Preservation Office concurred that the Area of Potential Effect for the portion of the undertaking under its jurisdiction had been adequately determined, and further concurred with the U.S. Department of the Navy's (Navy's) finding of No Historic Properties Affected (California State Historic Preservation Office 2012). A finding of No Effect on Historic Properties was submitted to the Hawaii State Historic Preservation Office, and no formal response or objection was received within the 30 days required by law. In accordance with 36 C.F.R. 800.4(d)(1)(i), concurrence by the Hawaii State Historic Preservation Office with the finding is assumed. Consultation with State Historic Preservation Offices, tribes, or Native Hawaiian organizations will continue if required, as stipulated by Section 106.

Additional regulations and guidelines for submerged historic resources include 10 U.S.C. 113, note for the Sunken Military Craft Act; the *Abandoned Shipwreck Guidelines* prepared by the National Park Service (National Park Service 2007) and, for the purposes of conducting research or recovering Navy ship and aircraft wrecks, the *Guidelines for Archaeological Research Permit Applications on Ship and Aircraft Wreck*s *under the Jurisdiction of the Department of the Navy* (36 C.F.R. Part 767) overseen by the Naval History and Heritage Command. The Sunken Military Craft Act does not apply to actions taken

by, or at the direction of, the United States. In accordance with the Abandoned Shipwreck Act of 1987, abandoned shipwrecks in state waters are considered the property of the U.S. Government if the shipwreck meets the criteria for inclusion in the National Register of Historic Places. However, the federal government may transfer the title of an abandoned shipwreck to the state if the shipwreck falls within the jurisdiction of the state (Barnette 2010). Warships or other vessels used for military purposes at the time of their sinking retain sovereign immunity (e.g., Japanese freighters). According to the principle of sovereign immunity, foreign warships sunk in U.S. territorial waters are protected by the U.S. Government, which acts as custodian of the sites in the best interest of the sovereign nation (Neyland 2001). In addition, the federal archaeological program developed by the National Park Service pursuant to a Presidential Order, includes a collection of historical and archaeological resource protection laws to which federal managers adhere.

The addendum to the National Historic Preservation Act (16 U.S.C. 470a-2: International Federal activities affecting historic properties) requires an assessment by federal agencies of project effects on resources located outside U.S. territorial waters that are identified on the World Heritage List. Papahanaumokuakea is located within the Study Area.

No specific procedures for identifying and protecting cultural resources in the open ocean have been defined by the international community (Zander and Varmer 1996). No treaty offering comprehensive protection of submerged cultural resources has been developed and implemented. However a few international conventions prepared by the United Nations Educational, Scientific, and Cultural Organization apply to submerged cultural resources, including the 1970 Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property, the 1972 Convention Concerning the Protection of the World Cultural and Natural Heritage, the 1982 Convention on the Law of the Sea, and the 2001 Convention on the Protection of the Underwater Cultural Heritage. Only the 1970 and 1972 conventions have been fully ratified by the United States.

3.10.1.3 Methods

3.10.1.3.1 Approach

The approach for establishing current conditions is based on different regulatory parameters defined by geographical location. Within U.S. territorial waters (12 nm), the National Environmental Policy Act (NEPA) is the guiding mandate. Areas beyond 12 nm in the open ocean will not be analyzed, as those areas are beyond the jurisdiction of the National Historic Preservation Act and NEPA.

The implementing regulations of Section 106 of the National Historic Preservation Act require federal agencies to take into account the effects that a proposed action would have on cultural resources included in or eligible for inclusion in the National Register of Historic Places. “Historic properties” is synonymous with National Register-eligible or -listed archaeological, architectural, or traditional resources. Cultural resources that have not been formally evaluated (i.e., a Consensus Determination in consultation with the State Historic Preservation Office) may be considered potentially eligible, and thus are afforded the same regulatory consideration as resources listed in the National Register. Evaluations and determinations of historic properties within the Study Area are the responsibility of the federal agency, in consultation with either the State Historic Preservation Office (California) or the State Historic Preservation Division (Hawaii).

Properties are evaluated for nomination to the National Register and for National Register eligibility using the following criteria (36 C.F.R. § 60.4(a)-(d)):

- Criterion A: Be associated with events that have made a significant contribution to the broad patterns of American history
- Criterion B: Be associated with the lives of persons significant in the American past
- Criterion C: Embody the distinctive characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction
- Criterion D: Yield, or may be likely to yield, information important in prehistory or history

A historic property also must possess the following aspects of integrity: location, design, setting, materials, workmanship, feeling, and association to convey its significance and to qualify for the National Register. These seven aspects, in various combinations, define integrity. To retain integrity, a property will always possess several, and usually most, of these aspects.

Cultural resources in U.S. territorial waters (within 12 nm of the coastline) are as follows:

- Resources listed on or eligible for listing on the National Register (Section 106 of the National Historic Preservation Act)
- Resources entitled to sovereign immunity (e.g., Japanese midget submarine)

3.10.1.3.2 Data Sources

Cultural resources information relevant to this EIS/OEIS was derived from a variety of sources, including previous environmental documents, national and international shipwreck databases, the National Register Information System (managed by the National Park Service), information repositories associated with State Historic Preservation Offices, on-line maps and data, and published sources, as cited. Previous environmental documents used for general information include the *Hawaii Range Complex EIS/OEIS* (U.S. Department of the Navy 2008a), *Southern California Range Complex EIS/OEIS* (U.S. Department of the Navy 2008b), and *Silver Strand Training Complex EIS* (U.S. Department of the Navy 2011).

The national and international shipwreck databases researched included the National Oceanic and Atmospheric Administration's Office of Coast Survey Advanced Wreck and Obstruction Information System, National Oceanic and Atmospheric Administration Aids to Navigation, California State Lands Commission Shipwrecks database, and the General Dynamics Global Maritime Wrecks Database, as well as secondary sources of shipwreck information. Many of the shipwreck databases and secondary sources overlap, generating repetitiveness in data. Many federal agencies "share" data as well as secondary sources. The intent of this analysis is not to provide a definitive number of shipwrecks, obstructions, or hazards within a defined area, however, but rather to provide an overview of the potential resources in an area.

The online National Register Information System was reviewed to identify National Register-listed properties, historic districts, and National Historic Landmarks. Appropriate information repositories associated with the State Historic Preservation Offices were contacted or their online databases were reviewed for information on shipwreck locations, types, and eligibility for listing on the state registers and National Register of Historic Places.

3.10.1.3.3 Cultural Context

Several types of cultural properties may be present in the Study Area, including: submerged prehistoric occupation sites along the continental shelf; wrecks of ships, submarines, aircraft, and barges; sunken navigational equipment, such as buoys; man-made obstructions; and Indian tribe and Native Hawaiian marine resource gathering areas (e.g., Traditional Cultural Properties such as traditional fishing, seaweed, mussel, abalone, clam-gathering grounds, and whaling areas). Research suggests that the sea level rose steadily from about 18,000 years ago to about 7,500 years ago, whereupon it reached present-day levels. In California, PaleoIndian and Archaic period sites were submerged by the rising ocean. Many of these sites would not have been preserved as the encroaching ocean inundated, reworked, and redeposited sediments. In California, locations where PaleoIndian and Archaic period sites may have been preserved include: back barrier deposits or mainland shore deposits located behind large, nearshore islands, estuaries, and portions of coastal floodplains.

3.10.1.3.3.1 Hawaii

Human colonization of the Hawaiian Islands occurred after sea levels stabilized, so no sites are known to exist beyond the current coast lines. Traditional Hawaiian cultural resources, such as stone artifacts, sinkers, and octopus lures, may be located below the water surface; however, because of environmental factors, such as weathering, the location of these resources are not known, and therefore they are not eligible for listing on the National Register of Historic Places (Minerals Management Service 1990, National Oceanic and Atmospheric Adminstration 2012).

Archaeological evidence suggests that the first permanent settlements appeared in the Hawaiian Islands around approximately Anno Domini (A.D.) 300. Because the sea level had already stabilized by the time the Hawaiian Islands were first settled, no pre-contact submerged archaeological sites are found in Hawaii. Any submerged cultural resources are the result of natural erosion or modern/historical development.

European contact with the Hawaiian Islands occurred when Captain James Cook landed in Waimea Harbor in 1778. Kamehameha I united the Hawaiian Islands in 1818. Hawaii assumed importance in the east-west fur trade during this period, and later became the focal point for the Pacific whaling industry. Honolulu and Lahaina became the principal ports for the whaling fleet in Hawaii. By the 1840s, approximately 600 whaling vessels were arriving in Hawaii each year (Kelley 2006). Sunken vessels from this period may be located near the coasts of the Hawaiian Islands. Pearl Harbor became an import harbor in the late 19th century and, in 1887, the U.S. Senate allowed the Navy to lease Pearl Harbor. The harbor was dredged in the early 20th century to accommodate large vessels and, in 1908, Pearl Harbor Naval Shipyard was established.

3.10.1.3.3.2 Southern California

The Late Prehistoric Period along the coast of Southern California was characterized by elaborate artifact inventories and distinctive local cultural complexes that lasted until contact with Europeans (Sutton 2010). Artifacts from this period include circular fishhooks, whalebone markers, asphalt skirt weights, steatite ollas, shell beads, bone gorges, composite fishhooks, Cottonwood series projectile points, and spear points (Noah 1998, Sutton 2010). Evidence from numerous archaeological sites along the coast suggests an exploitation of bay and estuary kelp beds, rocky areas, and offshore environments. Bones from numerous species of fish and marine mammals have been recovered from middens. Coastal Late Prehistoric settlements were located near estuaries, along mouths of sloughs and rivers, and around bays, such as Mission Bay in San Diego. Prehistoric habitation sites are not commonly found

outside of the inner continental shelf. During the Late Prehistoric Period, cultural traits associated with Kumeyaay, Luiseño, Cupeño, and Cahuilla peoples of the ethnographic period are found.

The maritime history along the west coast of the United States is a history of exploration, imperial competition, and commercial adventurism. The period of exploration began at least as early as the first Spanish voyages northward from Mexico in the 1530s, and by 1578 the British were encroaching on the Spanish monopoly along the coast of California. Undiscovered sunken vessels from early Spanish and British exploration, colonization, and trade may be present in coastal Southern California.

Prior to World War I, the Navy did not have strong presence in San Diego. By 1921, the Navy acquired a site for the U.S. Destroyer Base, San Diego facility. During the 1930s, San Diego harbor was dredged as a result of Public Works Administration projects, and San Clemente Island was purchased by the Navy as a firing range. The Navy base expanded considerably during World War II, with over 5,100 ships being serviced as a result of the war in the Pacific. Because of the importance of Naval Base San Diego and San Clemente Island Naval Auxiliary Landing Field, the region could contain sunken vessels that were associated with these facilities (Naval Base San Diego 2012).

3.10.2 AFFECTED ENVIRONMENT

The Study Area is divided into three distinct regions for cultural resources evaluation: Southern California, Hawaii, and the open ocean Transit Corridor between them (see Figure 2.1-1). The Study Area covers 335,000 square nautical miles (nm^2); however, only the regions that are located in the offshore waters of Hawaii and Southern California are being evaluated. In the Hawaii Operating Area (OPAREA) (235,000 nm^2), a component of the Hawaii Range Complex (HRC), there are a number of known wrecks, obstructions, and occurrences; however, these sites have not been evaluated as properties eligible for listing in the National Register of Historic Places. In the Southern California (SOCAL) Range Complex within the SOCAL OPAREA (120,000 nm^2), a few hundred such sites have been recorded. The Study Area could contain submerged prehistoric sites on the continental shelf.

3.10.2.1 Hawaii

3.10.2.1.1 Submerged Prehistoric Resources

A few submerged prehistoric resources are located in the waters surrounding the Hawaiian Islands. These resources primarily consist of old shoreline features, such as fishponds. Four extant fishponds lie within the boundaries of the Area of Potential Effects in Pearl Harbor. One fishpond, Pamoku/Puuloa, is filled in with boulders but is intact. The remaining three fish ponds, Paaiau, Okiokilepe, and Laulaunui, become submerged during tidal changes. These fishponds are filled with mangroves and are in waters too shallow for ships to safely navigate, so there would be no effect on these properties. In addition, these fishponds are not located in the loch where sonar testing would occur.

3.10.2.1.2 Known Wrecks, Obstructions, Occurrences, or “Unknowns”

A number of submerged cultural resources lie in the open, deep waters surrounding the Hawaiian Islands. Typical among these resources are wrecks of World War II submarines and ships, commercial fishing vessels and tankers, and aircraft. The most likely types of shipwrecks to occur around the Hawaiian Islands are 19th century cargo ships, submarines, old whaling and merchant ships, fishing boats, 20th century U.S. Warships, and recreational craft. The *Automated Wreck and Obstruction Information System*, Region 16 (2010) records the approximate locations of some deep-water submerged shipwrecks. The majority of these cultural resources, if not all, are likely in poor condition

and lack the integrity to qualify as historic properties eligible for listing to the National Register of Historic Places.

A variety of submerged resources are located in the waters surrounding the Hawaiian Islands (U.S. Department of the Navy 2008a). The most common of these submerged resources are shipwrecks. However, junked motor vehicles, harbor features, and old shoreline features are also present. Figure 3.10-1 through Figure 3.10-3 illustrate offshore shipwrecks near the Hawaiian Islands.

Shipwrecks located near the Island of Hawaii are concentrated along the northwestern coastline and within Hilo Bay. The numerous known wrecks in the waters surrounding Oahu include: the largely intact Sea Tiger, a World War II-era Japanese midget submarine; the *Mahi* a Navy minesweeper/cable layer intentionally sunk off the Waianae Coast to create an artificial reef; and the YO-257, a Navy yard oiler built in the 1940s, intentionally sunk off Waikiki to create an artificial reef. The *Mahi* and the YO-257 are both artificial reefs, so they are not eligible for listing in the National Register of Historic Places. Within the Ewa Training Minefield, off of the southern coast of Oahu, there is one known shipwreck (Figure 3.10-3). The wreck is likely the *USS Chittenden County* that was sunk as a target in 1958 by the *Sargo SS-583*; this shipwreck is not eligible for listing in the National Register. Because offshore shipwrecks are in relatively deep water and their locations are not precisely known, a figure illustrating offshore Hawaii shipwrecks is not presented in this document. Submerged resources in Pearl Harbor are discussed in Section 3.10.2.1.3.

3.10.2.1.3 Cultural Resources Eligible for Listing or Listed in the National Register

The data indicate that no shipwrecks in the State of Hawaii are listed in the National Register, excluding those at Naval Station Pearl Harbor. At Pearl Harbor, which is listed in the National Register as a National Historic Landmark, an abundance of submerged cultural resources are associated with World War II. Major shipwrecks include the *USS Arizona* and the *USS Utah*, both of which are listed in the National Register. Training and testing activities would not affect historic properties within Pearl Harbor.

3.10.2.1.4 Cultural Resources Eligible for or Listed on the State Inventory of Historic Places

Outside of Pearl Harbor, the Study Area contains no Hawaii State Register-listed or -eligible sites.

3.10.2.1.5 World Heritage Sites

The Hawaii region of the Study Area contains one World Heritage Site, the Papahanaumokuakea Marine National Monument. This area is protected and encompasses 140,000 square miles of ocean and 10 islands and atolls northwest of Kauai. The Monument contains historic shipwrecks; however, these shipwrecks are not listed as historic properties in the National Register. The Navy would continue its testing and training in existing designated areas, so no activities related to the HSTT would occur within the Papahanaumokuakea Marine National Monument.

3.10.2.1.6 Resources with Sovereign Immunity

The Study Area contains at least one resource with sovereign immunity: a World War II-era Japanese Midget “A” submarine that was sunk by the *USS Ward* (New South Wales 2012). As the midget submarine is a known obstruction, which the Navy avoids, training and testing activities associated with the HSTT would not affect this resource.

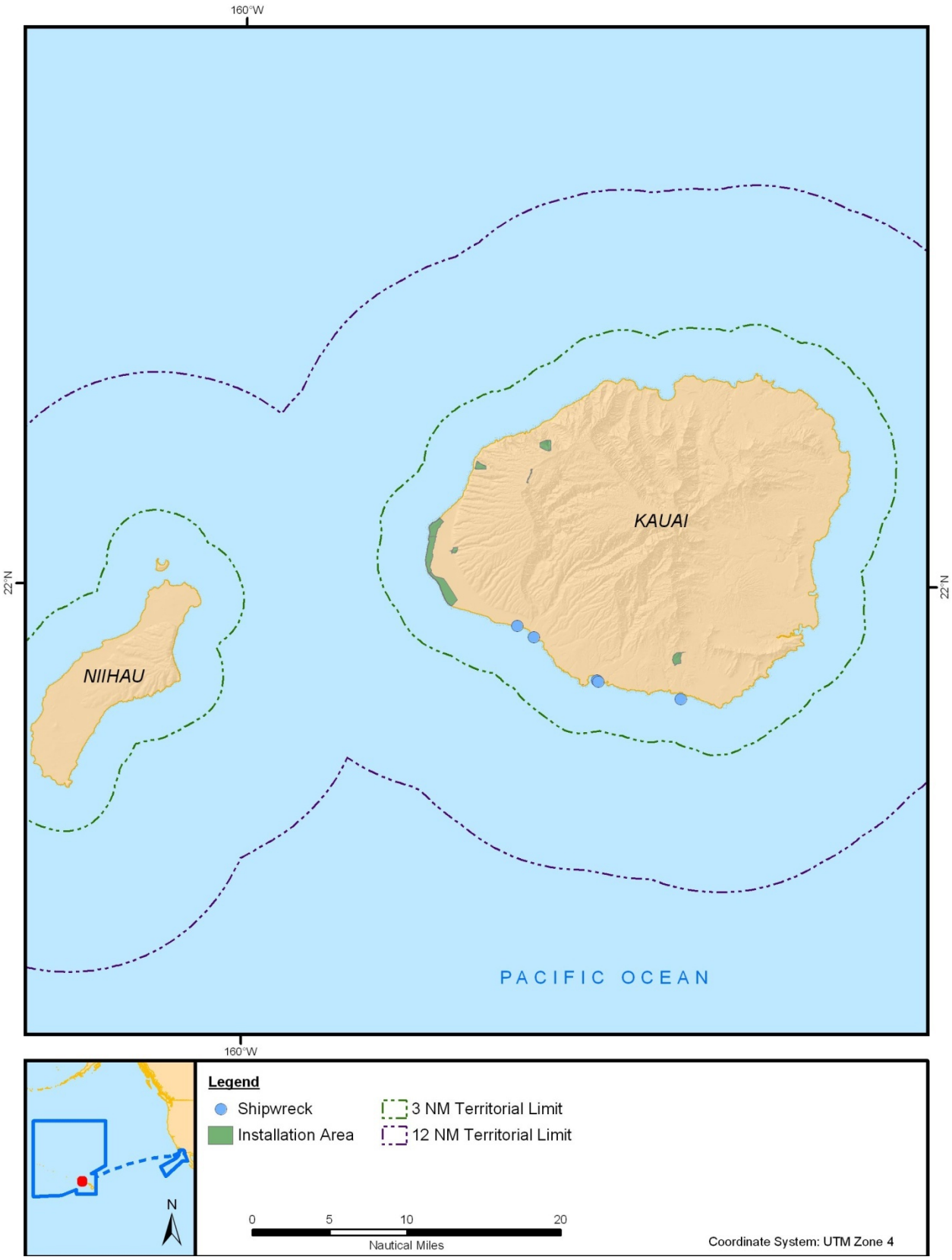

Figure 3.10-1: Kauai Known Shipwrecks

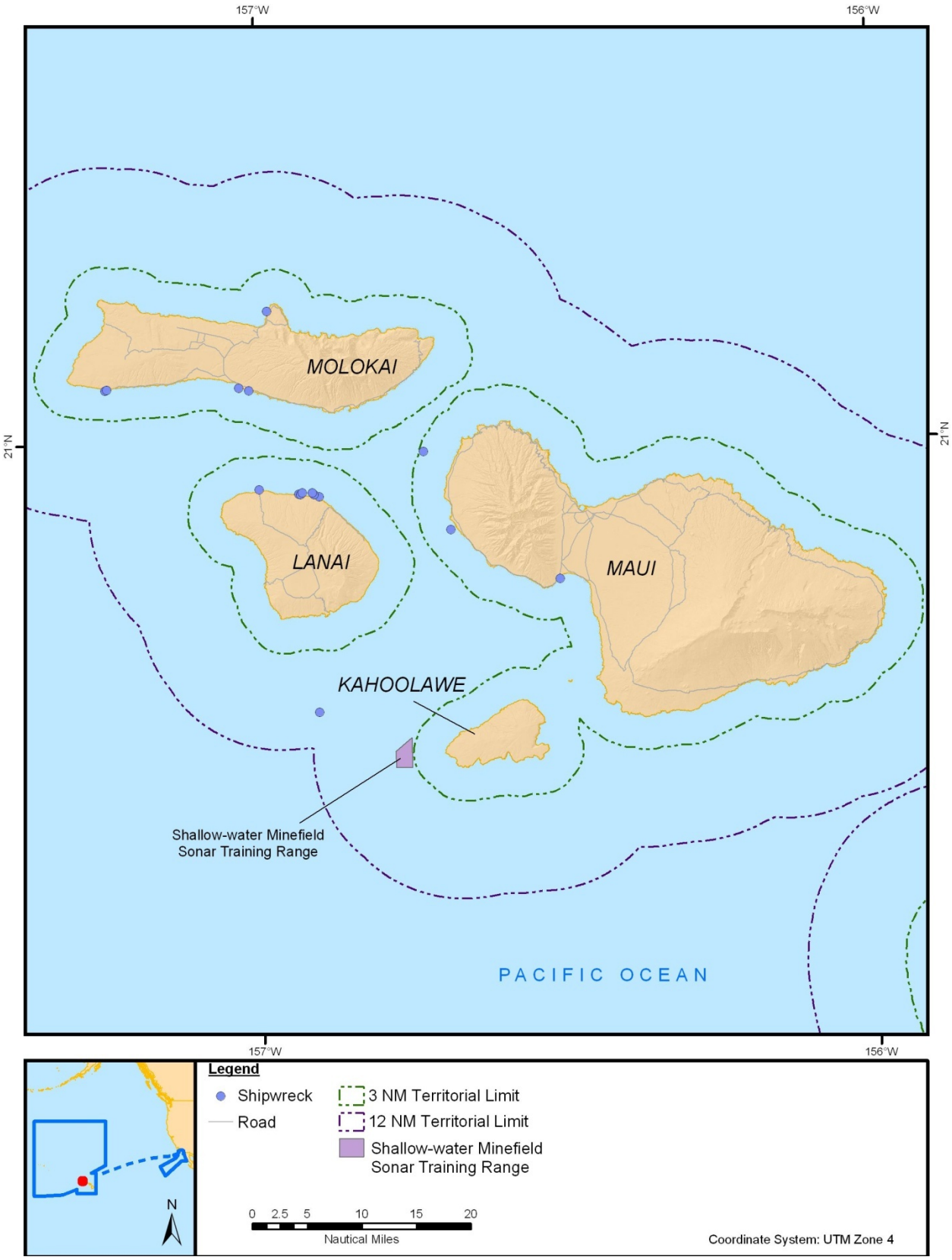

Figure 3.10-2: Molokai, Lanai, Maui, and Kahoolawe Known Shipwrecks

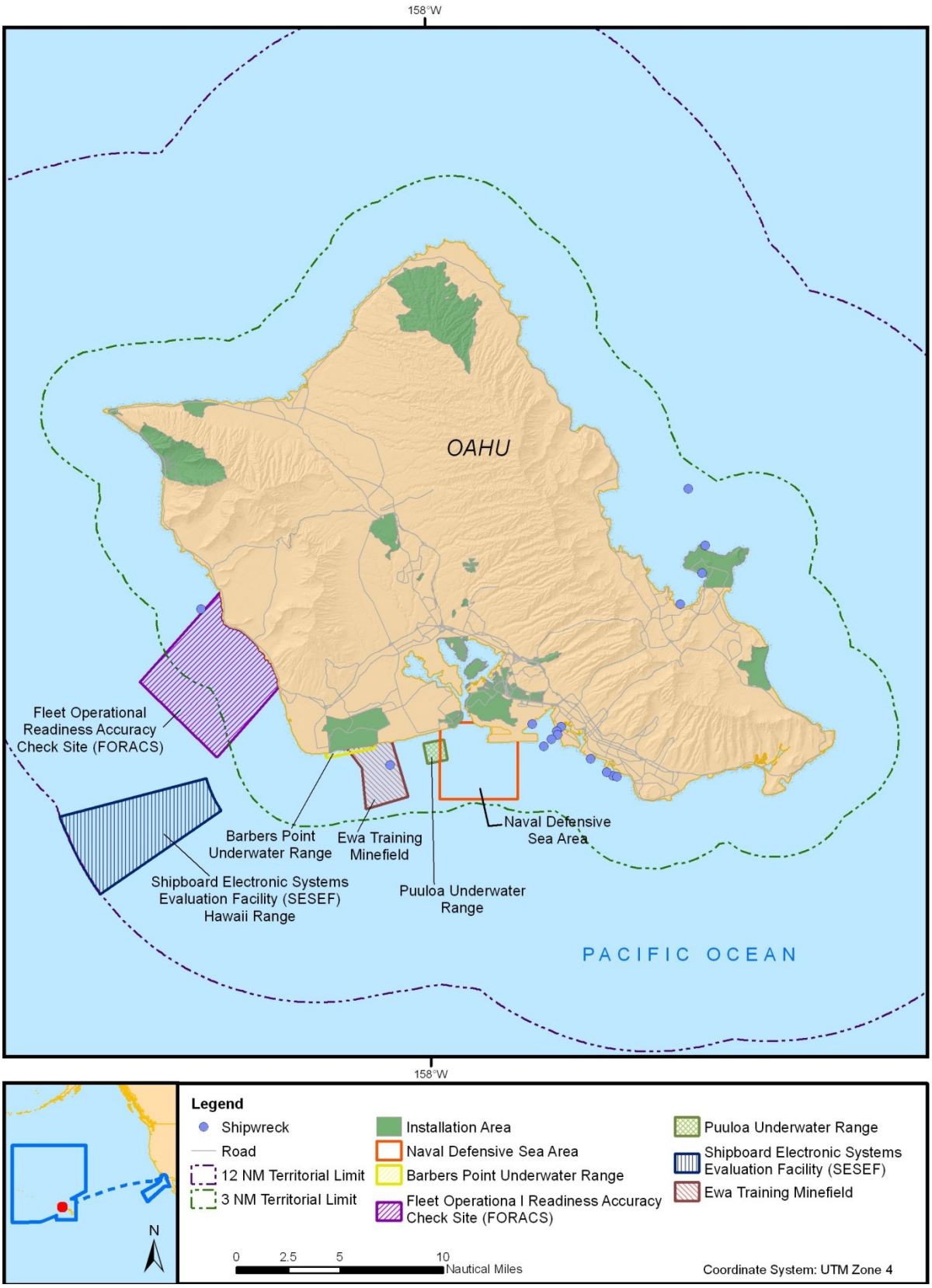

Figure 3.10-3: Oahu Known Shipwrecks

3.10.2.2 Southern California

3.10.2.2.1 Submerged Prehistoric Resources

PaleoIndian and Archaic period sites occur on the continental shelf off the coast of California. Approximately 110 submerged artifacts and sites from the Archaic period have been identified in Southern California (Masters 2003). However, they are located outside of Navy training and testing areas. Prehistoric cultural materials, such as stone bowls and mortars, are also common off the coast of San Diego County (Masters and Schneider 2000, Masters 2003). A concentration of this cultural material is located off La Jolla and Point Loma (Masters 2003).

3.10.2.2.2 Known Wrecks, Obstructions, Occurrences, or "Unknowns"

3.10.2.2.2.1 Offshore

From the early period of Spanish exploration to the intense commercialization of the 19th and 20th centuries, there has been a great variety of shipwrecks in the Pacific Ocean. The earliest known shipwreck was the Manila galleon *San Agustin* that sank off the northern coast of California in 1595. Since that time, thousands of vessels of varying types and descriptions have sunk off the coast of California. Various databases of these shipwrecks have been compiled, including the *Automated Wreck and Obstruction Information System* database (Automated Wreck and Obstruction Information System Database 2010). As part of a Minerals Management Service study (Minerals Management Service 1990), a database was compiled that documents 4,676 shipwrecks off the coast of California, with 876 wrecks in Southern California. The *Automated Wreck and Obstruction Information System* database (Automated Wreck and Obstruction Information System Database 2010) documents 292 wrecks just in San Diego, Orange, Los Angeles, and Ventura Counties.

Submerged cultural resources in the waters around San Clemente Island include pleasure craft, sport and commercial fishers, and cargo and military vessels (Department of the Navy 2008b). Of these 68 submerged cultural resources, 22 are within 12 nm of San Clemente Island and seven are beyond the territorial limit. Submerged aircraft are also reported off San Clemente Island. Figure 3.10-4 illustrates known submerged cultural resources near San Clemente Island.

The potential for long-term preservation of historic properties in the waters surrounding San Clemente Island is considered low, because the intertidal waters in the area create a high-energy environment that accelerates the decay of archaeological resources. Submerged cultural resources identified include 35 shipwrecks, 17 aircraft, an anchor, and the abandoned Sea Lab.

3.10.2.2.2.2 Silver Strand Training Complex

On the bay side of Silver Strand peninsula, three shipwrecks are in or near the training beaches. Unnamed wrecks are recorded in shallow water at the northern end of Delta South beach, in the middle of San Diego Bay, and at the mouth of Fiddler's Cove. The ages and cultural value of these wrecks are not known (U.S. Department of the Navy 2008b).

On the ocean side of the peninsula, three shipwrecks are located near Silver Strand Training Complex (SSTC) training areas: the bark Narwhale (sank in 1934); the submarine S-142: and the Subchaser YC689 (sank in 1943). The destroyer *USS Hogan* (DD178), a military aircraft (S2F Tracker), and a sunken sailboat are located offshore, south of SSTC and west of the City of Imperial Beach (Figure 3.10-5) (U.S. Department of the Navy 2008b).

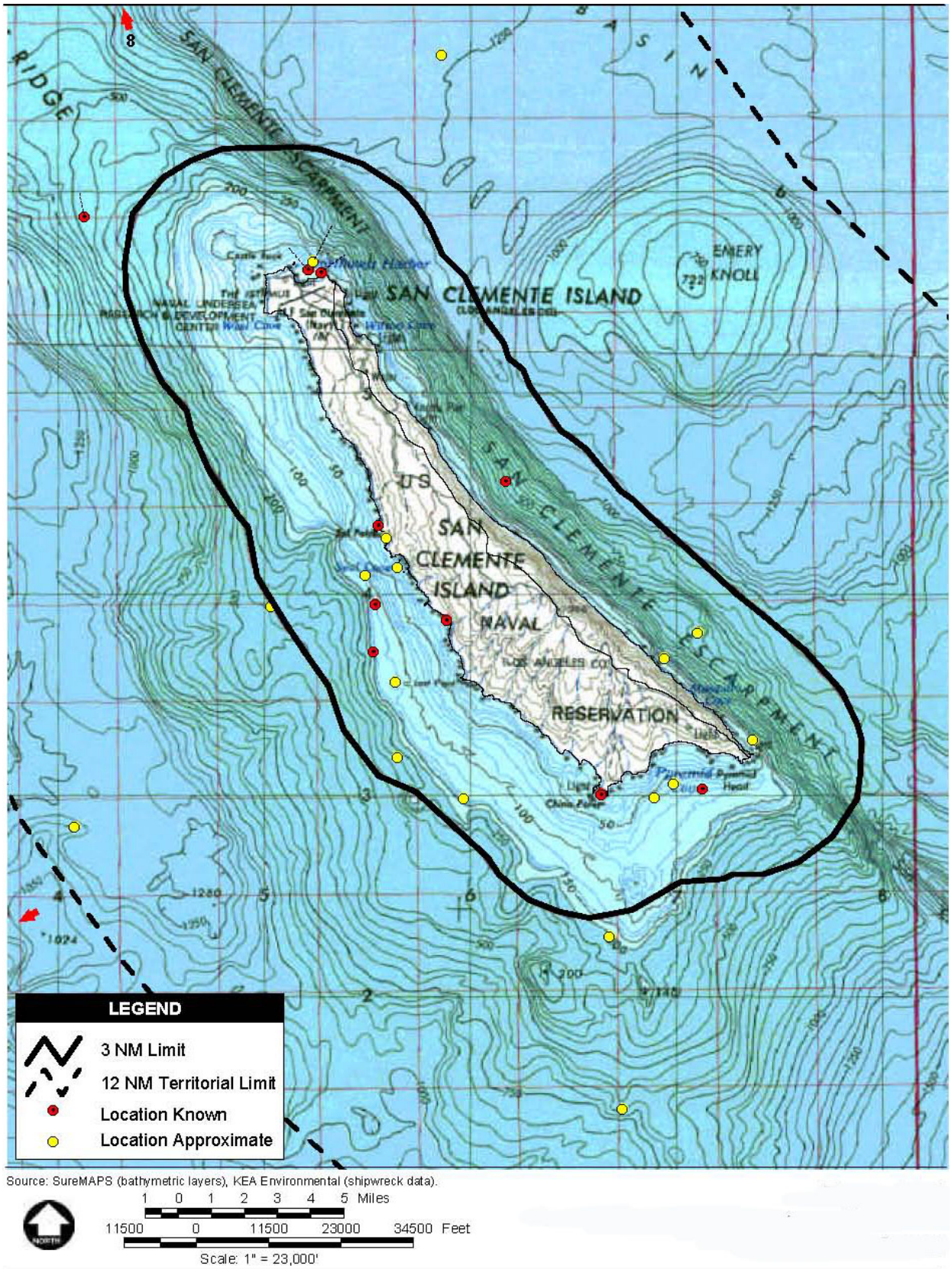

Figure 3.10-4: San Clemente Island Submerged Shipwrecks and Obstructions

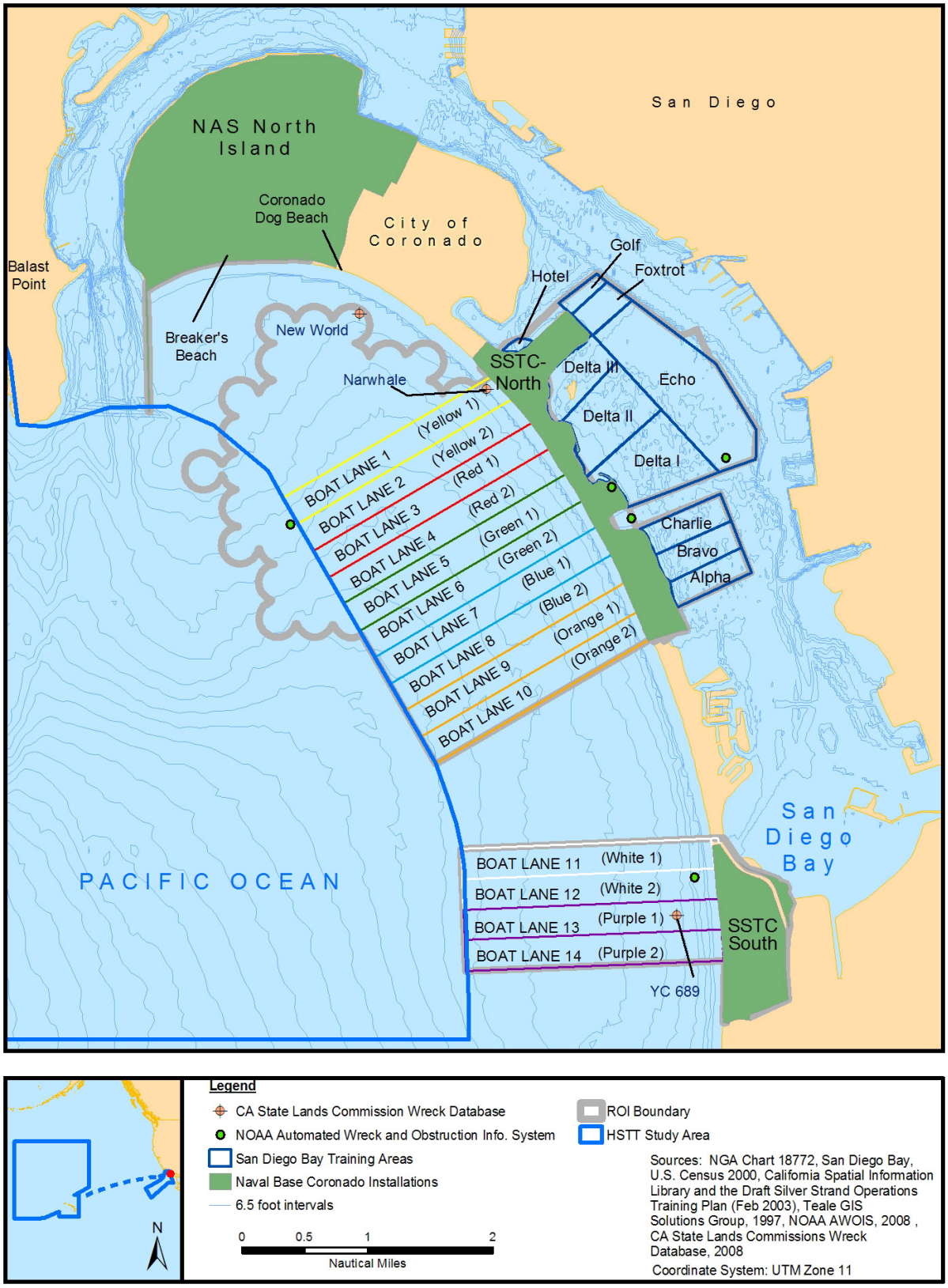

Figure 3.10-5: San Diego Bay and Silver Strand Training Complex Submerged Cultural Resources

3.10.2.2.2.3 San Diego Bay

Known cultural resources in San Diego Bay have not been inventoried. However, cultural resources were reviewed for the San Diego Deepening at Tenth Avenue Marine Terminal project (EDAW 2005). This review identified three known submerged cultural features: a shipwreck (the *Della*), an 1887 marine utility cable, and a sunken Ford Model T. The EDAW study identified 24 cultural resources with unknown location, but known to be lost in the San Diego area, including schooners, barges, a submarine, clippers, gas and oil screws, a yacht, a bark, a ferry, a ship, and a steamer. Figure 3.10-5 illustrates known submerged cultural resources in San Diego Bay.

3.10.2.2.3 Cultural Resources Eligible for or Listed on the National Register

The Study Area contains no National Register-listed or -eligible sites.

3.10.2.2.4 Cultural Resources Eligible for or Listed on the California Register

The Study Area contains no California Register-listed or -eligible sites.

3.10.2.2.5 World Heritage Sites

The Study Area contains no World Heritage Sites.

3.10.2.2.6 Resources with Sovereign Immunity

The Study Area contains no resources with sovereign immunity.

3.10.2.3 Hawaii-Southern California Training and Testing Transit Corridor

The length and variable width of the HSTT transit corridor creates such a vast area that it precludes a systematic survey for submerged historic resources. Waters along the HSTT transit corridor are deep, sometimes over 18,000 feet (ft.) (5,486.4 meters [m]); thus, identifying cultural resources on the ocean floor in the corridor is difficult. However, in accordance with the addendum to the National Historic Preservation Act (16 U.S.C. 470a-2) regarding international federal activities affecting historic properties, the World Heritage List was reviewed and no resources on the list were identified within the HSTT transit corridor.

3.10.2.4 Current Practices

The Navy routinely avoids locations of known obstructions, which include submerged cultural resources such as historic shipwrecks. Known obstructions are avoided to prevent damage to sensitive Navy equipment and vessels, allowing uninterrupted training and testing exercises.

3.10.2.5 Programmatic Agreement on Navy Undertakings in Hawaii

A programmatic agreement was executed for Navy undertakings in Hawaii, including Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility; outlying Oahu installations; and Pacific Missile Range Facility at Barking Sands, Kauai (Hawaii State Historic Preservation Division 2003). The Programmatic Agreement includes stipulations for development of an integrated cultural resources management plan, determinations of areas of potential effects, identification of historic properties, access to historic sites and interpretative activities, review of project effects, monitoring of ground disturbing activities, annual reporting requirements, and consultation with Native Hawaiians and other consulting parties. Submerged resources are specifically identified under Stipulation X.D (Ground Disturbing Activities: Any undertakings in areas known to have a potential for submerged cultural resources will be planned in consultation with the National Park Service, State Historic Preservation Office, and Office of Hawaiian

Affairs as appropriate to develop a work plan and monitoring plan that will ensure avoidance of effects on the resource) and Stipulation XI.A (Discoveries and Emergencies: If during the performance of an undertaking, historic properties, including submerged archaeological sites and traditional cultural properties, are discovered or unanticipated effects are found, or a previously unidentified property which may be eligible for listing on the National Register is discovered, Commander, Navy Region Hawaii would take all reasonable measures to avoid or minimize harm to the property until it concludes consultation with the State Historic Preservation Office and any Native Hawaiian organization, including Oahu Council of Hawaiian Civic Clubs, which has made known to Commander, Navy Region Hawaii that it attaches religious and cultural significance to the historic property).

3.10.2.5.1.1 Programmatic Agreement on Operational and Developmental Undertakings at San Clemente Island, California

Within the SOCAL Range Complex, a programmatic agreement was established to address impacts on cultural resources around San Clemente Island, off-island ranges, and operational training areas within the respective territorial and administrative jurisdictions of the United States and the State of California (California State Historic Preservation Office 2012). The programmatic agreement includes stipulations for the review of both range sustainability and operational training and support activities; determinations of areas of potential effects; identification of historic properties through survey; National Register evaluations through pro-active testing of selected resources; findings of effect; preparation of an integrated cultural resources management plan; treatment of archaeological historic properties including avoidance measures, monitoring, and protective signage; preparation of annual reports; and consultation with Native American Tribes and other consulting parties.

3.10.3 Environmental Consequences

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) could impact cultural resources within U.S. territorial waters and World Heritage sites located in the Study Area. Tables 2.8-1 through 2.8-5 present the baseline and proposed training and testing activity locations for each alternative (including numbers of events and ordnance expended). Appendix F (Training and Testing Activities Matrices) describes the warfare areas and associated stressors that were considered for analysis of cultural resources. The stressors vary in intensity, frequency, duration, and location within the Study Area. The stressors applicable to cultural resources in the Study Area that are analyzed include:

- Acoustic
  - Impacts from explosives- shock (pressure) waves from underwater explosions
  - Impacts from explosives-cratering
  - Impacts from pile-driving
- Physical
  - Impacts from in-water devices
  - Impacts from deposition of military expended materials
  - Impacts from seafloor devices

Sonar and other non impulsive sources do not affect the structural elements of historic shipwrecks and, therefore, an in-depth analysis of sonar impacts will not be included in this section. Archaeologists regularly use multi-beam sonar and side-scan sonar to explore shipwrecks without disturbing them. Based on the physics of underwater sound, the shipwreck would need to be very close (less than 22 ft. [6.7 m]) to the sonar sound source for the shipwreck to experience any slight oscillations from the induced pressure waves. Any oscillations experienced at a depth of less than 22 ft. (6.7 m) would be

negligible up to within a few yards from the sonar source. This distance is smaller than the typical safe navigation and operating depth for most sonar sources, and therefore is not expected to impact historic shipwrecks.

3.10.3.1 Acoustic Stressors

Acoustic stressors that could impact cultural resources are vibration and shock waves from underwater explosions. A shock wave and oscillating bubble pulses resulting from any kind of underwater explosion, such as explosive torpedoes, missiles, bombs, projectiles, mines, and certain sonobuoys and explosive sonobuoys, could impact the exposed portions of submerged historic resources if such resources were located nearby. Shock waves (pressure) generated by underwater explosions would be periodic rather than continuous, and could create overall structural instability and eventual collapse of architectural features of submerged historic resources. The amount of damage would depend on factors such as the size of the charge, the distance from the historic shipwreck, the water depth, and the topography of the ocean floor.

3.10.3.1.1 Impacts of Explosive Shock Waves from Underwater Explosions

Anti-surface missiles and projectiles explode at or immediately below the ocean surface (within one meter). Shock waves (pressure) from these types of explosions within the water column would not reach historic resources on the ocean floor. Underwater detonations of improved extended echo ranging sonobuoys and high explosives would occur well below the surface and on or near the ocean bottom. Shock waves from nearby underwater detonations may affect the exposed portions of historic shipwrecks if such resources were located in the area. Underwater explosions generating vibration and shock waves within the Study Area would not impact any cultural resources because (1) known historic shipwrecks, obstructions, and archaeological sites are routinely avoided during training and testing; and (2) most shipwrecks are located at substantial depths and they are distributed over large areas of the sea floor.

3.10.3.1.1.1 No Action Alternative

Training

Under the No Action Alternative, training activities would continue at current levels within existing designated areas within the OPAREAs in the offshore waters of Hawaii and Southern California. Current training activities would continue to be conducted in accordance with programmatic agreements that are already in place for existing training areas. Consequently, no impacts on cultural resources are expected by underwater detonations at depth.

Testing

Under the No Action Alternative, testing activities would continue within existing designated areas within the OPAREA along the offshore waters of Hawaii and Southern California. Current testing activities would continue to be conducted in accordance with programmatic agreements that are already in place for existing testing areas. Consequently, no impacts on cultural resources are expected by underwater detonations at depth.

3.10.3.1.1.2 Alternative 1

Training

Under Alternative 1, the number of explosive round detonations (high explosions) would remain the same as the No Action Alternative. Training would continue in the same localities specified in current HRC, SSTC, and SOCAL EIS documents. Because the Navy routinely avoids locations of known

obstructions, which include submerged historic resources, and because of the Navy's compliance with a programmatic agreement that includes the protection of cultural resources, no impacts on cultural resources by underwater detonations at depth are expected within U.S. territorial waters, and no World Heritage sites would be affected.

Testing

Under Alternative 1, the number of high-explosive rounds detonated during testing activities would increase within the OPAREAs in the offshore waters of Hawaii and Southern California. Testing would continue in the same localities specified in current HRC, SSTC, and SOCAL EIS documents. Because the Navy routinely avoids locations of known obstructions, which include submerged historic resources, and because of the Navy's compliance with a programmatic agreement that includes the protection of cultural resources, no impacts on cultural resources by underwater detonations at depth are expected within U.S. territorial waters, and no World Heritage sites would be affected.

3.10.3.1.1.3 Alternative 2

Training

Under Alternative 2, the number of high-explosive rounds detonated would remain the same as under the No Action Alternative. Training would continue in the same localities specified in current HRC, SSTC, and SOCAL EIS documents. Because the Navy routinely avoids locations of known obstructions, which include submerged historic resources, and because of the Navy's compliance with a programmatic agreement that includes the protection of cultural resources, no impacts on cultural resources by underwater detonations at depth are expected within U.S. territorial waters, and no World Heritage sites would be affected.

Testing

Under Alternative 2, the numbers of high-explosive rounds detonated during testing activities would increase within the OPAREA along the offshore waters of Hawaii and Southern California. Testing would continue in the same localities specified in current HRC, SSTC, and SOCAL EIS documents. Because the Navy routinely avoids locations of known obstructions, which include submerged historic resources, and because of the Navy's compliance with the programmatic agreement for Hawaii that includes the protection of cultural resources, no impacts on cultural resources by underwater detonations at depth are expected within U.S. territorial waters, and no World Heritage sites would be affected.

3.10.3.1.2 Impacts from Explosives – Cratering

Underwater explosions at depth or on or near the ocean bottom could displace sediment and leave a crater. Cratering could affect submerged prehistoric sites and previously unidentified historic resources (e.g., shipwrecks) located at or near the point of detonation. Cratering of unconsolidated, soft-bottom habitats would result from Mine Neutralization charges set on or near the bottom. These charges are set on the sea floor by Navy divers in shallow waters. Cratering could potentially disrupt stratigraphic sedimentation and/or affect cultural resources. However, it is unlikely that these resources could be disturbed or destroyed by cratering created by underwater explosions during mine warfare activities because the Navy routinely avoids locations of known obstructions, which include submerged historic resources.

3.10.3.1.2.1 No Action Alternative

Training

Under the No Action Alternative, training activities would continue at current levels within existing designated areas. In Southern California, cratering would be associated with underwater detonations at

San Clemente Island (Northwest Harbor, Horse Beach Cove, Kingfisher), Southern California Anti-Submarine Warfare Range, Shallow Water Training Range, Shallow Water Minefield, Camp Pendleton Amphibious Assault Area, and at SSTC (Boat Lanes 1-14, Breakers Beach, and Delta and Echo training areas). In Hawaii, cratering would be associated with underwater detonations at Puuloa Underwater Range, Marine Corps Base Hawaii, Marine Corps Training Area Bellows, Barbers Point Underwater Range, Naval Inactive Ship Maintenance Facility, Lima Landing, Kingfisher, Shallow Water Minefield, Sonar Training Area, and Ewa Training Minefield. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, effects on underwater cultural resources are not anticipated within U.S. territorial waters.

Testing

Under the No Action Alternative, testing activities would continue at current levels within existing designated areas within the OPAREAs in the offshore waters of Hawaii and Southern California. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, effects on underwater cultural resources are not anticipated within U.S. territorial waters.

3.10.3.1.2.2 Alternative 1

Training

Under Alternative 1, the number of high explosive rounds associated with mine warfare training activities would increase within the OPAREA in the offshore waters of Hawaii and Southern California. Cratering created by deep underwater explosions could disturb or damage previously unidentified artifacts on the sea floor and archaeological deposits buried in the ocean sediments if such resources were located nearby. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, effects on underwater cultural resources are not anticipated.

Testing

Under Alternative 1, the number of high explosive rounds associated with mine warfare activities would increase within the OPAREAs in the offshore waters of Hawaii and Southern California. Cratering created by deep underwater explosions could disturb or damage previously unidentified artifacts on the sea floor and archaeological deposits buried in the ocean sediments if such resources were located nearby. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, effects on underwater cultural resources are not anticipated.

3.10.3.1.2.3 Alternative 2 (Preferred Alternative)

Training

Under Alternative 2, the number of high explosive rounds associated with mine warfare activities would increase within the OPAREA along the offshore waters of Hawaii and Southern California. Cratering created by deep underwater explosions could disturb or damage previously unidentified artifacts on the sea floor and archaeological deposits buried in the ocean sediments if such resources were located nearby. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, effects on underwater cultural resources are not anticipated.

Testing

Under Alternative 2, the number of high explosive rounds associated with mine warfare activities would increase within the OPAREA in the offshore waters of Hawaii and Southern California. Cratering created by deep underwater explosions could disturb or damage previously unidentified artifacts on the sea floor and archaeological deposits buried in the ocean sediments if such resources were located nearby. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, effects on underwater cultural resources are not anticipated.

3.10.3.1.3 Impacts of Pile-Driving

3.10.3.1.3.1 No Action Alternative

Training

Under the No Action Alternative, training activities would continue at current levels within existing designated areas. In Southern California pile-driving for Elevated Causeway training at SSTC, would subject nearshore sediments to vibration, disruption, and compaction. Pile-driving would not occur in Hawaii. Elevated Causeway training at SSTC would occur only in the Oceanside Boat Lanes 110 and in the bayside Bravo training area. A bark (a three- or four-masted sailing vessel) built in 1883, the Narwhal, lies in Boat Lane 1, but the Navy would routinely avoid training near known submerged cultural resources. On the bayside of SSTC, sediments have been periodically dredged and the potential for encountering submerged historic resources that retain their integrity is low.

Testing

Pile-driving is not associated with any testing activities under the No Action Alternative.

3.10.3.1.3.2 Alternative 1

Training

Under Alternative 1, the number of Elevated Causeway training events would not increase relative to the No Action Alternative. Therefore, the potential for affecting submerged historic resources would be the same as described under the No Action Alternative.

Testing

Pile-driving is not associated with any testing activities under Alternative 1.

3.10.3.1.3.3 Alternative 2 (Preferred Alternative)

Training

Under Alternative 2, the number of Elevated Causeway training events would not increase relative to the No Action Alternative. Therefore, the potential for affecting submerged historic resources would be the same as described under the No Action Alternative.

Testing

Pile-driving is not associated with any testing activities under Alternative 2.

3.10.3.1.4 Regulatory Conclusions for Acoustic Stressors

In accordance with Section 106 of the National Historic Preservation Act, acoustic stressors resulting from underwater explosions at depth during training and testing activities would not affect submerged historic resources in U.S. territorial waters, and no World Heritage sites would be affected under the No Action Alternative, Alternative 1, and Alternative 2 because the Navy routinely avoids known submerged obstructions and protective measures are in place as stipulated by a programmatic agreement.
Pile-driving for Elevated Causeway training at SSTC is not expected to affect submerged cultural resources.

3.10.3.2 Physical Disturbance and Strike Stressors

Any physical disturbance on the continental shelf and seafloor, such as ship anchoring, targets or mines resting on the seafloor, moored mines, bottom-mounted tripods, unmanned underwater vehicles, or bottom crawlers, could inadvertently damage or destroy submerged prehistoric sites and historic resources. A towed system and attachment cable or vessel strike could inadvertently encounter, snag, damage, or destroy submerged historic resources in shallow water. Expended materials such as chaff, flares, projectiles, casings, target or missile fragments, non-explosive practice munitions, rocket fragments, ballast weights, sonobuoys, torpedo launcher accessories, or mine shapes could be deposited on the ocean bottom on or near submerged prehistoric sites or historic resources. Heavier expended materials could damage intact fragile shipwreck features if they landed with velocity on a resource. However, it is unlikely that these resources could be disturbed or destroyed because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources.

3.10.3.2.1 Impacts from Vessels and In-Water Devices

Use of a towed system and attachment cable could inadvertently encounter, snag, damage, or destroy historic shipwrecks, particularly those situated in relatively shallow water, and especially during low tide. Prior to deploying a towed device, the standard operating procedure is to search the intended path of the device for any floating debris (e.g., driftwood) or other potential surface obstructions, since they could damage the device. Therefore, submerged objects, including cultural resources, if present, would be avoided.

3.10.3.2.1.1 No Action Alternative

Training

Under the No Action Alternative, training operations and major range events would continue at current levels within designated areas of the OPAREAs in the offshore waters of Hawaii and Southern California. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, no significant impacts on known cultural resources are expected from towed-in-water devices snagging and damaging historic shipwrecks within U.S. territorial waters in the Study Area.

Testing

Under the No Action Alternative, testing activities using towed-in-water devices would continue within existing designated areas of the OPAREAs in the offshore waters of Hawaii and Southern California. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, effects on underwater cultural resources are not anticipated within U.S. territorial waters.

3.10.3.2.1.2 Alternative 1

Training

Under Alternative 1, the number of training activities using towed-in-water devices would increase in the OPAREAs in offshore waters of Hawaii and Southern California. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, no impacts on cultural resources are expected within U.S. territorial waters, and no World Heritage sites would be affected.

Testing

Under Alternative 1, the number of testing activities using towed-in-water devices would increase in the OPAREAs in the offshore waters of Hawaii and Southern California. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, no impacts on cultural resources are expected within U.S. territorial waters, and no World Heritage sites would be affected.

3.10.3.2.1.3 Alternative 2 (Preferred Alternative)

Training

Under Alternative 2, the number of training activities using towed-in-water devices would increase in the OPAREAs in the offshore waters of Hawaii and Southern California. Because the Navy routinely avoids locations of known obstructions, which include submerged historic resources, and because of the Navy's compliance with a programmatic agreement that includes the protection of cultural resources, no impacts on cultural resources are expected within U.S. territorial waters, and no World Heritage sites would be affected.

Testing

Under Alternative 2, the number of testing activities using towed-in-water devices would increase in the OPAREAs in the offshore waters of Hawaii and Southern California. Because the Navy routinely avoids locations of known obstructions, which include submerged historic resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, no impacts on cultural resources are expected within U.S. territorial waters, and no World Heritage sites would be affected.

3.10.3.2.2 Impacts from Military Expended Materials

The deposition of non-explosive practice munitions, sonobuoys, and military expended materials other than ordnance could impact submerged cultural resources if such resources are located nearby. Most of the anticipated expended munitions (e.g., large-caliber, non-explosive practice munitions) would be small objects and fragments that would slowly drift to the sea floor after striking the ocean surface. Larger and heavier objects (e.g., ship hulks) could displace sediments and artifacts upon impacting the ocean floor despite a reduction in their descent velocity. Additionally, post deposition and impacts on sites could occur should expended material fall on or near them. However, the likelihood of these materials either impacting or landing on submerged cultural resources is very low because of the sizes of the regions and because the Navy routinely avoids submerged obstructions.

3.10.3.2.2.1 No Action Alternative

Training

Under the No Action Alternative, training activities would continue at current levels within existing designated areas within the OPAREA along the offshore waters of Hawaii and Southern California. Expended materials may be deposited on the ocean bottom on or near submerged prehistoric sites and historic resources. If they sink near either type of cultural resource, the expended materials would not affect the archaeological or historic characteristics of the submerged prehistoric site or the historic resource. Because the Navy routinely avoids known submerged obstructions, these materials likely would not contact a submerged prehistoric site or a historic resource.

Testing

Under the No Action Alternative, testing activities would continue at current levels within existing designated areas within the OPAREA along offshore waters of Hawaii and Southern California. Expended materials may be deposited on the ocean bottom on or near submerged prehistoric sites and historic resources. Because the Navy routinely avoids known submerged obstructions, these materials likely would not contact a submerged prehistoric site or a historic resource.

3.10.3.2.2.2 Alternative 1

Training

Under Alternative 1, the number of expended items from training activities would increase within designated areas of the OPAREA along the offshore waters of Hawaii and Southern California (most of the expended items are small- to medium-sized caliber that are no larger than a roll of quarters). Expended materials could be deposited on the ocean bottom on or near submerged. Because the Navy routinely avoids known submerged obstructions, these materials likely would not contact a submerged prehistoric site or a historic resource.

Testing

Under Alternative 1, the number of expended items from testing activities would increase within designated areas of the OPAREA along the offshore waters of Hawaii and Southern California (most of the expended items are small- to medium-sized caliber that are no larger than a roll of quarters). Expended materials could be deposited on the ocean bottom on or near submerged prehistoric sites and historic resources. Because the Navy routinely avoids known submerged obstructions, these materials likely would not contact a submerged prehistoric site or a historic resource.

3.10.3.2.2.3 Alternative 2 (Preferred Alternative)

Training

Under Alternative 2, the number of expended items from training activities would increase within designated areas of the OPAREA along the offshore waters of Hawaii and Southern California (most of the expended items are small- to medium-sized caliber that are no larger than a roll of quarters). Expended materials could be deposited on the ocean bottom on or near submerged prehistoric sites and historic resources. Because the Navy routinely avoids known submerged obstructions, these materials likely would not contact a submerged prehistoric site or a historic resource.

Testing

Under Alternative 2, the number of expended items from testing activities would increase within designated areas of the OPAREA along the offshore waters of Hawaii and Southern California (most of the expended items are small- to medium-sized caliber that are no larger than a roll of quarters). Expended materials could be deposited on the ocean bottom on or near submerged prehistoric sites and

historic resources. Because the Navy routinely avoids known submerged obstructions, these materials likely would not contact a submerged prehistoric site or a historic resource.

3.10.3.2.3 Impacts from Seafloor Devices

Physical disturbances on the continental shelf and seafloor, such as precision anchoring, targets or mines resting on the ocean floor, moored mines, bottom-mounted tripods, bottom crawlers (unmanned underwater vehicles) could damage or destroy submerged prehistoric sites or historic resources if such resources are located nearby. Precision anchoring could crush or snag structural elements of historic resources and damage intact sediments of submerged prehistoric sites; however, this is highly unlikely because divers are used to set bottom and moored mine anchors (blocks of concrete weighing several hundred pounds) in waters less than 150 ft. (45.7 m) deep and routinely avoid known obstructions, which include cultural resources and any unrecorded obstructions they might encounter.

3.10.3.2.3.1 No Action Alternative

Training

Under the No Action Alternative, training activities using seafloor deployed devices would continue at current levels in existing designated areas within the offshore waters of the Hawaii and Southern California OPAREAs. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, effects on underwater cultural resources are not anticipated within U.S. territorial waters.

Testing

Under the No Action Alternative, testing activities using seafloor deployed devices would continue at current levels in existing designated areas in the offshore waters of the Hawaii and Southern California OPAREAs. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, effects on underwater cultural resources are not anticipated within U.S. territorial waters.

3.10.3.2.3.2 Alternative 1

Training

Under Alternative 1, the number of training activities using seafloor deployed devices would not increase in the offshore waters of the Hawaii and Southern California OPAREAs. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, no impacts on cultural resources are expected within U.S. territorial waters, and no World Heritage sites would be affected.

Testing

Under Alternative 1, testing activities would increase in the offshore waters of the Hawaii and Southern California OPAREAs. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, no impacts on cultural resources are expected within U.S. territorial waters, and no World Heritage sites would be affected.

3.10.3.2.3.3 Alternative 2 (Preferred Alternative)

Training

Under Alternative 2, the number of annual training activities using seafloor deployed devices would not increase within the offshore waters of the Hawaii and Southern California OPAREAs. Because the Navy routinely avoids locations of known obstructions, which include submerged cultural resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, no impacts on cultural resources are expected within U.S. territorial waters, and no World Heritage sites would be affected.

Testing

Under Alternative 2, testing activities would increase in the offshore waters of the Hawaii and Southern California OPAREAs. Because the Navy routinely avoids locations of known obstructions, which include submerged historic resources, and because the Navy complies with a programmatic agreement that includes the protection of cultural resources, no impacts on cultural resources are expected within U.S. territorial waters, and no World Heritage sites would be affected.

3.10.3.2.4 Regulatory Conclusions for Physical Stressors

In accordance with Section 106 of the National Historic Preservation Act, physical stressors resulting from use of marine and seafloor devices during training and testing activities under the No Action Alternative, Alternative 1, and Alternative 2 would not adversely affect submerged cultural resources in U.S. territorial waters, and no World Heritage sites would be affected. Both Alternative 1 and Alternative 2 would increase the number of training and testing activities. However, because the Navy routinely avoids known submerged obstructions and protective measures are in place as stipulated by programmatic agreement, no submerged cultural resources would be affected.

3.10.3.3.1 No Action Alternative

Acoustic and physical stressors associated with training and testing activities would not impact submerged cultural resources. Training and testing activities would continue in existing locations, as specified in the HRC, SSTC, and SOCAL EISs, however, so no impacts on cultural resources are expected within U.S. territorial waters because measures have been previously implemented to protect these resources.

3.10.3.3.2 Alternative 1

An increase in training and testing activities would occur in existing locations, as specified in the HRC, SSTC, and SOCAL EISs, under Alternative 1. Acoustic and physical stressors associated with training and testing activities would not impact cultural resources because measures have been previously implemented to protect them.

3.10.3.3.3 Alternative 2 (Preferred Alternative)

Under Alternative 2, an increase in training and testing activities would occur only in the existing locations, as specified in the HRC, SSTC, and SOCAL EISs. Acoustic and physical stressors associated with training and testing activities would not impact cultural resources because measures have been previously implemented to protect them.

3.10.3.4 Regulatory Determinations

Table 3.10-1 summarizes the potential effects of the Proposed Action on submerged resources under the No Action Alternative, Alternative 1, and Alternative 2. The Proposed Action is not anticipated to affect known cultural resources within the Study Area, and programmatic agreements between the Navy and State Historic Preservation Offices exist to address the protection and management of cultural resources. Accordingly, per Section 106, the Navy will continue, as appropriate, to consult with the California and Hawaii State Historic Preservation Offices.

Table 3.10-1: Summary of Section 106 Effects of Training and Testing Activities on Cultural Resources

Alternative and Stressor	Section 106 Effects of Training and Testing Activities
No Action Alternative	
Acoustic Stressors	Acoustic stressors resulting from underwater explosions creating shock (pressure) waves and cratering of the sea floor would not affect submerged cultural resources. Training and testing would continue only in areas currently utilized for these activities. As a result, effects on cultural resources are not anticipated within United States (U.S.) territorial waters because measures have been previously implemented to protect these resources.
Physical Stressors	Physical stressors resulting from use of towed-in water devices, and use of seafloor devices would not adversely affect submerged cultural resources. Testing and training would continue only in areas currently utilized for these activities. As a result, effects on cultural resources are not anticipated within U.S. territorial waters because measures have been previously implemented to protect these resources. Military expended materials are not expected to affect submerged cultural resources.
Alternative 1	
Acoustic Stressors	Acoustic stressors resulting from underwater explosions creating shock (pressure) waves and cratering of the seafloor would not affect submerged cultural resources. Testing and training would continue only in areas currently utilized for these activities. As a result, effects on cultural resources are not anticipated within U.S. territorial waters because measures have been previously implemented to protect these resources.
Physical Stressors	Physical stressors resulting from use of seafloor devices during training and testing activities could affect submerged cultural resources. Testing and training would continue only in areas currently utilized for these activities. As a result, effects on cultural resources are not anticipated within U.S. territorial waters because measures have been previously implemented to protect these resources. Military expended materials are not expected to affect submerged cultural resources.
Regulatory Determination	Alternative 1 contains increases in the number of training and testing activities compared to the No Action Alternative. No effects on submerged cultural resources would occur because measures were previously implemented to protect these resources. A Finding of No Effects on historic properties within the Area of Potential Effect has been determined by the California State Historic Preservation Officer (Saunders 2012). A Finding of No Effects on historic properties within the Area of Potential Effect has been determined by the Hawaii State Historic Preservation Office, as assumed by their no response or objections under 36 Code of Federal Regulations 800.4(d)(1)(i).

Table 3.10-1: Summary of Section 106 Effects of Training and Testing Activities on Cultural Resources (continued)

Alternative and Stressor	Section 106 Effects of Training and Testing Activities
Alternative 2 (Preferred Alternative)	
Acoustic Stressors	Acoustic stressors resulting from underwater explosions creating shock (pressure) waves and cratering of the seafloor would not affect submerged cultural resources. Testing and training would continue only in areas currently utilized for these activities. As a result, effects on cultural resources are not anticipated within U.S. territorial waters because measures have been previously implemented to protect these resources.
Physical Stressors	Physical stressors resulting from use of towed-in water devices, and use of seafloor devices during training and testing activities would not affect submerged cultural resources. Testing and training would continue only in areas currently identified for these activities. As a result, effects on cultural resources are not anticipated within U.S. territorial waters because measures have been previously implemented to protect these resources. Military expended materials are not expected to affect submerged cultural resources.
Regulatory Determination	Alternative 2 contains increases in the number of training and testing activities compared to the No Action Alternative. Depending on the location, an increase in the number of activities could increase the probability of disturbing submerged cultural resources. Submerged cultural resources would not be affected, however, because testing and training would only occur within areas now used for these activities. As a result, effects on cultural resources are not anticipated within U.S. territorial waters because measures have been previously implemented to protect these resources.

REFERENCES

Automated Wreck and Obstruction Information System Database. (2010). Shipwreck Database. Retrieved from http://shipwrecks.slc.ca.gov/ShipwrecksDatabase/Shipwrecks_Database.asp, January 5, 2011.

Barnette, M. C. (2010). Lost at sea: A treatise on the management and ownership of shipwrecks and shipwreck artifacts. Retrieved from http://uwex.us/lostatsea.htm, 2010, October 22.

California State Historic Preservation Office. (2012). Hawaii-Southern California Training and Testing Activities, Various Ocean Areas, Southern California.

EDAW, I. (2005). Final Environmental Impact Report (EIR) Disposition of Offshore Cooling Water Conduits. (pp. 14). Prepared for California State Lands Commission.

Hawaii State Historic Preservation Division. (2003). Programmatic Agreement among the Commander Navy Region Hawaii, the Advisory Council on Historic Preservation, and the Hawaii State Historic Preservation Officer Regarding Navy Undertakings in Hawaii. (Including Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility; outlying Oahu installations; and the Pacifica Missile Range Facility at Barking Sands, Kauai.)

Kelley, D. (2006). Historical Collections of Hawaii – Keepers of the Culture – Influence of Foreigners on Hawaii – Part 16 Whaling – Whalers Influence – Lord Byron and New Laws http://www.usgwarchives.org/copyright.htm

Masters, P. & Schneider, J. (2000). Cobble Mortars/Bowls: Evidence of Prehistoric Fisheries in the Southern California Bight.

Masters, P. M. (2003). Prehistoric Underwater Archaeological Sites of San Diego County: WAN Conservancy.

Minerals Management Service. (1990). California, Oregon, and Washington Archaeological Resource Study. (Vol. III: Prehistory, pp. 141). Prepared by P. Snethkamp, G. Wessen, A. York, J. Cleland, S. Hoyt and R. Gearhart. Prepared for Minerals Management Service.

National Park Service. (2007). Abandoned Shipwreck Act Guidelines. Retrieved from http://www.nps.gov/archeology/submerged/intro.htm, October 10, 2011.

Naval Base San Diego. (2012). Naval Base San Diego – History. Retrieved from http://www.cnic.navy.mil/SanDiego/About/History/index.htm, February 16, 2012.

Neyland, R. S. (2001). Sovereign immunity and the management of United States naval shipwrecks and shipwreck artifacts. Retrieved from http://www.history.navy.mil/branches/org12-7h.htm, 2010, October 22.

New South Wales. (2012). Japanese midget submarine wrecks. Retrieved from http://www.environment.nsw.gov.au/M24/discovery/midgetwrecks.htm.

National Oceanographic and Atmospheric Administration. (2012). Maritime History. Retrieved from http://hawaiihumpbackwhale.noaa.gov/maritime/maritime_history.html, 2012 October 4.

Saunders, Jenan. (2012). Written communication of June 5, 2012 to Andy Yatsko (Naval Facilities Engineering Command, SW) regarding Hawaii-Southern California Training and Testing Activites, Various Ocean Areas Southern California concurrence of Finding of No Effects.

Sutton, M. (2010). The Del Rey Tradition and Its Place in the Prehistory of Southern California. Pacific Coast Archaeological Society Quarterly, 44(2).

U.S. Department of the Navy. (2008a). Hawaii Range Complex, Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). Hawaii Range Complex. Prepared by Pacific Missile Range Facility.

U.S. Department of the Navy. (2008b). Southern California Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement. U.S. Navy Pacific Fleet. Prepared by Naval Facilities Engineering Command Southwest.

U.S. Department of the Navy. (2011). Silver Strand Training Complex Environmental Impact Statement [EIS]. Prepared by U.S. Pacific Fleet.

Zander, C. M. and Varmer, O. (1996). Closing the Gaps in Domestic and International Law: Achieving Comprehensive Protection of Submerged Cultural Resources. Contested Waters Vol 1 (3/4). Retrieved from http://www.nps.gov/archeology/cg/vol1_num3-4/gaps.htm, October 10, 2011.

3.11 Socioeconomic Resources

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3.11 SOCIOECONOMIC RESOURCES

SOCIOECONOMIC RESOURCES SYNOPSIS

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

- Accessibility (limiting access to the ocean and the air)
- Physical disturbance and strike (aircraft, vessels and in-water devices, military expended materials)
- Airborne acoustics (weapons firing, aircraft and vessel noise)
- Secondary

Preferred Alternative (Alternative 2)

- Accessibility: Accessibility stressors are not expected to result in impacts on commercial transportation and shipping, commercial and recreational fishing, subsistence use, or tourism because inaccessibility to areas of co-use would be temporary and of short duration (hours).
- Physical disturbance and strike: Physical disturbance and strikes are not expected to result in impacts on commercial and recreational fishing, subsistence use, or tourism because of the large size of the Study Area, the limited areas of operations, and implementation of the Navy's standard operating procedures.
- Airborne acoustics: Airborne acoustic stressors are not expected to result in impacts to tourism or recreational activity because the Navy's training and testing would occur well out to sea, far from tourism and recreation locations.
- Secondary: Secondary stressors are not expected to result in impacts to fishing, subsistence use, or tourism, based on the level of impacts described in other resources sections.

3.11.1 INTRODUCTION AND METHODS

This section provides an overview of the characteristics of socioeconomic resources in the Hawaii-Southern California Training and Testing (HSTT) Study Area (Study Area) and describes in general terms the methods used to analyze potential impacts on these resources from the Proposed Action.

The Council on Environmental Quality regulations implementing the National Environmental Policy Act (NEPA) state that when economic or social effects and natural or physical environmental effects are interrelated, the Environmental Impact Statement (EIS) will discuss these effects on the human environment (40 Code of Federal Regulations [C.F.R.] 1508.14). The Council on Environmental Quality regulations state that the "human environment shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment." To the extent that the ongoing and proposed United States (U.S.) Department of the Navy (Navy) training and testing activities in the Study Area could affect the natural or physical environment, the socioeconomic analysis evaluates how elements of the human environment might be affected. The Navy identified four broad socioeconomic topics based on their association with human activities and livelihoods in the Study Area. Each of these socioeconomic resources is an aspect of the human environment that involves economics (i.e., employment, income, or revenue) and social conditions (i.e., enjoyment and quality of life)

associated with the marine environment of the Study Area. Therefore, this evaluation considered potential impacts on four topics:

- Commercial transportation and shipping
- Commercial and recreational fishing
- Subsistence use
- Tourism

The baseline for identifying the socioeconomic conditions in the Study Area was derived using relevant published information from sources that included federal, state, regional and local government agencies and databases, academic institutions, conservation organizations, technical and professional organizations, and private groups. Previous environmental studies were also reviewed for relevant information.

The alternatives were evaluated based upon the potential for and the degree to which training and testing activities could impact socioeconomics. The potential for impacts depends on the likelihood that the testing and training activities would interface with public activities or infrastructure. Factors considered in the analysis include whether there would be temporal or spatial interfaces between the public or infrastructure and Navy testing and training. If there is potential for this interface, factors considered to estimate the degree to which an exposure could impact socioeconomics include whether there could be an impact on livelihood, quality of experience, resource availability, income, or employment. If there is no expected potential for the public to interface with an activity, the impacts would be considered negligible.

3.11.2 AFFECTED ENVIRONMENT

The area of interest for assessing potential impacts on socioeconomic resources is the U.S. Territorial Waters of Hawaii and Southern California coasts (seaward of the mean high water line to 12 nautical miles [nm]). This section describes the four socioeconomic resources associated with human activities and livelihoods in the Study Area from shore to 12 nm from shore consistent with NEPA.

3.11.2.1 Transportation and Shipping

Current military and civilian use of the offshore sea and air areas is compatible, with Navy ships accounting for six percent of the total ship presence out to 200 nm (Mintz and Filadelfo 2011). The Navy conducts training and testing activities in operating areas (OPAREAs) away from commercially used waterways and within special use airspace (Mintz and Filadelfo 2011). Notifications of potentially hazardous operations are communicated to all vessels and operators by use of Notices to Mariners, issued by the U.S. Coast Guard and Notices to Airmen, issued by the Federal Aviation Administration. The Department of Defense (DoD) also publishes separate Notices to Airmen about runway closures, missile launches, special traffic management procedures, and malfunction of navigational aids.

3.11.2.1.1 Ocean Traffic

Ocean traffic is the transit of commercial, private, or military vessels at sea, including submarines. The ocean traffic flow in congested waters, especially near coastlines, is controlled by the use of directional shipping lanes for large vessels, including cargo, container ships, and tankers. Traffic flow controls are also implemented to ensure that harbors and ports-of-entry remain as uncongested as possible. There is less control on open-ocean traffic involving recreational boating, sport fishing, commercial fishing, and activity by naval vessels. In most cases, the factors that govern shipping or boating traffic include the

following: adequate depth of water, weather conditions (primarily affecting recreational vessels), availability of fish, and temperature. Higher air and water temperatures increase recreational boat traffic (e.g., sailing, power boating, windsurfing, kayaking, and using jet skis) as well as diving activities. Recreational activities also fluctuate seasonally, with increased activity in summer when, along with warmer weather, there are more daylight hours and greater opportunity for recreational activities.

Areas of surface water within the Study Area are designated as danger zones and restricted areas as described in the C.F.R., Title 33 (Navigation and Navigable Waters), Part 334 (Danger Zone and Restricted Area Regulations) and established by the U.S. Army Corps of Engineers. Danger zones are areas used for target practice, bombing, rocket firing, or other especially hazardous training operations. A danger zone may be closed to the public full-time or on an intermittent basis, as stated in the regulations. A restricted area is designated for the purpose of prohibiting or limiting public access to an area. Restricted areas generally provide security for government property and protection to the public from risks of damage or injury arising from government activities occurring in the area (33 C.F.R. 334.2). Danger zones and restricted areas located within 12 nm from shore in the Study Area have the potential to impact the four socioeconomic resources identified above.

3.11.2.1.1.1 Hawaii Range Complex

Ocean shipping is a significant component to Hawaii's economy. Major inter-island ports include Honolulu, Barbers Point, Hilo, Kawaihae, and Kahului. The U.S. Army Corps of Engineers ranked 149 U.S. ports by cargo volume in 2009. Based on those rankings, Barbers Point (Oahu) ranked 48th in total trade (domestic and foreign) with over 9.6 million tons of imports and exports. Other ranked cities in Hawaii were Honolulu at 49th, Kahului at 96th, Kawaihae at 125th, Hilo at 126th, and Nawiliwili (Kauai) at 130 (Table 3.11-1)

Shipping routes around the Hawaiian Islands are shown in Figure 3.11-1.

Table 3.11-1: United States Port Rankings by Cargo Volume for Hawaii Ports in 2009

Port Name	Total Trade Rank (Domestic and Foreign)	Total Foreign Trade	Total Domestic Trade
Barbers Point, Oahu	48th	35th	101st
Honolulu, Oahu	49th	81st	31st
Kahului, Maui	96th	113th	74th
Kawaihae Harbor, Hawaii	125th	130th	105th
Hilo, Hawaii	126th	116th	106th
Nawiliwili, Kauai	130th	118th	108th

Source: Association of Port Authorities 2009

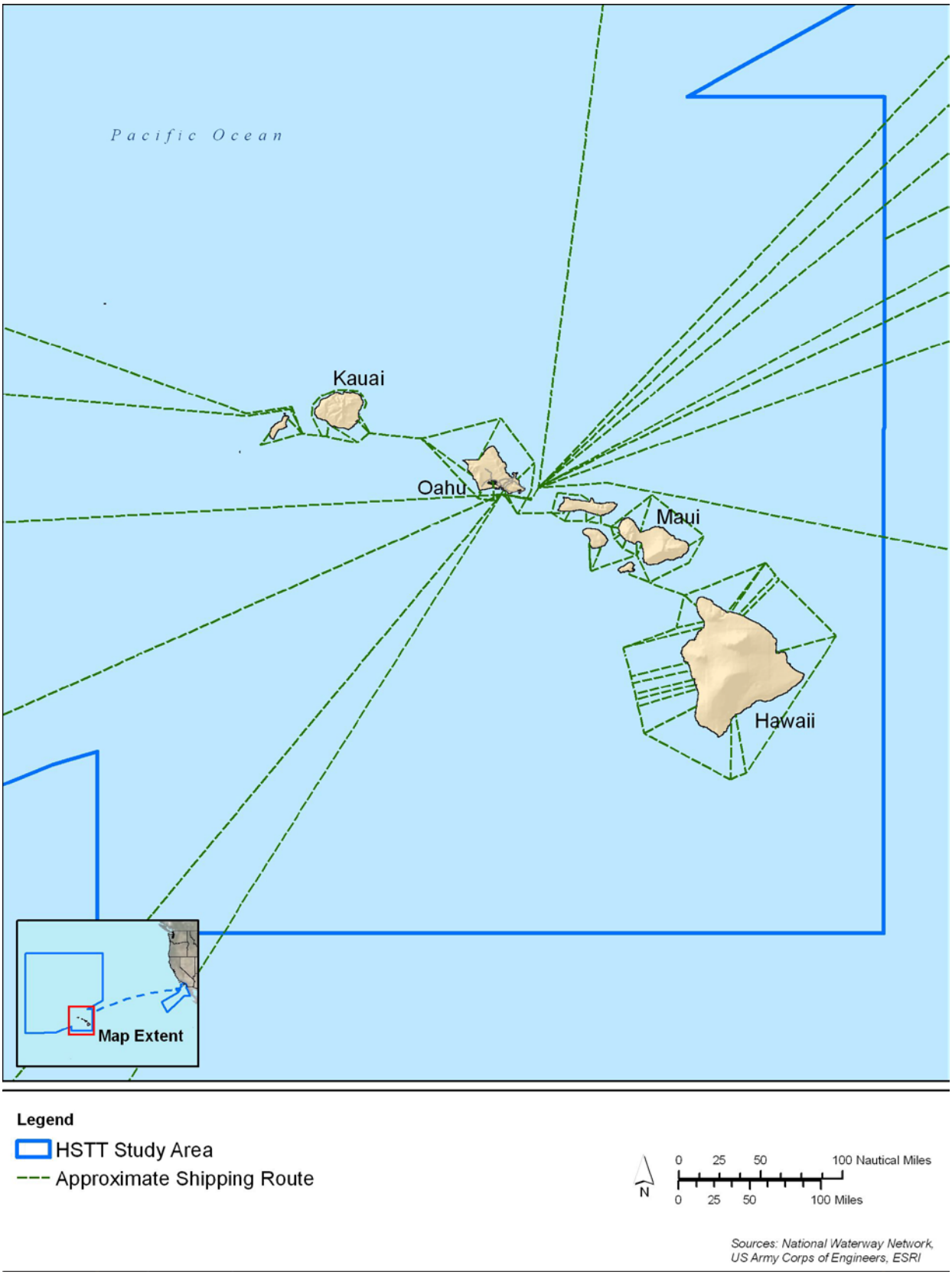

Figure 3.11-1: Hawaiian Islands Shipping Routes

3.11.2.1.1.2 Southern California Range Complex and Silver Strand Training Complex

Ocean shipping is a significant component of the Southern California regional economy. Key ports in Southern California include Los Angeles, Long Beach, and, to a lesser degree, Port Hueneme and San Diego. Of 149 U.S. ports evaluated by the U.S. Army Corps of Engineers, Los Angeles and Long Beach ranked fourth and ninth, respectively, in total trade (measured in tons) in 2009 (the most recent year data are available); Port Hueneme ranked 118th and San Diego ranked 123rd (Intermodal Association of North America 2008; Association of Port Authorities 2009) (Table 3.11-2). Total trade at Long Beach exceeded 72 million tons of foreign and domestic imports and exports. Total trade at Los Angles was over 58 million tons.

Table 3.11-2: United States Port Rankings by Cargo Volume for Southern California Ports in 2009

Port Name	Total Trade Rank (Domestic and Foreign)	Total Foreign Trade	Total Domestic Trade
Long Beach	4th	4th	20th
Los Angeles	9th	5th	38th
Port Hueneme	118th	71st	142nd
San Diego	123rd	76th	139th

Source: Association of Port Authorities 2009

A significant amount of ocean traffic, consisting of both large and small vessels, transits through the Southern California (SOCAL) Range Complex. For instance, there was an annual average of over 1,200 commercial ship transits into and out of the Port of San Diego between 2007 and 2010 (San Diego Unified Port District 2011). For commercial vessels, the major transoceanic routes to the southwest pass north and south of San Clemente Island (Figure 3.11-2).

The approach and departure routes into San Diego and the ports of Los Angeles-Long Beach Harbor pass to the east of San Clemente Island and Santa Catalina Island. Naval vessels operate within and transit through the SOCAL Range Complex. The location of San Clemente Island creates a separation zone within the SOCAL Range Complex. Most vessels entering or leaving the ports of Los Angeles or Long Beach travel northwest through the Santa Barbara Channel, west just south of the northern Channel Islands, or south along the coast to San Diego, the Panama Canal, or South America.

Shipping to and from the south includes an inshore route to the east of San Clemente Island within the SOCAL Range Complex. Ships traveling between Los Angeles/Long Beach and Hawaii via the most direct route pass to the north of the SOCAL Range Complex. Vessels coming or going from the Port of San Diego generally travel along shipping routes north or south near the coast, which includes inshore waters of the SOCAL Range Complex but bypass San Clemente Island to the east. Another commercial shipping route extends from the Port of San Diego to Japan and the eastern Pacific crossing the SOCAL Range Complex just south of San Clemente Island.

Recreational traffic is typically found within a mile from shore and rarely found in the outer waters, shipping lanes, or near San Clemente Island, with the exception of recreational fishing (i.e., charter) vessels traveling to deeper water. Within the SOCAL Range Complex, fishing is centered primarily around San Clemente Island and secondarily in the shallower waters over the Tanner and Cortes Banks. Because those banks are inherently more hazardous, the nearshore waters of San Clemente Island are a more popular destination than the more remote banks.

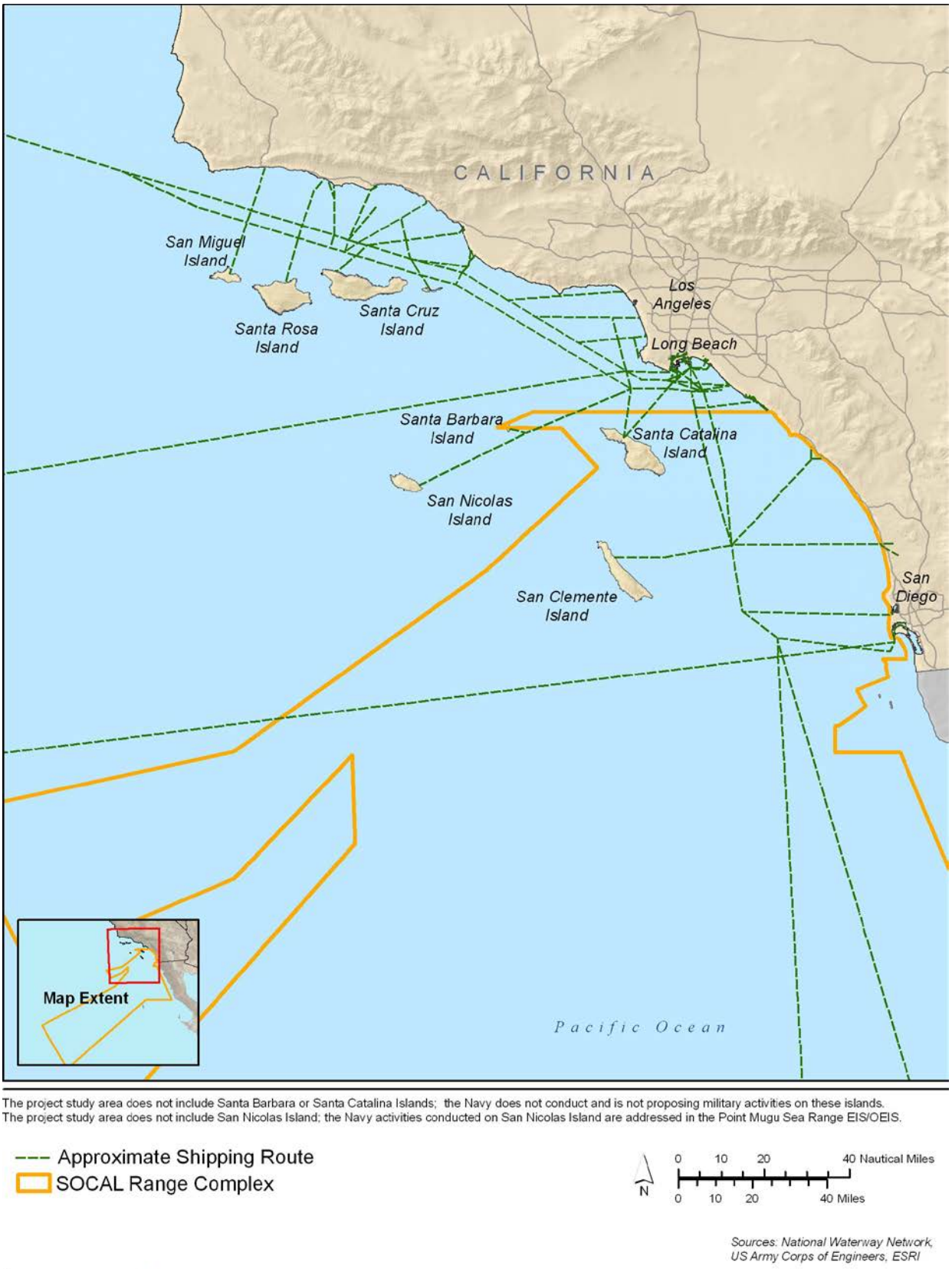

Figure 3.11-2: Southern California Range Complex Shipping Routes

Marine traffic in the Silver Strand Training Complex (SSTC) region consists of vessels transiting to multiple marinas, mooring locations, commercial ports, fishing harbors, and military installations. San Diego Bay is bordered by the cities of San Diego, National City, Chula Vista, Imperial Beach, and Coronado. The SSTC Boat Lanes located on the ocean side of the SSTC are commonly used by sportfishing charters, baitfishing to support sportfishing, lobster fishing, and competition sailing regattas. Access to San Diego Bay by incoming vessels is through the mouth of the harbor to the north, or through the many marinas and boat launch facilities located along the perimeter of the Bay.

3.11.2.1.1.3 Transit Corridor

Major commercial shipping vessels use the transit corridor for shipping goods between Southern California and Hawaii because it is the shortest distance between these two points (Figure 2.1-1). Vessels using this corridor are outside of military training areas and typically follow all U.S. Coast Guard maritime regulations. The Navy also uses this corridor for training and testing activities while en route between Southern California and Hawaii.

3.11.2.1.2 Air Traffic

Air traffic refers to movements of aircraft through airspace (Figure 3.11-3). Safety and security factors dictate that use of airspace and control of air traffic be closely regulated. Accordingly, regulations applicable to all aircraft are promulgated by the Federal Aviation Administration to define permissible uses of designated airspace, and to control that use. These regulations are intended to accommodate the various categories of aviation, whether military, commercial, or general aviation.

The system of airspace designation uses various definitions and classifications of airspace in order to facilitate control. Airspace is categorized generally as either “controlled” airspace or “uncontrolled” airspace. Controlled airspace is further organized into several difference classes of airspace distinguished by altitude range, use (e.g., commercial or military), and proximity to a major airport. Controlled airspace means that services supporting aircraft flying under Instrument Flight Rules are available. Such services include air-to-ground radio communication, navigational aids, and air traffic control services for maintaining separation between aircraft. Controlled airspace does not mean that all flights are controlled by air traffic control.

Special use airspace consists of both controlled and uncontrolled airspace and has defined dimensions where flight and other activities are confined because of their nature and the need to restrict or prohibit non-participating aircraft for safety reasons. Special use airspace are established under procedures outlined in 14 C.F.R. Part 73.1. The majority of special use airspace is established for military flight activities and, with the exception of prohibited areas (e.g., over the White House) may be used for commercial or general aviation when not reserved for military activities. There are multiple types of special use airspace, including prohibited, restricted, warning, alert, and military operations areas (Federal Aviation Administration 2009). One type of special use airspace, of particular relevance to the Study Area, is a warning area, which is defined in 14 C.F.R. Part 1 as follows:

> “A warning area is airspace of defined dimensions, extending from 3 nm outward from the coast of the United States that contains activity that may be hazardous to nonparticipating aircraft. The purpose of such warning areas is to warn nonparticipating pilots of the potential danger. A warning area may be located over domestic or international waters or both.”

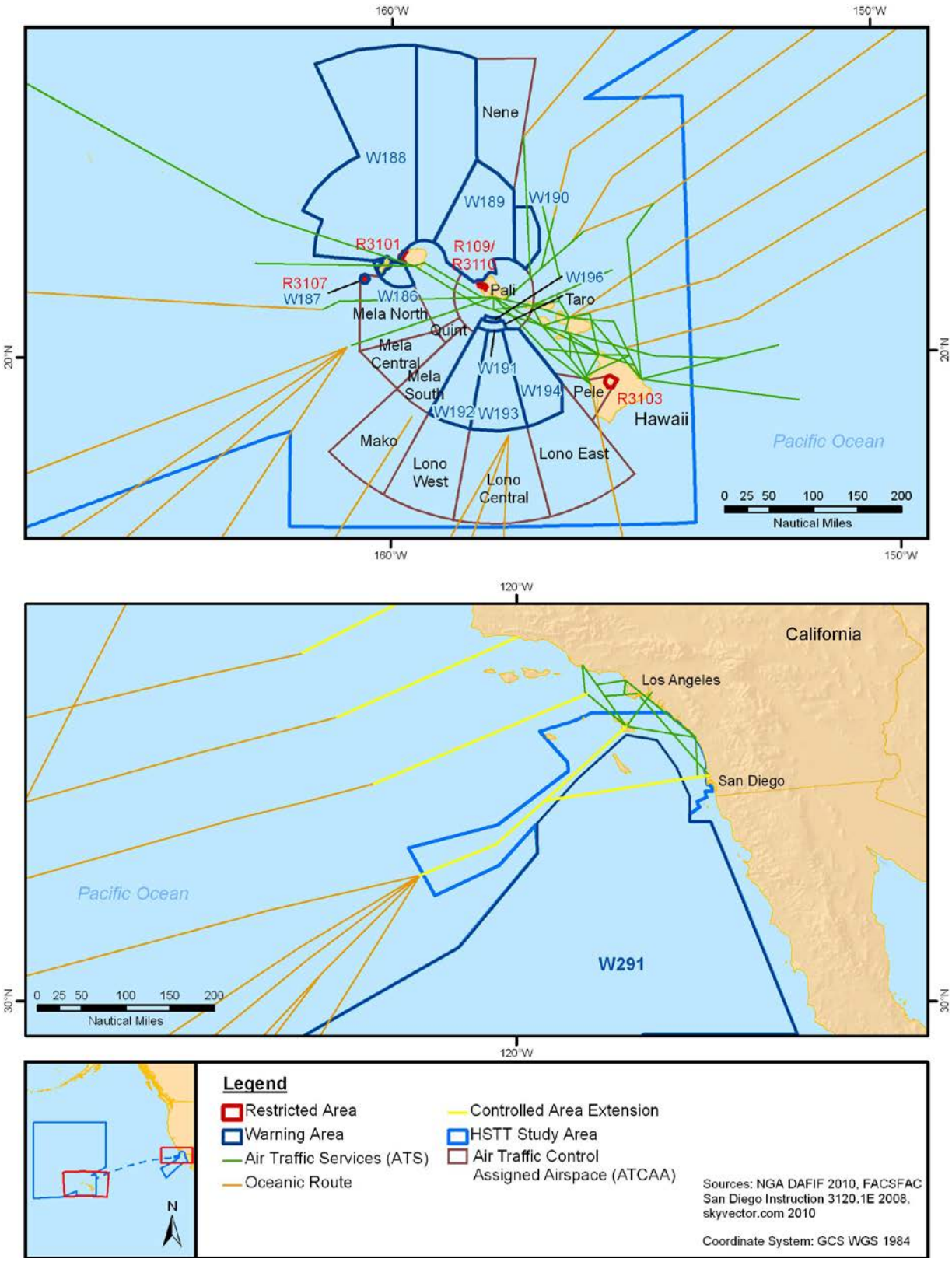

Figure 3.11-3: Air Traffic Routes in the Study Area, Hawaii Range Complex (top) and Southern California Range Complex (bottom)

Warning areas are established to contain a variety of hazardous aircraft and non-aircraft activities, such as aerial gunnery, air and surface missile firings, bombing, aircraft carrier operations, surface and subsurface operations, and naval gunfire. When these activities are conducted in international airspace, the Federal Aviation Administration regulations may warn against, but do not have the authority to prohibit, flight by nonparticipating aircraft. A restricted area, such as Restricted Area 3107 (R-3107), is a type of special use airspace within which nonmilitary flight activities are closely restricted.

3.11.2.1.2.1 Hawaii Range Complex

Military Air Transit

The special use airspace in the region of influence (Figure 3.11-3) consists of W-188 and R-3101 north and west of Kauai, and W-186 southwest of Kauai, controlled by Pacific Missile Range Facility. Warning Areas 188 Rainbow, W-189 and W-190 north of Oahu, W-187 and R-3107 surrounding Kaula Island, and W-191, W-192, W-193, W-194, and W-196 south of Oahu are scheduled through the Navy Fleet Area Control and Surveillance Facility Pearl Harbor, which then coordinates with the Honolulu Combined Facility. There are also 12 Air Traffic Control Assigned Airspace areas within the Hawaii Range Complex (HRC). These Air Traffic Control Assigned Airspace areas provide additional controlled airspace adjacent to and between the warning areas.

Commercial and General Aviation

Most of the airspace within the region of influence is in international airspace, and air traffic is managed by the Honolulu Control Facility. The Honolulu Control Facility includes the Air Route Traffic Control Center, the Honolulu Control Tower, and the Combined Radar Approach Control collocated in a single facility. Airspace outside that managed by the Hawaii Combined Facility is managed by the Oakland Air Route Traffic Control Center.

The airspace within the HRC has several en route high-altitude jet routes, as shown on Figure 3.11-3. Most of the oceanic routes enter the HRC from the northeast and southwest and are generally outside the special use airspace warning areas described above. The Air Traffic Services routes are concentrated along the Hawaiian islands chain. Most of the open-ocean area region of influence is well removed from the jet routes that crisscross the north Pacific Ocean.

3.11.2.1.2.2 Southern California Range Complex

Military Air Transit

The SOCAL Range Complex contains three warning areas (W): W-290, W-291, and a small portion of W-289. Each extends from the surface to 80,000 feet (ft.) (24,384 meters [m]) above mean sea level (Figure 3.11-4). All three warning areas can be activated by the Federal Aviation Administration at the Navy's request when operations that would pose a hazard to nonparticipating aircraft are being conducted. Other special use airspace within W-291 includes nine Tactical Maneuvering Areas and two Missile Ranges.

Military pilots travel under Instrument Flight Rules from local air bases until they reach W-291 and proceed under a Visual Flight Rules to their instructed tactical maneuvering areas or missile range OPAREA. Activation by the Federal Aviation Administration is performed by notifying the controlling air traffic agency of the change in status in the area. This allows the agency to issue notices to pilots to alter their courses to avoid military activities.

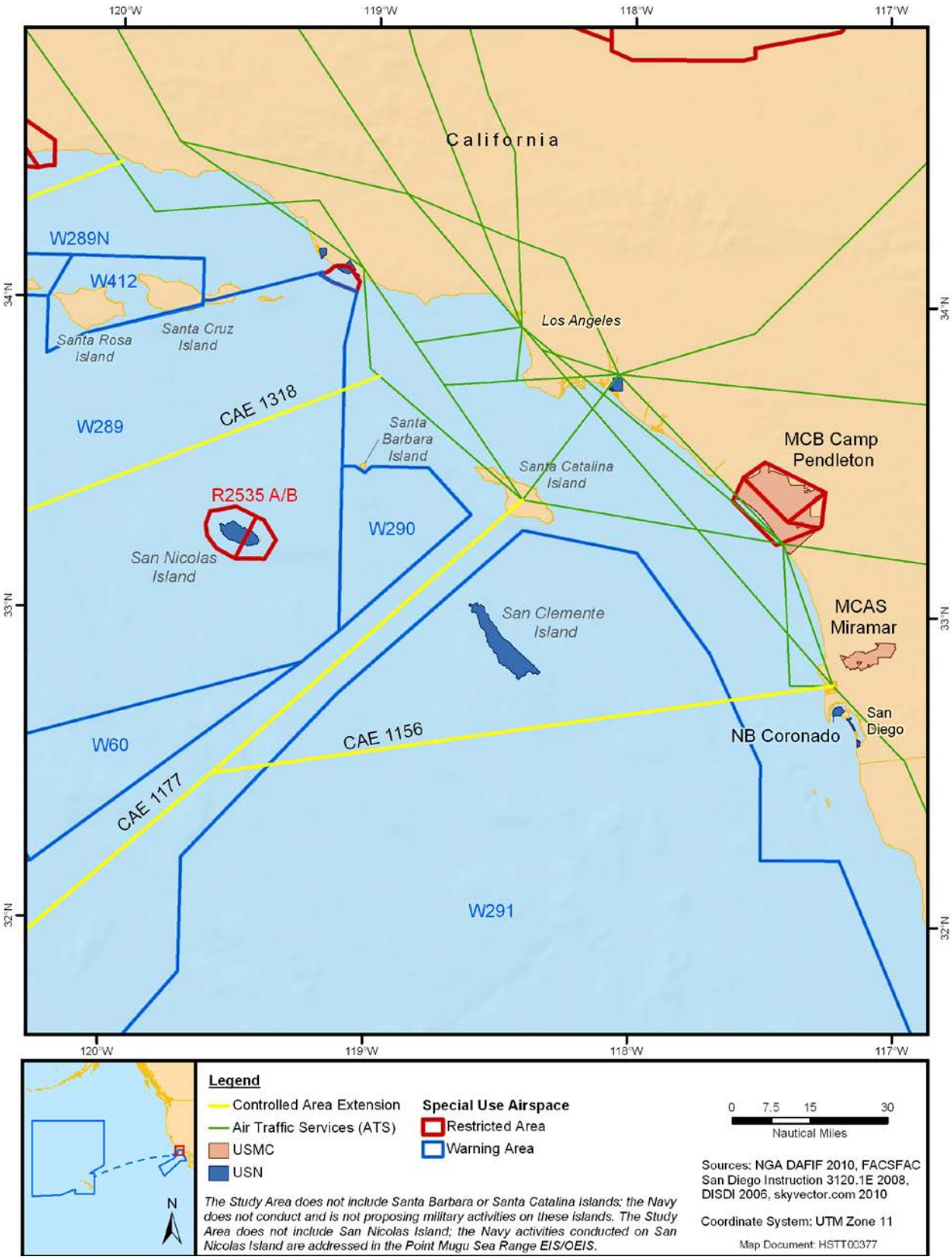

Figure 3.11-4: Southern California Offshore Airspace

In the Fleet Area Control and Surveillance Facility San Diego annual utilization report for fiscal year 2010, (1 October 2009 through 30 September 2010) there were 36,194 air operations in W-291, exclusive of air operations that utilize the Naval Auxiliary Landing Field at San Clemente Island (see below). During fiscal year 2010, W-291 airspace was released to the controlling agency, Los Angeles Air Route Traffic Control Center, for 619 hours of public use.

The Study Area off the coast of Southern California contains a restricted area over San Nicolas Island, R-2535 A/B, which is located within the Pt. Mugu Sea Range. Other types of special use airspace are found within the SOCAL Range Complex OPAREAs including missile ranges and tactical maneuvering areas.

The Naval Auxiliary Landing Field at San Clemente Island is located within W-291 airspace. To support the safe and efficient air traffic movement to/from Naval Auxiliary Landing Field San Clemente Island, Class D airspace has been established. Class D airspace is airspace tailored to the specific needs of the airport to ensure separation between aircraft. The airspace above San Clemente Island consists of a 5 nm radius circle centered on Fleet Area Control and Surveillance Facility San Clemente Island and includes the airspace from the surface to 2,700 ft. (823 m) mean sea level. All aircraft entering this airspace, or operating within it, must maintain radio contact with the Fleet Area Control and Surveillance Facility San Clemente Island control tower. An aircraft operation at Fleet Area Control and Surveillance Facility San Clemente Island is defined as an aircraft event that involves a takeoff, landing, low approach to the airfield, or touch-and-go landing. Thus, a single sortie from the airfield could generate several reportable “operations.” The baseline level of airfield operations at Fleet Area Control and Surveillance Facility is 25,120 operations.

Commercial and General Aviation

Aircraft operating under Visual Flight Rules can fly along the coast between San Diego and Orange County and out to Santa Catalina Island largely unconstrained, except by safety requirements and mandated traffic flow requirements. Aircraft operating under Instrument Flight Rules clearances, authorized by the Federal Aviation Administration, normally fly on the airway route structures. In Southern California, these routes include both high and low altitude routes between San Diego and Los Angeles and to Santa Catalina Island. There are two control area extensions from Southern California through nearby W-291 to facilitate easier access to air routes out to Hawaii and other transpacific locations. These routes allow general aviation and commercial air travel to coexist with military operations. Control area extension 1177 extends from Santa Catalina Island southwest between W-291 and the Pt. Mugu Sea Range. Control area extension 1156 extends west from San Diego through the northern portion of W-291. When W-291 is active, control area extension 1156 is normally closed. Control area extension 1177, the more important route through the coastal warning areas, is closed only when weapons hazard patterns extend into the area, and this closure is fully coordinated with the Federal Aviation Administration. When W-291 is active, aircraft on Instrument Flight Rules clearances are precluded from entering W-291 by the Federal Aviation Administration. However, since W-291 is located entirely over international waters, nonparticipating aircraft operating under Visual Flight Rules are not prohibited from entering the area. Examples of aircraft flights of this nature include light aircraft, fish spotters, and whale watchers, which occur under Visual Flight Rules throughout W-291 on a variable basis.

3.11.2.1.2.3 Silver Strand Training Complex

Military Air Transit

Military overflights generated for SSTC activities are based out of Naval Air Station North Island and Navy Outlying Landing Field Imperial Beach. The airspace over both facilities is classified as Class D airspace defined by a five nautical miles (nine kilometers) radius and extending to 2,800 ft. (853 m) over Naval Air Station North Island and to 1,500 ft. (457 m) over Navy Outlying Landing Field Imperial Beach. The two airspace extend over the SSTC and much of San Diego Bay and the surrounding area. These airspace are under Navy control, and air operations in support of SSTC training, including helicopter insertions and extractions, and parachute drops into designated drop zones must comply with the Air Operations Manual. Flight paths servicing nearby San Diego Airport are geographically separate from helicopter sorties bound for SSTC training areas and approach and departure patterns for fixed wing aircraft into Naval Air Station North Island.

Commercial and General Aviation

Commercial and general aviation air traffic is controlled by the San Diego Air Route Traffic Control Center. Flight paths servicing San Diego Airport located to the North of Naval Air Station North Island are geographically separate from helicopter sorties traveling to SSTC training areas and approach and departure patterns for fixed wing aircraft into Naval Air Station North Island.

3.11.2.1.2.4 Transit Corridor

There are numerous commercial air routes over the transit corridor between Southern California and Hawaii. Commercial aircraft typically fly above 30,000 ft. (9,144 m) in this area. These air routes are controlled by the Federal Aviation Administration.

3.11.2.2 Commercial and Recreational Fishing

Commercial fishing takes place throughout the Study Area from nearshore waters adjacent to the mainland and offshore islands, to the offshore banks and waters within the transit area. Many different types of fishing gear are used by commercial and recreational fishermen in the Study Area, such as gillnets, longline gear, troll gear, trawls, seines, traps or pots, harpoons, and hook and line.

3.11.2.2.1.1 Hawaii Range Complex

The data that individual fishermen report on commercial fishing reports are confidential, protected by Hawaii state law (189-3, Hawaii Revised Statutes), and can only be released to the public in summarized form. Table 3.11-3 shows that commercial landings for all fisheries from 2006 to 2010 in Hawaiian waters totaled 140,142,310 pounds (lb.) (63,567,480 kilograms [kg]). Based on the catch data presented in Table 3.11-3, the total value of reported commercial landings for all accounted species in Hawaii from 2006-2010 was $381,742,062 (National Marine Fisheries Service 2011).

Hawaii does not collect data on non-commercial marine fishing consistently, although occasional surveys have been conducted. In 2001, NMFS and the Hawaii Division of Aquatic Resources began collecting data on recreational fishing in Hawaii using the Marine Recreational Fishing Survey. Results of the survey are reported through the Marine Recreational Fishery Statistics Survey website, which has been reporting similar data for other coastal states since 1979. Hawaii does not have a mandatory recreational marine fishing license as many other coastal states do, and does not have mandatory reporting of recreational catches (National Marine Fisheries Service and Hawaii Division of Aquatic Resources 2010). Fishing destinations vary in response to changing fishing conditions, and many charter boats fish HRC waters on a routine basis. Sport fishermen pursue various fish species with hook and line; some divers also spearfish or take invertebrates by hand within the Hawaii nearshore waters.

Table 3.11-3: Total Commercial Landings (Pounds) and Total Value (Dollars) within the Hawaii Range Complex (2006–2010)

Major Species and Species Group		Total Catch 2006–2010 (pounds)
Fish	Tuna (yellowfin, skipjack, bluefin, albacore, etc.)	81,749,277
	Billfish (blue marlin, striped marlin, swordfish)	25,616,726
	Bottomfish (opakapaka, onaga, uku)	1,522,474
	Other Pelagic Fish (mahimahi and wahoo)	10,433,429
	All Other Fish	20,774,305
	Total Fish	**140,096,211**
Invertebrates	Spiny Lobster	45,046
	Saltwater Shrimp	1,053
Totals	**Total Invertebrates**	**46,099**
	Combined Total	**140,142,310**
	Value of Combined Total	**$381,742,062**

Source: National Marine Fisheries Service 2011, Pacific Islands Fisheries Science Center 2011, National Marine Fisheries Service 2012

Nearshore target fish species include akule, opelu, ta'ape, snapper, moana, weke, ulua, menpachi, o'ie, and bonefish. Longer charters target species typically found father offshore, such as mahi mahi, ono, ahi, swordfish, tuna, and marlin (blue, black, striped). Although, many of these species are caught relatively close to shore (within 3 nm), because water depth increases dramatically only a short distance from shore creating habitat attract to many pelagic species. In many areas, such as off Kona, fishing takes place year round. Tournaments held off of Oahu, Maui, and Kona occur from February through early November; however, most tournaments are scheduled between June and August (Sportfish Hawaii 2008).

The U.S. Fish and Wildlife Service conducts a telephone survey every 5 years to estimate the total numbers of fishermen and hunters in each state. On average, in 1995, about 260,000 people fished recreationally in Hawaii, of which about half were residents. The estimated 130,000 Hawaii residents who fish recreationally far outnumber the 3,500-plus licensed commercial fishermen in Hawaii (National Marine Fisheries Service and Hawaii Division of Aquatic Resources 2010).

State and federal agencies protect a variety of marine areas in Hawaii; fisheries have improved as a result. These areas include Marine Life Conservation Districts, Fisheries Management Areas, Fisheries Replenishment Areas, Bottomfish Restricted Fishing Areas, Hawaii Marine Laboratory Refuge-Coconut Island, Kahoolawe Island Reserve, Paiko Lagoon Wildlife Sanctuary, Ahihi-Kinau Natural Area Reserve, South Kona Opelu Fishing Area, the Hawaiian Islands Humpback Whale National Marine Sanctuary, and the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve (Friedlander, Aeby et al. 2004).

3.11.2.2.1.2 Southern California Range Complex and Silver Strand Training Complex

The California Department of Fish and Game maintains commercial catch block data for waters in the northern part of W-291 (Section 3.9, Fish), and all statements referring to catch are for that part of the Study Area for which data are available. For 2011, the most commonly harvested commercial species in

the SOCAL Range Complex were tuna, Pacific sardine, swordfish, spiny lobster, crab, sea urchin, squid, and other invertebrates (Table 3.11-4). During 2011, Southern California accounted for 39 percent of all California fish and invertebrate landings. In 2009, Southern California accounted for 10 percent of all fish and invertebrate landings, for California waters.

Table 3.11-4: Annual Commercial Landing of Fish and Invertebrates and Value within the Southern California Range Complex and Silver Strand Training Complex (2011)

Major Species and Species Group		Annual 2011 Catch (pounds)	Value ($)
Fish	Tuna (yellowfin, bluefin, and albacore)	455,630	$508,914
	Pacific Sardine	38,804,579	$3,378,952
	Swordfish	88,511	$468,963
	All Other Fish	5,724,708	$3,564,549
	Total Fish	**45,073,428**	**$7,921,378**
Invertebrates	Spiny Lobster	503,492	$8,636,545
	Crab	294,392	$344,609
	Other Crustaceans (shrimp and prawn)	176,892	$1,536,512
	Sea Urchins	1,683,458	$1,622,037
	Squid	112,390,626	$30,391,039
	Other Invertebrates	308,146	$1,121,981
Totals	**Total Invertebrates**	**115,357,006**	**$43,652,723**
	Combined Total	**160,430,434**	**$51,574,101**

Source: California Department of Fish and Game 2012

In the SOCAL Range Complex, groundfishes (e.g., flatfishes, skates, sharks, chimeras, rockfishes) are important recreational and commercial species. Highly migratory species (e.g., tuna, billfish, sharks, dolphinfish, and swordfish) and coastal pelagic species such as anchovies, mackerel, sardines, and squid also support extensive fisheries in the area. The harvest of coastal pelagic species is one of the largest fisheries in the SOCAL Range Complex in terms of landed biomass and volume, as well as revenue (California Department of Fish and Game 2012). In 2010, California ranked fourth in the nation for commercial fisheries landings (measured in pounds) (National Marine Fisheries Service 2011). For recreational fisheries, California ranked 14th in the nation in landings of finfish (bony and cartilaginous fish that use fins for locomotion).

Pelagic, flatfish, demersal fish, and other fish associated with the ocean bottom account for about 50 percent of the average annual catch of fish within the Study Area OPAREAs (Table 3.11-4). Pelagic species encompass the majority of the commercial portion of the average annual pound of catch. The average annual catch of pelagic, flatfish, demersal, and all other fish amounts to 36,951,285 lb. (16,760,818 kg) and $8,152,845. The Pacific sardine fishery is one of the most valuable fisheries among the coastal pelagic finfish in California, with the majority of the fish landed in SOCAL and Ensenada (California Department of Fish and Game 2005).

The average annual catch of crustaceans is comprised of approximately half spiny lobster (377,607 lb. [171,279.6 kg] per year) and half crab and shrimp (average 340,845 lb. [154,604.7 kg] per year). The

catch of crustaceans in the SOCAL Range Complex OPAREAs was worth $10,517,666 in 2011. In comparison, total commercial landings of market squid in 2011 were worth $30,391,039 and urchins were worth $1,622,037. Red sea urchins are the most commonly harvested invertebrate species within the SOCAL OPAREA. Other invertebrates (e.g., snails, sea cucumbers, sea stars, whelks) were worth $1,121,981 in 2009 (Table 3.11-4) (California Department of Fish and Game 2009).

Fishing activities occur at varying degrees of intensity and duration throughout the year within the SOCAL Range Complex. Fishermen often fish for more than one species and land their catch in various ports depending on the season in order to maximize their economic return. Key commercial fishing ports in Southern California include Los Angeles and San Diego, with numerous smaller ports and harbors located between these major port complexes. A wide range of commercial fishing methods are used in this region that are fishery-specific such as drift gillnets, longline gear, troll gear, trawls, seining, and traps or pots (Naval Undersea Warfare Center 2009).

The SOCAL Range Complex marine environments are popular locations for recreational fishing. Charter and privately operated boats enter the SOCAL Range Complex and San Clemente Island waters for salt-water sport fishing, recreational diving, and other boating activities. Commercial passenger fishing vessels, more commonly target fish further offshore compared to private boats, due to the high cost of private large boat ownership, the capability of the larger vessels to go farther, and the greater experience of professional captains. Recreational fishing and diving are centered primarily around San Clemente Island and secondarily in the shallower waters over Tanner and Cortes banks. These banks are inherently more hazardous due to their distance from shore and open-ocean diving conditions. Therefore, the near shore waters off San Clemente Island are a more popular destination than the more remote banks. Commercial passenger fishing vessels usually perform full-day trips; however, some charter boats occasionally may spend nights at sea (Naval Undersea Warfare Center 2009). More than 200 commercial passenger fishing vessels operate between Point Conception and the U.S./Mexican border (California Marine Life Protection Act Initiative 2009). These vessels operate from ports including San Diego, Oceanside, Dana Point, Newport Beach, Long Beach, Los Angeles, and from other locations all along the coast.

Major sport fish species include albacore and yellowfin tuna, shallow water rockfish (*Sebastes* spp.), yellowtail rockfish (*Sebastes flavidus*), kelp bass (*Paralabrax clathratus*), yellowtail (*Seriola lalandi*), California sheephead (*Semicossyphus pulcher*), ocean whitefish (*Caulolatilus princeps*), dolphin (*Coryphaena hippurus*), marlin (*Tetrapturus audax*), barracuda (*Sphyraena argentea*), swordfish (*Xiphias gladius*) and lingcod (*Opiodon elongatus*) (Fletcher 1999, Helgren 1999). Sport fishermen fish for bluefin tuna, yellowfin tuna, yellowtail rockfish, and rock cod (*Sebastes* spp.) in the vicinity of the offshore islands and on Tanner and Cortes banks (Fletcher 1999, Helgren 1999). Halibut (*Paralichthys californicus*) and white seabass (*Atractoscion nobilis*) are fished in sand channels and kelp beds around San Clemente Island.

Fishing destinations are generally fluid, in response to changing fishing conditions, but a number of charter boats fish waters of the SOCAL Range Complex on a routine basis. Sport fishermen pursue various fish species with almost exclusively rod and reel gear (hook and line); some divers also spearfish or take invertebrates (mainly lobster) by hand within the SOCAL Range Complex. The recreational fishing season is dependent on oceanographic conditions and generally occurs in late spring through the fall (Pacific Fishery Management Council 2007).

3.11.2.2.1.3 Transit Corridor

There are no data on commercial or recreational fishing within the transit corridor area because of the distance from land.

3.11.2.3 Subsistence Use

The U.S. Environmental Protection Agency considers subsistence fishers to be people who rely on noncommercial fish as a major source of protein. Subsistence fishers tend to consume noncommercial fish and/or shellfish at higher rates than other fishing populations, and for a greater percentage of the year, because of cultural and/or economic factors. There are very few studies in the United States that have focused specifically on subsistence fishers. The United States has issued no regulations to determine what or who would be considered a subsistence fisher. In addition, in the United States, there are no particular criteria or thresholds (such as income level or frequency of fishing) that definitively describe subsistence fishers. The U.S. Environmental Protection Agency issued guidance to state that at least 10 percent of licensed fishers in any area will be subsistence fishers (U.S. Environmental Protection Agency 2011). Because the 10 percent estimate is not based on actual subsistence fishing data, the number may overestimate or underestimate the number.
The U.S. Environmental Protection Agency (2011) suggests that Native Americans, lower income urban populations, and Asian-Americans are often subsistence fishers (Gassel et al. 1997). Therefore, an increased number of individuals below the poverty rate or an increased percentage of population classified as Native American or Asian may indicate an area with a higher amount of subsistence fishers.

Low-income populations would have limited means and opportunity to travel offshore to federal waters (i.e., beyond 3 nm from shore) for fishing. Nearshore waters surrounding the city of Coronado and the Silver Strand Training Complex provide fishing opportunities in San Diego Bay and along the Pacific coast of the peninsula. A variety of fish are caught mainly by hook and line from beaches, piers, and small boats (USA Today 2012). Thus, it is assumed that the majority of subsistence fishing would occur in waters close to the coastline. Inshore fishing usually occurs within sight of the shoreline in bays, flats, and marshes or under piers, bridges, or near the jetties where water is generally less than 100 ft. (30 m) deep. Boats used by subsistence fishers are generally smaller and more affordable.

3.11.2.3.1.1 Hawaii Range Complex

There have been no comprehensive surveys of subsistence-fishing activities in Hawaii and economic surveys have been episodic. Therefore, there is limited information from which to fully assess the subsistence fishing contribution to island economies, but the value of fishing for subsistence by contemporary Native Hawaiians is known to be an important component of some communities, particularly rural communities (Pooley 1993). However, it is believed that combined offshore recreational and subsistence catch is likely equal to or greater than the offshore commercial fisheries catch, with more species taken using a wider range of fishing gear (Friedlander et al. 2004).

3.11.2.3.1.2 Southern California Range Complex and Silver Strand Training Complex

In Southern California, people fish off piers and in local bays, harbors, and waterways for regular subsistence rather than for recreation. In Los Angeles County, where a high cost of living and low incomes have produced food insecurity among certain populations, subsistence fishing is more and more common. Although the economic value of subsistence fisheries may often be low, they may be critical for the livelihoods of many communities.

3.11.2.3.1.3 Transit Corridor

It is assumed that there is limited to no subsistence fishing activity within the Transit Corridor because of the distance from land to the Transit Corridor and because the majority of subsistence use occurs nearshore.

3.11.2.4 Tourism

Coastal tourism and recreation can be defined as the full range of tourism, leisure, and recreationally oriented activities that take place in the coastal zone and the offshore coastal waters. These activities include coastal tourism development (hotels, resorts, restaurants, food industry, vacation homes, second homes, etc.), and the infrastructure supporting coastal development (retail businesses, marinas, fishing tackle stores, dive shops, fishing piers, recreational boating harbors, beaches, recreational fishing facilities, etc.). Also included is ecotourism (e.g., whale watching) and recreational activities such as recreational boating, cruises, swimming, recreational fishing, surfing, snorkeling, and diving (National Oceanic Atmospheric Administration 1998).

3.11.2.4.1.1 Hawaii Range Complex

Navy vessels present on the waters of the HRC represent a small fraction of the overall commercial and recreational boat traffic and, correspondingly, account for only a small fraction of the potentially restrictive circumstances present in the open-ocean area around Hawaii.

The waters surrounding the main Hawaiian Islands are used for a variety of recreational, commercial, scientific, transportation, cultural, and institutional purposes. The intensity of use generally declines with increasing distance from shore, although specific resources in the open-ocean area may result in a concentration of use (e.g., seamounts are preferred fishing and diving locations). Offshore areas that are shielded by landmasses from the full force of wind and waves, such as the channels between Maui and adjacent islands, are preferred areas for recreational boating and diving. In addition, there are numerous beaches and parks throughout the islands (Figure 3.11-5 through Figure 3.11-7).

Recreational fishing in Hawaii is very important economically with anglers spending over $755 million on trip and durable expenditures in 2006. This level of expenditures generated $253.6 million in income, supported 7,000 jobs, and generated $105.0 million in government revenue in 2006 (Gentner 2009). Tourism, and by extension recreational fishing by tourists, varies seasonally. Additionally, the country or region of origin (e.g., U.S. west coast, U.S. east coast, Japan, etc.) of the tourists varies seasonally, influencing the types of activities in which tourists participate (Hawai'i Tourism Authority 2010). Surfing can also be found in the nearshore areas of all the Hawaiian Islands depending on the seasonal swell direction. Swells typically approach from the north in the winter months and from the south in the summer.

Humpback whale watching around the Hawaiian Islands peaks from late February through early April (Mobley, Spitz et al. 2001; Carretta, Forney et al. 2005). Direct revenues attributed to whale watching were $11–$16 million in Hawaii during the 1999 whale season (National Oceanic and Atmospheric Administration 2000; Pendleton 2006). Marine mammal sightings are expected to occur from the coast to 50 nm offshore, including the areas off Pacific Missile Range Facility, close to shore at Pyramid Rock Beach on Oahu, or areas within the 100-fathom contours such as the Molokai–Lanai–Maui–Kahoolawe channels and Penguin Bank. However, tourist day trips typically stay closer to shore or from beach vantage points, these activities can occur throughout the HRC. Additional information on humpback whales, including description, habitat, abundance, and distribution, is provided in Section 3.4 (Marine Mammals).

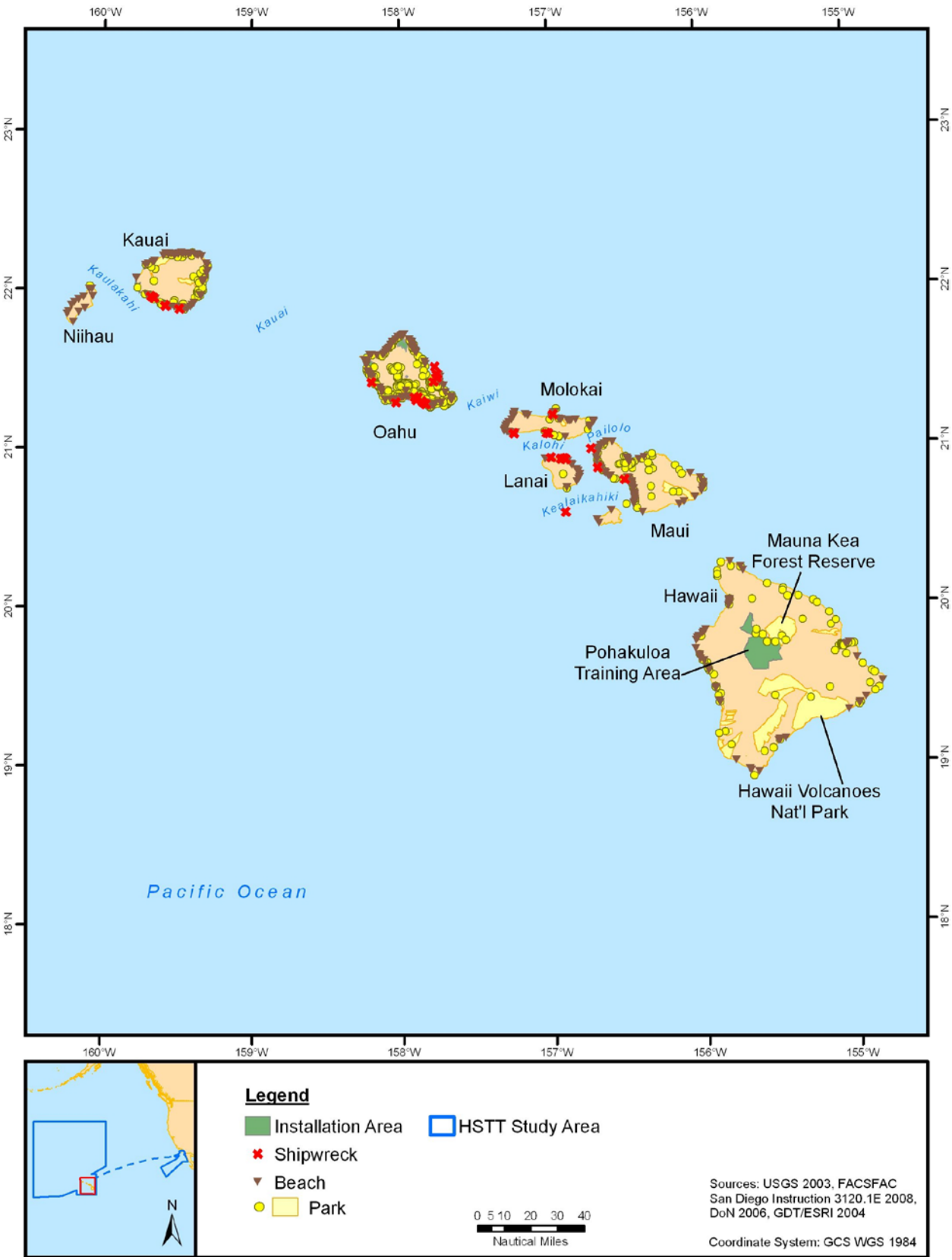

Figure 3.11-5: Hawaiian Island Recreational Areas

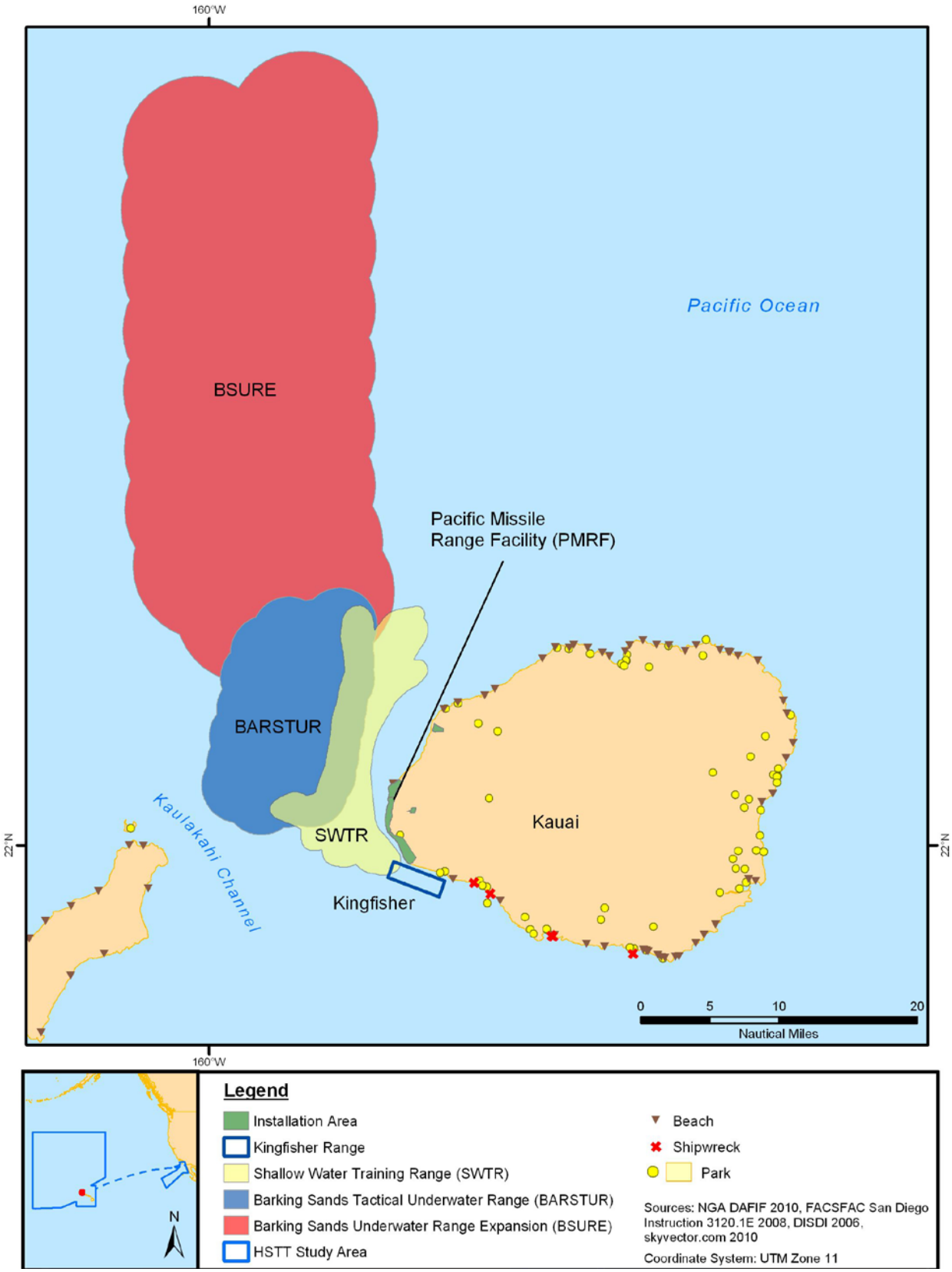

Figure 3.11-6: Kauai–Niihau Island Recreation Areas

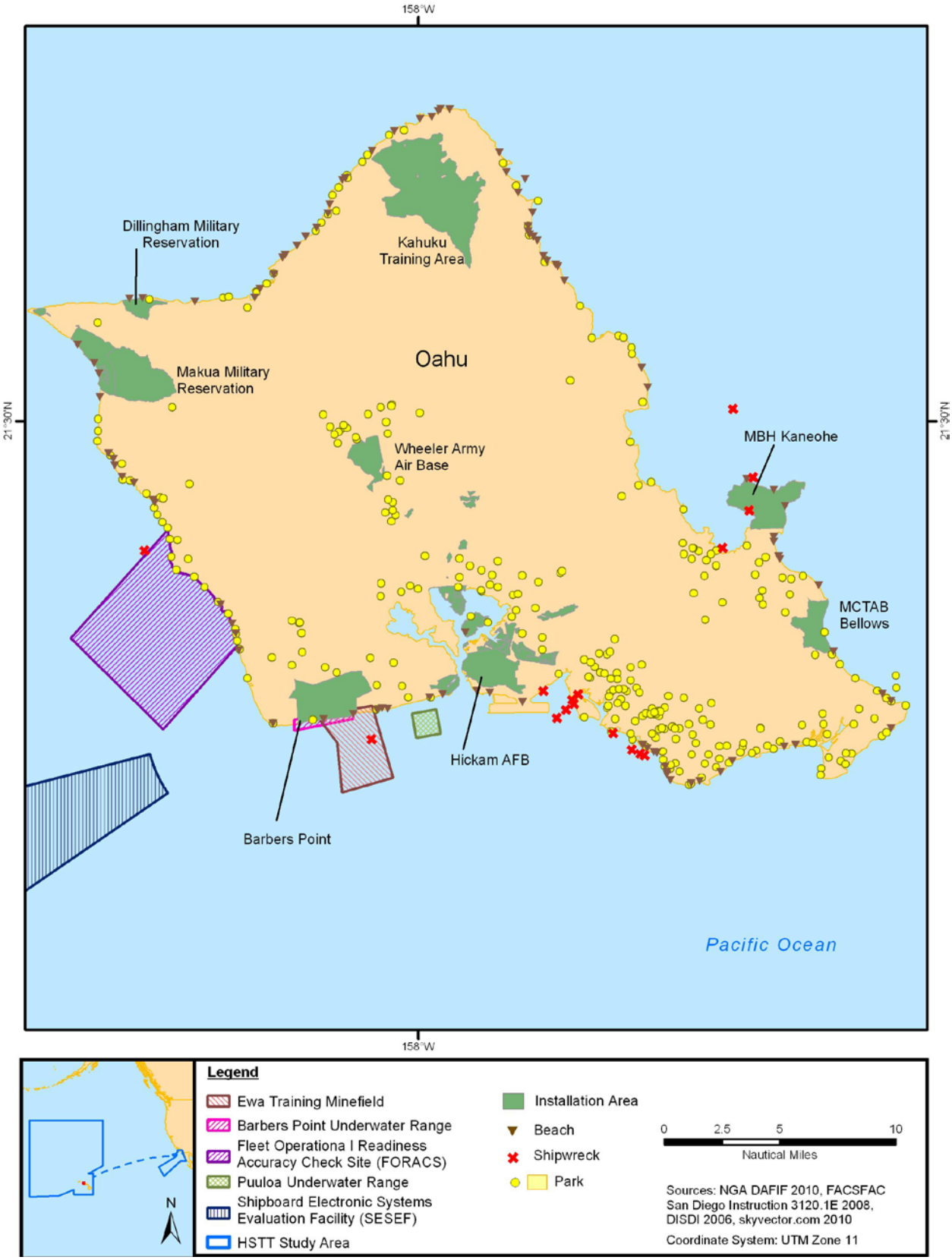

Figure 3.11-7: Oahu Island Recreation Areas

3.11.2.4.1.2 Southern California Range Complex

The SOCAL Range Complex marine environments are popular locations for recreational activities including sightseeing, whale watching, sport fishing, boating, diving, and surfing. Most recreation and tourism activities occur close to the mainland coast of Southern California or between the mainland and the Channel Islands. The shallower waters near the Channel Islands and some offshore banks, such as Tanner and Cortes Banks, are especially popular areas for self-contained underwater breathing apparatus (SCUBA) diving, fishing, and occasionally surfing. There is very little recreational activity in the southwestern portion of the SOCAL Range Complex due to its distance from land and its water depth.

Santa Catalina and Santa Barbara Islands are within the Study Area and visited by tourists. While Navy activities are conducted offshore of these islands, there is little interaction between the public and Navy activities.

Whale watching takes place primarily from December through March, for the annual gray whale southward migration and the northward migration. Though tourist day trips typically stay closer to the mainland, these activities can occur throughout the SOCAL Range Complex.

During the fall-winter period, primarily charter and privately operated boats enter the SOCAL Range Complex OPAREAs and San Clemente Island waters for salt-water sport fishing (Figure 3.11-8), recreational diving, surfing, and other boating activities. Salt-water sport fishing and recreational diving take place primarily around San Clemente Island, and to a lesser extent in the shallower waters over the Tanner and Cortes Banks. Some limited, seasonal surfing can occur near the Tanner and Cortes Banks. Due to distance from shore, Tanner and Cortes Banks are inherently more hazardous due to their open ocean diving conditions. Therefore, the nearshore waters off San Clemente Island are a more popular destination than the more remote banks. This makes them suitable primarily for skilled divers, a more limited market for charter operators.

San Clemente Island's relatively warm waters, good underwater visibility, and largely pristine diving conditions make it a popular destination. Charter dive trips to specific sites are often published and booked as many as six months in advance. Diving occurs year-round, though the number of trips to San Clemente Island and the banks appear to peak during lobster season (October–March).

Fishing destinations are generally more fluid, in response to changing fishing conditions, but a number of charter boats operate in SOCAL Range Complex waters on a routine basis. Sport fishermen pursue various fish species with hook and line; some divers also spearfish or take invertebrates (mainly lobster) by hand within the SOCAL Range Complex OPAREAs. Surfing can also be found in the offshore OPAREAs and nearshore San Clemente Island areas.

In the winter months, when large northern Pacific ocean swell is generated, some charter and private vessels travel out to Cortes Bank to surf the waves created by the rapidly rising seamounts. In addition, surfers can venture year-round to the breaks off of San Clemente Island to surf the island's south points (China and Pyramid Points) and up the west shore of the island depending on the swell direction of the season (Figure 3.11-8). Although both areas within the SOCAL Range Complex OPAREAs are accessed throughout the year, due to the difficulty in access and a rare culmination of conditions necessary for surfing these spots, these areas are rarely accessed.

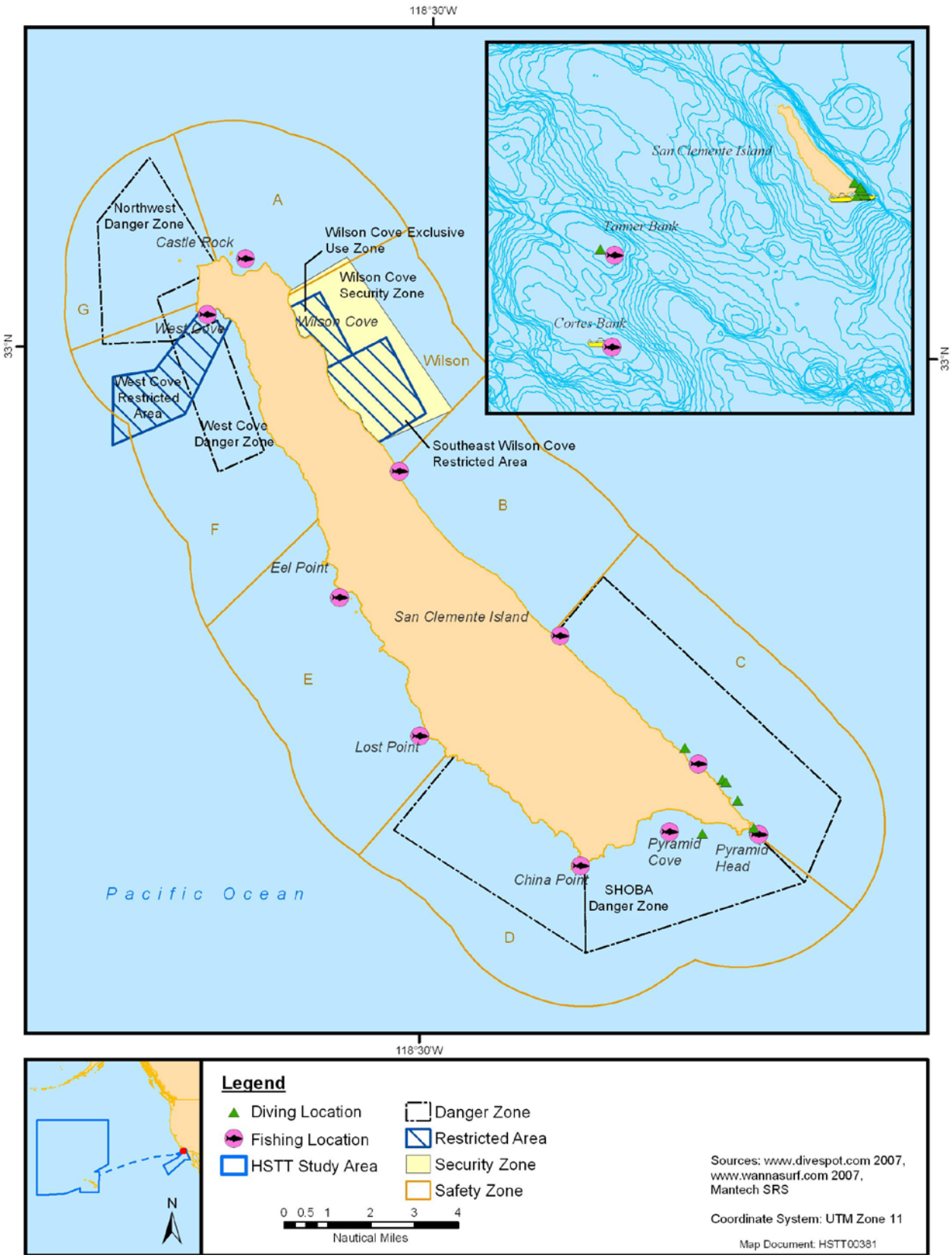

Figure 3.11-8: Recreation Areas around San Clemente Island

Other limited surf spots and dive sites occur throughout the nearshore areas, for diving, at various shipwrecks and reefs and, for surfing, off of Point Loma and around Santa Catalina Island. In addition, "big wave" surfers are known to travel farther offshore to Tanner and Cortez banks when ocean conditions produce large swells that form into giant waves in excess of 60 ft. (18 m) in height when they reach the shallow banks (Casey 2010).

3.11.2.4.1.3 Silver Strand Training Complex

The San Diego Bay is a natural harbor adjacent to downtown San Diego. The San Diego Bay is frequently used by recreational boaters from surrounding marinas and mooring areas. The City of San Diego, City of Coronado, City of Imperial Beach, City of Chula Vista, and National City all surround, and have an interest in activities within San Diego Bay. The Sweetwater Canal, located in south San Diego Bay is the site of the National City Marina and Pepper Park. Further south in San Diego Bay is the Chula Vista Marina. Both marinas are recreational boating access points that contribute to the amount of vessels within San Diego Bay (Figure 3.11-9).

Fiddler's Cove Marina, operated by the Navy, is located to the south of SSTC-North on the bayside along Silver Strand State Highway/SR-75, just north of Loews Coronado Resort. The marina has approximately 150 moorings and approximately 130 dock slips; the recreational vehicle park offers year-round camping. Both facilities are open to active duty, retirees, DoD civilians, and sponsored civilian guests.

Glorietta Bay is located to the north of SSTC-North on the bayside and is used by the public for recreation and pleasure boating (Figure 3.11-9). Navy piers at the Naval Amphibious Base Coronado extend into Glorietta Bay from its southern shore and support small boat training activities at the SSTC.

In San Diego Bay, there is a designated restricted area from the northern and eastern boundary of Naval Amphibious Base Coronado (33 C.F.R. 334.860) (Figure 3.11-9); activities such as swimming, fishing, waterskiing, and mooring are not allowed within this area. All vessels entering the restricted area must proceed across the area by the most direct route and without unnecessary delay. For vessels under sail, necessary tacking constitutes a direct route. A portion of the restricted area extending 120 ft. from pierheads and from the low water mark on shore where piers do not exist is closed to all persons and vessels except those owned by, under hire to, or performing work for, the Naval Amphibious Base.

Recreational activities offshore of SSTC and the Naval Amphibious Base Coronado are permitted outside of the restricted areas and include sportfishing, bait fishing for the sport fishermen, lobster fishing, and sailboat regattas. Organized activities (such as sail races and regattas) within the restricted area may be allowed providing that a request has been made to the Commanding Officer, Naval Amphibious Base, Coronado. Silver Strand State Beach offers ocean side camping, kite surfing, and surfing. The City of Coronado beach, which lies between Naval Air Station North Island and Naval Amphibious Base Coronado, is a major public beach. The YMCA Surf Camp at SSTC-S is a major recreational facility for military and civilian families with surfing and beach activities.

3.11.2.4.1.4 Transit Corridor

It is assumed that there is limited to no tourism activity within the transit corridor because of the distance from land to the transit corridor and because the majority of tourism activity occurs nearshore.

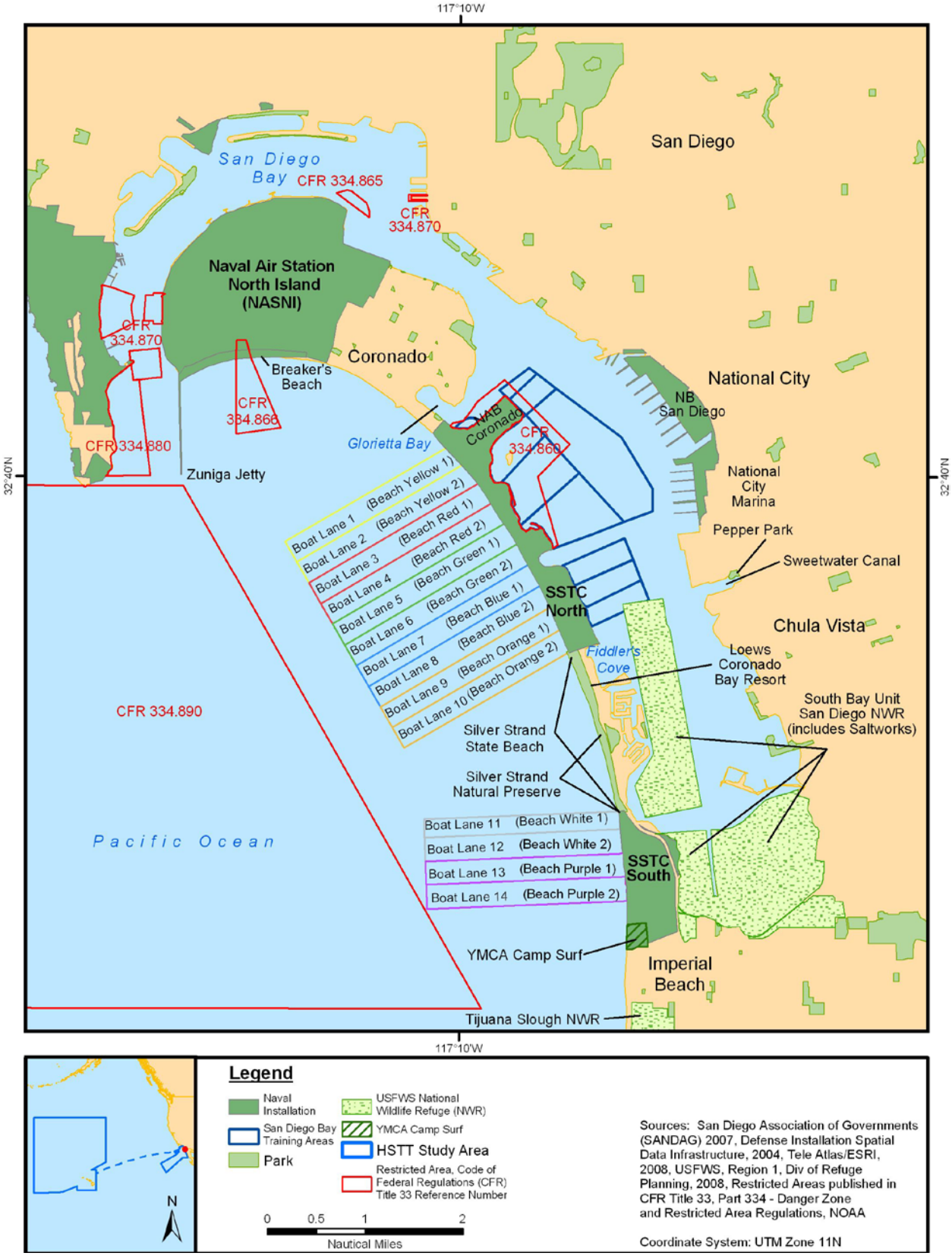

Figure 3.11-9: Recreational Map of the Silver Strand Training Complex

3.11.3 ENVIRONMENTAL CONSEQUENCES

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) could impact socioeconomic resources of the Study Area. Tables 2.8-1 through 2.8-5 present the baseline and proposed training and testing activity locations for each alternative (including number of events and ordnance expended). Each socioeconomic resource stressor is introduced, analyzed by alternative, analyzed for training and testing activities, and then a NEPA determination is made by stressor. Table H-3 in Appendix H shows the warfare areas and associated stressors that were considered for analysis of socioeconomic resources. The stressors vary in intensity, frequency, duration, and location within the Study Area. The primary stressors applicable to socioeconomic resources in the Study Area and that are analyzed include the following:

- Accessibility
- Physical disturbance and strikes
- Airborne acoustics
- Secondary

Secondary stressors resulting in indirect impacts to socioeconomic resources are discussed in Section 3.11.4. Analysis of economic impacts evaluates the impacts of the alternatives on the economy of the region of influence while analysis of social impacts considers the change to human populations and how the action alters the way individuals live, work, play, relate to one another, and function as members of society. Because proposed HSTT activities are predominantly offshore, socioeconomic impacts would be associated with economic activity, employment, income, and social conditions (i.e., livelihoods) of industries or operations that use the ocean resources within the Study Area. Although there are no permanent population centers in the region of influence and the typical socioeconomic considerations such as population, housing, and employment are not applicable, this section will analyze the potential for fiscal impacts on marine-based activities and coastal communities. When considering impacts on recreational activities such as fishing, boating, and tourism, both the economic impact associated with revenue from recreational tourism and public enjoyment of recreational activities are considered.

The proposed HSTT training and testing activities were evaluated to identify specific components that could act as stressors by having direct or indirect effects on sources of commercial transportation and shipping, commercial and recreational fishing, subsistence use, and tourism. For each stressor, a discussion of impacts on these sources is included for each alternative.

The evaluation indicated that the relative potential for socioeconomic impacts would be similar across various areas and marine ecosystems in the Study Area. Therefore, the analysis of environmental consequences was not broken down by large marine ecosystem. Based on an initial screening of potential impacts of sonar maintenance and testing, pierside locations have been eliminated from detailed consideration in the analysis of impacts on energy, mineral extraction, and transportation and shipping. Elimination of these resources was based on the extremely limited potential for active sonar to damage infrastructure or interfere with transportation operations.

3.11.3.1 Accessibility

Navy training and testing activities have the potential to temporarily limit access to areas of the ocean for a variety of human activities associated with commercial transportation and shipping, commercial recreation and fishing, subsistence use, and tourism in the Study Area.

When training or testing activities are scheduled that require specific areas to be free of nonparticipating vessels due to public safety concerns, the Navy requests that the U.S. Coast Guard issue Notices to Mariners to warn the public of upcoming Navy activities. Training and testing activities occur in established restricted or danger areas as published on navigation charts.

The changes in accessibility to human activities in the ocean would be an impact if it directly contributed to loss of income, revenue, or employment. Disturbance to human activities that result in impacts on payrolls, revenue, or employment is quantified by the amount of time the activity may be halted or rerouted or the ability to move to another location.

Accessibility, or restrictions to the availability of ocean space, would be a temporary condition. While mariners have a responsibility to be aware of conditions on the ocean, it is not expected that direct conflicts in accessibility would occur. The locations of restricted areas are published and available to mariners, who typically review such information before boating in any area. Restricted areas are typically avoided by experienced mariners. Prior to initiating a training activity, the Navy would follow standard operating procedures to visually scan an area to ensure that nonparticipants are not present. If nonparticipants are present, the Navy delays, moves, or cancels its activity. Public accessibility is no longer restricted once the activity concludes.

3.11.3.1.1 Socioeconomic Activities

3.11.3.1.1.1 Commercial Transportation and Shipping

The offshore and nearshore areas of the Study Areas include established Navy OPAREAs used for military training and testing activities. Commercial vessels entering OPAREAs, including established restricted areas and danger zones, within the Study Area operate under maritime regulations and are not limited by Navy activities. Potential disruptions to commercial shipping are limited or avoided by the Navy issuing Notices to Mariners through the U.S. Coast Guard. Notices to Mariners advise commercial ship operators, commercial fishermen, recreational boaters, and other users of the area that the military will be operating in a specific area, allowing them to plan their activities accordingly. These temporary clearance procedures are established and implemented for the safety of the public and have been employed regularly over time without significant socioeconomic impacts on commercial shipping activities.

3.11.3.1.1.2 Commercial and Recreational Fishing

Commercial and recreational fishing activities make an appreciable contribution to the overall economy within the Study Area. The Navy has performed military activities within this region in the past with limited interruption to fishing or recreational activities. Commercial and recreational interests such as fishing, boating, and beach use are only restricted temporarily. Temporary closing of areas within the Study Area (typically offshore areas of the Pacific Missile Range Facility and areas in the vicinity of San Clemente Island) for security and safety does not limit public access to surrounding areas. These areas that are temporarily closed are only closed for the duration of the activity and are re-opened at the completion of the activity.

These temporary range clearance procedures for safety purposes do not adversely affect commercial and recreational fishing activities because displacement is of short duration (less than 24 hours). When range clearance is required, the public is notified via Notices to Mariners. These measures provide mariners with advance notice of areas being used by the Navy for training and testing activities. This allows the public to select an alternate destination without appreciable effect to their activities.

Scheduled closures to Navy training and testing areas are also posted on several publicly accessible Navy websites. Online searches for San Clemente Island or the Southern California Offshore Range (SCORE) should provide links with information on closures around San Clemente Island. The public website for the Naval Base Coronado provides advance notice of training activities originating from the base.

The Notices to Mariners and postings on Navy websites are intended to prevent fishermen from expending time and fuel resources transiting to a closed location. In 2009, the Navy completed a study to assess the effects of Navy activities on commercial and recreational fishing near San Clemente Island in the SOCAL Range Complex (Naval Undersea Warfare Center 2009). The SOCAL Fisheries Study reported the results of a survey of local fishermen and resulted in several recommendations to improve communications between the Navy and commercial and recreational fishermen. Improved communications would enable fishermen to be better informed of range closures, and would reduce the number of times fishermen traveled to temporarily closed areas. To enhance communications with fishermen and the local community, the Navy (1) issues regular and up-to-date broadcasts of scheduled closures on very high frequency (VHF) radio, (2) provides frequent updates to the San Clemente Island website, (3) has established a single Navy point of contact with the most up-to-date information on closures for fishermen without website access, and (4) specifies if a scheduled Navy activity requires a complete closure or if fishing can occur simultaneously with the Navy activity. During the course of the study, some of the recommendations have been addressed by the Southern California Offshore Range, which has operational authority over the San Clemente Island ranges. In particular, the Southern California Offshore Range initiated development of more robust range operations control, which allows fishermen to contact the San Clemente Island range in real-time using marine band VHF radio or cellular phones to obtain the status of OPAREA availability. In addition, a list of acronyms and codes was generated and posted as a link on the main page of the San Clemente Island website, which, along with other user-friendly website implementations (e.g., Twitter link for updates to safety zone scheduling), have been added to the San Clemente Island website.

Upon completion of training, the range would be reopened and fishermen would be able to return to fish in the previously closed area. To help manage competing demands and maintain public access in the Study Area, the Navy conducts its offshore operations in a manner that minimizes restrictions to commercial fisherman. Navy ships, fishermen, and recreational users operate within the area together, and keep a safe distance between each other, and the Navy exercise participants relocate as necessary to avoid conflicts with nonparticipants. Only specific areas within the HRC, SSTC, and SOCAL Range Complex have been designated as danger zones or restricted areas. In addition to these areas, the Navy may temporarily establish an exclusion zone for the duration of a specific activity (e.g., an activity involving the detonation of explosives) to prevent non-participating vessels and aircraft from entering and unsafe area. Exclusion zones typically have a radius of only a couple of miles (this varies depending on the activity), are surveyed before during, and after the activity takes place, and end after the activity is completed (see Section 3.12, Public Health and Safety).

The Navy does not exclude fishing activities from occurring in areas of the HRC, SOCAL Range Complex, and SSTC that are not being used by the Navy during training and testing activities. The Navy has been conducting training and testing activities within the Study Area for decades, and has taken and will continue to take measures to prevent interruption of commercial and recreational fishing activities. To minimize potential military/civilian interactions, the Navy will continue to publish scheduled operation times and locations on publicly accessible Navy websites and through U.S. Coast Guard issued Notices to Mariners up to 6 months in advance. These efforts are intended to ensure that commercial and recreational users are aware of the Navy's plans and allow users to plan their activities to avoid

scheduled Navy activities. Therefore, decreases in the frequency of fishing trips or in the availability of desirable fishing locations due to Navy activities is not expected. For safety reasons, the Navy may restrict access to a specific surface water area through the establishment of an exclusion zone, which would temporarily limit commercial and recreational fishing in that specific area; however, other areas in the Study Area would remain open to commercial and recreational fishing. A Navy activity involving the use of explosive ordnance is one example of an activity that could require establishment of a temporary exclusion zone. Typically, an exclusion zone is established only for a few hours and extends over a circular area with a radius of a couple of miles (depending on the activity). Commercial and recreational fishing activities could occur in the area before and after the temporary restriction. Should the Navy find nonparticipants present in an exclusion zone, the Navy would halt or delay (and reschedule, if necessary) all potentially hazardous activity until the nonparticipants have exited the exclusion zone.

3.11.3.1.1.3 Subsistence Use

Subsistence uses typically occur from the shore or from small vessels within state waters (3 nm or closer to shore). Navy training and testing activities occur farther from shore in offshore waters where subsistence fishing typically does not occur. Therefore, there would be no foreseeable impact on subsistence uses from conducting proposed training and testing activities in the Study Area.

3.11.3.1.1.4 Tourism

Tourism activities make an appreciable contribution to the overall economy within the Study Area. Temporary range clearance procedures in the area, mainly around the Pacific Missile Range Facility and San Clemente Island, for safety purposes, do not adversely affect tourism activities because displacement is of short duration (typically less than 24 hours) and are in areas where tourism activities are not as prevalent. The Navy temporarily limits public access only to areas where there is a risk of injury or property damage and publishes scheduled activities through the use of Notices to Mariners and publically accessible websites. The Navy strives to conduct its operations in a manner that is compatible with recreational ocean users by minimizing temporary access restrictions. Published notices allow recreational users to adjust their routes to avoid temporary restricted areas. If civilian vessels are within a testing or training area at the time of a scheduled operation, Navy personnel would continue operations only where and when it is safe and possible to avoid the civilian vessels. If avoidance is not safe or possible, the operation would be halted and may relocate or be delayed. In some instances where safety requires exclusive use of a specific area, nonparticipants in the area are asked to relocate to a safer area for the duration of the operation.

3.11.3.1.2 No Action Alternatives

Training

Under the No Action Alternative, potential accessibility impacts would be associated primarily with anti-air warfare, anti-surface warfare, anti-submarine warfare, mine warfare, amphibious warfare, and naval special warfare. Training activities would continue at current levels and within established ranges and training locations. There would be no anticipated impacts on commercial transportation and shipping, commercial and recreational fishing, subsistence use, or tourism because inaccessibility to areas of co-use would be temporary and of short duration (hours). In addition, the Navy has implemented recommendations from the SOCAL Fisheries Study, which should improve communications between the Navy and fishermen, both recreational and commercial, and reduce the number of instances when fishermen must leave a temporarily closed area (Naval Undersea Warfare Center 2009). Based on the Navy's standard operating procedures and the large expanse of the Study Area that would be available to the public, accessibility impacts would remain negligible.

Testing

Under the No Action Alternative, the impact on accessibility would be negligible for the same reasons stated for training activities above.

3.11.3.1.3 Alternative 1

Alternative 1 consists of the No Action Alternative plus the expansion of the Study Area boundaries, adjustments to the tempo of training and testing activities, and the addition of new weapons, platforms, and systems. The changes in the tempo of training and testing activities would result in an increase in sonar activities, underwater detonations, aircraft transits, and weapons firing throughout the Study Area.

Training

Training activities as described under the No Action Alternative would continue but with an approximate 5 percent increase in tempo within the Study Area. There would be no changes to the Navy's current standard operating procedures defining safety precautions and actions taken by the Navy to protect the public during hazardous training activities on the ocean. Under Alternative 1, potential impacts affecting accessibility to areas of the Study Area would be the same as those associated with the No Action Alternative. Despite the increase in tempo of training activities and the expansion of the Study Area, no impacts from Alternative 1 activities on commercial transportation and shipping, commercial and recreational fishing, subsistence use, or tourism are anticipated, because training activities would place only temporary and short duration (hours) restrictions on public use of scheduled training areas. In addition, the Navy is implementing recommendations from the SOCAL Fisheries Study, which should improve communications between the Navy and fishermen, both recreational and commercial, and reduce the number of instances when fishermen must leave a temporarily closed area (Naval Undersea Warfare Center 2009). Based on the Navy's standard operating procedures and the large expanse of the Study Area that would be available to the public, accessibility impacts would remain negligible.

Testing

Under the Alternative 1, the impact on accessibility from testing activities would be negligible for the same reasons stated for training activities above.

3.11.3.1.4 Alternative 2

Alternative 2 consists of Alternative 1 plus an increase in tempo. Changes in testing tempo under Alternative 2 would result in an increase in sonar activities, underwater detonations, aircraft transiting, and weapons firing throughout the Study Area.

Training

Training activities as described under Alternative 1 would continue at the same tempo within the Study Area. There would be no changes to the Navy's current standard operating procedures defining safety precautions and actions taken by the Navy to protect the public during hazardous training activities on the ocean. Despite the increase in tempo of training activities, no impacts from Alternative 2 activities on commercial transportation and shipping, commercial and recreational fishing, subsistence use, or tourism are anticipated, because training activities would place only temporary and short duration (hours) restrictions on public use of scheduled training areas. In addition, the Navy is implementing recommendations from the SOCAL Fisheries Study which should improve communications between the Navy and recreational fishermen and reduce the number of instances when fishermen must leave a temporarily closed area (Naval Undersea Warfare Center 2009). Based on the Navy's standard operating

procedures and the large expanse of the Study Area that would be available to the public, accessibility impacts would remain negligible.

Testing

Under the Alternative 2, the impact on accessibility from testing activities would be negligible for the same reasons stated for training activities above.

3.11.3.2 Physical Disturbances and Strikes

The evaluation of impacts on socioeconomic resources from physical disturbance and strike stressors focuses on direct physical encounters or collisions with objects moving through the water or air (e.g., vessels, aircraft, unmanned devices, and towed devices), dropped or fired into the water (non-explosive practice munitions, other military expended materials, and ocean bottom deployed devices), or resting on the ocean floor (anchors, mines, targets) that may damage or encounter civilian equipment. Physical disturbances that damage equipment and infrastructure could disrupt the collection and transport of products, which may impact industry revenue or operating costs.

Navy training and testing equipment and vessels moving through the water could collide with non-Navy vessels and equipment. Most of the training and testing activities involve vessel movement and use of towed devices. However, the likelihood that a Navy vessel would collide with a non-Navy vessel is remote because of the prevalent use of navigational aids or buoys separating vessel traffic, shipboard lookouts, radar, and marine band radio communications by both Navy and civilians. Therefore, the potential to impact commercial transportation and shipping by physical disturbance or strike is negligible and requires no further analysis.

Aircraft conducting training or testing activities in the Study Area operate in designated military special use airspace (e.g., warning areas). All aircraft, military and civilian, are subject to Federal Aviation Administration regulations, which define permissible uses of designated airspace, and are implemented to control those uses. These regulations are intended to accommodate the various categories of aviation, whether military, commercial, or general aviation. By adhering to these regulations, the likelihood of civilian aircraft coming into contact with military aircraft or ordnance is remote. In addition, Navy aircraft follow procedures outlined in Navy air operations manuals, which are specific to a warning area or other special use airspace, and which describe procedures for operating safely when civilian aircraft are in the vicinity.

Military expended materials can physically interact with civilian equipment and infrastructure. Almost all training and testing activities produce military expended materials such as chaff, flares, projectiles, casings, target fragments, missile fragments, rocket fragments, and ballast weights.

3.11.3.2.1 Socioeconomic Activities

3.11.3.2.1.1 Commercial and Recreational Fishing/Subsistence Use

The majority of commercial and recreational fishing in the Study Area takes place in state waters, where the Navy conducts very limited training and testing activities. Less than 10 percent of recreational fishing takes place in federal waters, which are located beyond 3 nm from shore. Therefore, most recreational fishing would occur away from physical disturbances and strikes associated with training and testing activities. Some commercial fishing may occur beyond 3 nm in Navy training and testing areas and could be affected by the proposed activities if those activities were to alter fish population levels in those areas to such an extent that commercial fishers would no longer be able to find their target species. As described in Section 3.9.3 (Fish, Environmental Consequences), the behavioral responses that could

occur from various types of physical stressors associated with training and testing activities would not compromise the general health or condition of fish and, as such, commercial or recreational fishing resources.

Commercial fishing activities have the potential to interact with equipment placed in the ocean or on the ocean floor for use during proposed Navy training and testing activities. This equipment could include ship anchors, moored or bottom mounted targets, mines and mine shapes, tripods, and use of towed system and attachment cables. Many different types of commercial fishing gear are used in the Study Area, including gillnets, longline gear, troll gear, trawls, seines, and traps or pots. Commercial bottom fishing activities that use these types of gear have a greater potential to be affected by interaction with Navy training and testing equipment, resulting in the loss of or damage to both the Navy equipment and the commercial fishing gear. The Navy recovers many of the targets (e.g., mines and mine shapes) and target fragments used in training and testing activities, and would continue to do so to minimize the potential for interaction with fishing gear and fishing vessels. Unrecoverable items are typically small, constructed of soft materials (such as target cardboard boxes or tethered target balloons), or are intentionally designed to sink to the bottom after serving their purpose (such as expended 55-gallon steel drums), so that they would not represent a collision risk to vessels, including commercial fishing vessels. Although larger expended items, such as 55-gallon drums, may pose a risk to certain types of fishing gear used for bottom fishing, the probability of encountering such an item is remote given the large area over which expended materials would be distributed; the depth of the water where most activities using expended materials would occur; and the tendency for larger, heavier materials to become embedded in soft sediments, making them less likely to be snagged by fishing gear.

3.11.3.2.1.2 Tourism

While Navy training and testing activities can occur throughout the Study Area, most (especially hazardous) activities occur well out to sea. Most civilian recreational activities engaged in by both tourists and residents take place within a few miles of land.

Snorkeling and diving take place primarily at known recreational sites, including shipwrecks and reefs. Temporary range clearance procedures in the areas, mainly around the Pacific Missile Range Facility and San Clemente Island, for safety purposes, do not adversely affect tourism activities because displacement is of short duration (typically less than 24 hours) and are in areas where tourism activities are not as prevalent. The Navy temporarily limits public access to areas where there is a risk of injury or property damage through the use of Notices to Mariners. The Navy also maintains a website which provides information on scheduled closures around San Clemente Island. Published notices allow recreational users to adjust their routes to avoid temporary restricted areas. If civilian vessels are within a testing or training area at the time of a scheduled operation, Navy personnel continue operations and avoid them if it is safe and possible to do so. If avoidance is not safe or possible, the operation may relocate or be delayed. In some instances where safety requires exclusive use of a specific area, nonparticipants in the area are asked to relocate to a safer area for the duration of the operation. Because Navy training and testing activities vary in location and are primarily short-term in duration, impacts on tourism activities from rerouting or postponing activities would be negligible.

Other tourism activities such as whale watching, boating, or use of other watercraft occur farther out at sea and are conducted by boat, aircraft, or from land. These activities would be conducted with boats that are typically well marked and visible to Navy ships conducting training and testing activities. Individual boaters engaged in tourism activities, such as whale watching, plan and monitor navigational information to avoid Navy training and testing areas. Vessels are responsible for being aware of

designated danger areas in surface waters and any Notices to Mariners that are in effect. Operators of recreational or commercial vessels have a duty to abide by maritime requirements as administered by the U.S. Coast Guard. At the same time, Navy vessels ensure that an area is clear of nonparticipants prior to testing and training exercises. As a result, conflicts between Navy training and testing activities in offshore areas and whale watching or other offshore recreational use would not occur. Changes to current offshore tourism activities in the Study Area would not be expected from the proposed training and testing activities. Therefore, loss of revenue or employment associated with tourism would not occur.

The Navy would continue to recover many of the targets (e.g., mines and mine shapes) and target fragments used in training and testing activities so that they would not pose a collision risk to vessels. Unrecoverable items are typically small, constructed of soft materials (such as target cardboard boxes or tethered target balloons), or are intentionally designed to sink to the bottom after serving their purpose (such as expended 55-gallon steel drums), so that they would not represent a collision risk to vessels.

3.11.3.2.2 No Action Alternative

Training

Under the No Action Alternative, potential physical disturbance and strike impacts would be associated primarily with anti-air warfare, anti-surface warfare, anti-submarine warfare, mine warfare, and amphibious warfare. Training activities would continue at current levels and within established ranges and training locations.

There would be no anticipated impacts on commercial and recreational fishing, subsistence use, or tourism because of the large size of the Study Area, the limited areas of operations, and implementation of the Navy's standard operating procedures, which includes ensuring that an area is clear of all nonparticipating vessels before training activities take place. In addition, the Navy provides advance notification of training activities to the public through Notices to Mariners and postings on Navy websites (e.g., the San Clemente Island website). Damage to or loss of commercial fishing gear from interaction with Navy equipment or other expended materials is unlikely. The Navy recovers many practice munitions (e.g., mines and mine shapes) for reuse following the activity. The Navy also recovers larger floating objects or materials, such as targets or target fragments, to avoid having them become hazards to navigation. Smaller objects that remain in the water column would be unlikely to pose a risk to fishing gear. Considering the expansive size of the Navy's OPAREAs, the disbursement of military expended materials over these large areas, and the Navy's standard operation procedures and mitigation measures (see Chapter 5), impacts from physical disturbances and strikes on commercial and recreational fishing, subsistence use, or tourism would be negligible.

Testing

Under the No Action Alternative, the impact associated with physical disturbances and strikes from testing activities would be negligible for the same reasons stated for training activities above.

3.11.3.2.3 Alternative 1

Alternative 1 consists of the No Action Alternative plus the expansion of the Study Area boundaries, adjustments to the tempo of training and testing activities, and the addition of new weapons, platforms and systems. The changes in training tempo would result in an increase in sonar activities, underwater detonations, aircraft transiting, and weapons firing throughout the Study Area.

Training

Under Alternative 1, potential physical disturbance and strike impacts would be the same as those associated with the No Action Alternative. Training activities would continue but with an approximate 5 percent increase in tempo and associated increase in the quantity of military expended materials released within the Study Area. There would be no changes to the Navy's standard operating procedures for hazardous training activities performed in the Study Area. The expansive size of the Navy's OPAREAs, the disbursement of military expended materials over these large areas, and implementation of the Navy's standard operating procedures and mitigation measures (see Chapter 5) ensure that impacts from physical disturbances and strikes would be negligible. The advance public release of Notices to Mariners and postings of upcoming activities on Navy websites (e.g., the San Clemente Island website) would inform the public of upcoming activities, and enable them to plan to avoid the area. Therefore, impacts from physical disturbance and strike on commercial and recreational fishing, subsistence use, and tourism would be negligible.

Testing

Under Alternative 1, the impact associated with physical disturbances and strikes from testing activities would be negligible for the same reasons stated for training activities above.

3.11.3.2.4 Alternative 2

Alternative 2 consists of Alternative 1 plus an increase in tempo. Changes in testing tempo under Alternative 2 would result in an increase in sonar activities, underwater detonations, aircraft transiting, and weapons firing throughout the Study Area.

Training

Under Alternative 2, potential physical disturbance and strike impacts would be the same as those associated with the No Action Alternative. Training activities would continue at the same tempo as Alternative 1. There would be no changes to the Navy's standard operating procedures for hazardous training activities performed in the Study Area. The expansive size of the Navy's OPAREAs, the disbursement of military expended materials over these large areas, and implementation of the Navy's standard operating procedures and mitigation measures (see Chapter 5) ensure that impacts from physical disturbances and strikes would be negligible. The advance public release of Notices to Mariners and postings of upcoming activities on Navy websites (e.g., the San Clemente Island website) would inform the public of upcoming activities, and enable them to plan to avoid the area. Therefore, impacts from physical disturbance and strike on commercial and recreational fishing, subsistence use, or tourism would be negligible.

Testing

Under Alternative 2, the impact associated with physical disturbances and strikes from testing activities would be negligible for the same reasons stated for training activities above.

3.11.3.3 Airborne Acoustics

As an environmental stressor, loud noises, sonic booms, and vibrations generated from Navy training and testing activities such as weapons firing, in-air explosions, and aircraft transiting have the potential to disrupt wildlife and humans in the Study Area.

3.11.3.3.1 Socioeconomic Activities

3.11.3.3.1.1 Tourism

Noise interference could decrease public enjoyment of recreational activities. These effects would occur on a temporary basis, only when weapons firing, in-air explosions, and aircraft transiting occur. Of these activities, Navy training and testing activities involving weapons firing and in-air explosions would only occur when the Navy can confirm the area is clear of nonparticipants, reducing the likelihood that noise from these activities would disturb tourists. Most naval training would occur well out to sea, while tourism and civilian recreational activities are largely conducted within a few miles of shore. Tourism and recreational activity revenue is not expected to be impacted by airborne noise.

3.11.3.3.2 No Action Alternative

Training

Under the No Action Alternative, potential airborne noise impacts would be associated primarily with anti-air warfare, anti-surface warfare, anti-submarine warfare, mine warfare, and amphibious warfare. Training activities would continue at current levels and within established ranges and training locations. There would be no anticipated impacts on tourism because (1) most Navy training occurs well out to sea, while most tourism and recreational activities occur near shore; and (2) Navy training activities producing airborne noise are normally short term and temporary. Therefore, airborne noise impacts on tourism would be negligible.

Testing

Under the No Action Alternative, impacts associated with airborne acoustics from testing activities would be negligible for the same reasons stated for training activities above.

3.11.3.3.3 Alternative 1

Alternative 1 consists of the No Action Alternative plus the expansion of the Study Area boundaries, adjustments to the tempo of training and testing activities, and the addition of new weapons, platforms and systems. The changes in training tempo would result in an approximate 5 percent increase in noise-generating activities such as sonar activities, underwater detonations, aircraft transiting, and weapons firing throughout the Study Area.

Training

Under Alternative 1, potential airborne noise would be the same as that associated with the No Action Alternative. Training activities would continue but with an increase in tempo within the Study Area. Similar to the No Action Alternative and despite the increase in tempo, there would be no anticipated impacts on tourism because (1) most Navy training occurs well out to sea, while most tourism and recreational activities occur near shore and (2) Navy training activities producing airborne noise are normally short term and temporary. Therefore, airborne noise impacts on tourism would be negligible.

Testing

Under Alternative 1, impacts associated with airborne acoustics from testing activities would be negligible for the same reasons stated for training activities above.

3.11.3.3.4 Alternative 2

Alternative 2 consists of Alternative 1 plus an increase in tempo. Changes in testing tempo under Alternative 2 would result in an increase in sonar activities, underwater detonations, aircraft transiting, and weapons firing throughout the Study Area.

Training

Under Alternative 2, potential airborne noise would be the same as that associated with the No Action Alternative. Training activities would continue at the same tempo as Alternative 1 within the Study Area. Similar to Alternative 1, there would be no anticipated impacts on tourism because (1) most Navy training occurs well out to sea, while most tourism and recreational activities occur near shore and (2) Navy training activities producing airborne noise are normally short term and temporary. Therefore, airborne noise impacts on tourism would be negligible.

Testing

Under Alternative 2, impacts associated with airborne acoustics from testing activities would be negligible for the same reasons stated for training activities above.

3.11.3.4 Analysis of Secondary Stressors

Socioeconomics could be impacted if the proposed activities led to changes to physical and biological resources to the extent that they would alter the way industries can utilize those resources. The secondary stressor of resource availability pertains to the potential for loss of fisheries resources within the Study Area.

Fishing, subsistence use, and tourism could be impacted if the proposed activities altered fish population levels to such an extent that these activities would no longer be able to find their target species. Similarly, disturbances to marine mammal populations could impact the whale watching industry. Analyses in Sections 3.4 (Marine Mammals), 3.8 (Marine Invertebrates), and 3.9 (Fish) concluded that impacts to marine species from training and testing activities are not anticipated. Based on these conclusions, secondary impacts on commercial or recreational fishing, subsistence use, or tourism are not anticipated.

3.11.4 Summary of Potential Impacts (Combined Impacts of All Stressors) on Socioeconomics

Stressors described in this EIS/OEIS that could result in potential impacts on socioeconomic resources include accessibility to areas within the Study Area, physical disturbance and strikes, airborne acoustics, and secondary stressors resulting from Impacts to marine species populations. Under the No Action Alternative, Alternative 1, and Alternative 2, these activities would be widely dispersed throughout the Study Area. These activities are also dispersed temporally (i.e., few stressors would occur in the same location at the same time). Therefore, no greater impacts from the combined operation of more than one stressor are expected. The aggregate impact on socioeconomics would not observably differ from existing conditions.

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REFERENCES

Association of Port Authorities. (2009). U.S. Port Rankings by Cargo Volume 2009, U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center. 2012

Calfornia Department of Fish and Game. (2005). Final 2005 California Commercial Landings, Table 15. Retrieved from: http://www.dfg.ca.gov/marine/landings05.asp

California Department of Fish and Game. (2009). Catch Block Data 2009.

California Department of Fish and Game. (2012). Final 2011 California Commercial Landings, Table 15. 2012.

California Marine Life Protection Act Initiative. (2009). Regional Profile of the Marine Life Protection Act (MLPA) South Coast Study Region (Point Conception to the California/Mexico Border). Sacramento, CA, California Resources Agency.

Carretta, J. V., K. A. Forney, M.M. Muto, J. Barlow, J. Baker, B. Hanson, & M.S. Lowry. (2005). U.S. Pacific Marine Mammal Stock Assessments: 2004. NOAA Technical Memorandum NMFS, National Oceanic and Atmospheric Administration.

Casey, S. (2010). The Wave: In Pursuit of the Rogues, Freaks, and Giants of the Ocean. New York, Doubleday.

Federal Aviation Administration. (2009). "Appendix A: National Airspace System Overview." from http://www.faa.gov/air_traffic/nas_redesign/regional_guidance/eastern_reg/nynjphl_redesign/documentation/feis.

Fletcher R. (1999). Sports Fishing Association of California. Personal communication 4 January 1999, San Diego, CA.

Friedlander, A., G. Aeby, R. Brainard, E. Brown, A. Clark, S. Coles, E. Demartini, S. Dollar, S. Godwin, C. Hunter, P. Jokiel, J. Kenyon, R. Kosaki, J. Maragos, P. Vroom, B. Walsh, I. Williams, & W. Wiltse. (2004). Status of Coral Reefs in the Hawaiian Archipelago. In. Status of Coral Reefs of the World: 2004: 411-430.

Gassel, M., R. K. Brodberg, G. A. Pollock, & A.M. Fan. (1997). Chemicals in Fish, Report No. 1, Consumption of Fish and Shellfish in Californis and the United States, Final Draft Report. Berkeley, CA, Pesticide and Environmental Toxicology Section, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency: 101.

Gentner, B. (2009). AN ASSESSMENT OF RECREATIONAL FISHERY DEVELOPMENT OPTIONS, Gentner Consulting Group.

Hawai'i Tourism Authority. (2010). 2010 Annual Visitor Research Report. Honolulu, HI.

Helgren R. (1999). Helgren sport fishing. Personal communication. 11 Jan 1999, Oceanside, CA.

Intermodal Association of North America. (2008). Intermodal Industry Statistics 2004-2008. 2011.

Mintz, J. and R. Filadelfo. (2011). Exposure of Marine Mammals to Broadband Radiated Noise. Specific Authority N0001-4-05-D-0500. CNA Analysis & Solutions: 42.

Mobley, J., S. Spitz, & R. Grotefendt. (2001). Abundance of Humpback Whales in Hawaiian Waters: Results of 1993-2000 Aerial Surveys, Hawaiian Islands Humpback Whale National Marine Sanctuary, Department of Land and Natural Resources, State of Hawaii: 17.

National Marine Fisheries Service. (2011). Fisheries of the United States 2010, National Marine Fisheries Service, 2012, Retrieved from: http://www.pifsc.noaa.gov/wpacfin/hi/dar/Pages/hi_data_1.php.

National Marine Fisheries Service. (2012). Annual Landings by Species for Hawaii As Of 10_JAN-12. 2012.

National Marine Fisheries Service and Hawaii Division of Aquatic Resources. (2010). Hawaii Marine Recreational Fishing Survey (HMRFS). 2011.

National Oceanic and Atmospheric Administration. (1998). 1998 Year of the Ocean, Coastal Tourism and Recreation. 2011.

National Oceanic and Atmospheric Administration. (2000). The Economic Contribution of Whalewatching to Regional Economies: Perspectives From Two National Marine Sanctuaries, National Ocean Service: 90.

Naval Undersea Warfare Center. (2009). Southern California (SOCAL) Fisheries Study: Catch Statistics (2002-2007), Fishing Access, and Fishermen Perception. Newport, Rhode Island, Department of the Navy.

Pacific Islands Fisheries Science Center. (2011). Hawaii Annual Reported Commercial landings (Million Pounds) of Pelagic Fishes, Bottomfishes, Reef Fishes, and Other Fishes. 2012.

Pacific Fishery Management Council. (2007). Fishery Management Plan for U. S. West Coast Fisheries for Highly Migratory Species. As Amended by Amendment 1. Portland, OR, Pacific Fishery Management Council: 129.

Pendleton, L. (2006). Understanding the Potential Economic Impact of Marine Wildlife Viewing and Whale Watching in California: Using the Literature To Support Decision-Making for the Marine Life Protection Act.

Pooley, S. G. (1993). Hawaii's marine fisheries: some history, long term trends, and recent developments. (Fisheries of Hawaii and U.S.-associated Pacific Islands), HighBeam Encyclopedia. 2007.

San Diego Unified Port District. (2011). Annual shipping arrivals in the Port of San Diego from 2007 to 2010, Unpublished data.

Sportfish Hawaii. (2008). Hawaii Fishing Adventures and Charters. 2012.

U.S. Environmental Protection Agency. (2011). Revised Technical Support Document: National-Scale Assessment of Mercury Risk to Populations with High Consumption of Self-caught Freshwater Fish. Research Triangle Park, North Carolina: 196.

USA Today. (2012). Fishing Spots on San Diego Bay.

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3.12 Public Health and Safety

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3.12 PUBLIC HEALTH AND SAFETY

PUBLIC HEALTH AND SAFETY SYNOPSIS

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

- Underwater energy
- In-air energy
- Physical interactions
- Secondary

Alternative 2 (Preferred Alternative)

Because of the Navy's standard operating procedures, impacts on public health and safety would be unlikely.

3.12.1 INTRODUCTION AND METHODS

3.12.1.1 Introduction

This section analyzes potential impacts on public health and safety within the Hawaii-Southern California Training and Testing (HSTT) Study Area (Study Area). Unlike military training and testing activities conducted within the boundaries of a fenced-land installation, public access to ocean areas or to the overlying airspace cannot be physically controlled. The United States (U.S.) Department of the Navy (Navy) coordinates use of these areas through the scheduling of activities, and issues warnings and notices to the public prior to conducting potentially hazardous activities (Section 3.12.2.2). Sensitivity to public health and safety concerns within the Study Area is heightened in areas where the public may be close to certain activities (e.g., pierside testing or littoral training).

Generally, the greatest potential for a proposed activity to affect the public is near the coast because that is where public activities are concentrated. These coastal areas could include dive sites or other recreational areas where the collective health and safety of groups of individuals that could be exposed to the hazards of training and testing would be of concern. Most commercial and recreational marine activities are close to the shore, and are usually limited by the capabilities of the boat used. Commercial and recreational fishing may extend as far as 100 nautical miles (nm) from shore, but are concentrated near the coast.

3.12.1.2 Methods

Baseline public health and safety conditions were derived from the current training and testing activities in the Southern California (SOCAL) Range Complex and the Hawaii Range Complex (HRC). The No Action Alternative does not include the Transit Corridor of the Study Area (Chapter 2, Description of Proposed Action and Alternatives). Existing procedures for assuring public health and safety and other elements of the baseline (e.g., restricted areas) were derived from federal regulations, Department of Defense (DoD) directives, and Navy instructions for training and testing. The directives and instructions provide specifications for mission planning and execution that describe criteria for public health and safety considerations. These directives and instructions include criteria for public health and safety considerations for training and testing planning and execution.

The alternatives were evaluated based on two factors: the potential for a training or testing activity to impact public health and safety and the degree to which those activities could have an impact. The likelihood that the public would be near a training or testing activity determines the potential for exposure to the activity. If the potential for exposure exists, the degree of the potential impacts on public health and safety, including increased risk of injury or loss of life, is determined. If the potential for exposure were zero, then public health and safety would not be affected. Isolated incidents and other conditions that affect single individuals, although important for safety awareness, may not rise to the level of a public health or safety issue, and are not considered in this assessment (i.e., airborne noise effects are not addressed in this section).

3.12.2 AFFECTED ENVIRONMENT

3.12.2.1 Overview

Military, commercial, institutional, and recreational activities take place simultaneously in the Study Area (Figure 3.12-1), and have coexisted safely for decades. These activities coexist because established rules and practices lead to safe use of the waterway and airspace. The following paragraphs briefly discuss the rules and practices for recreational, commercial, and military use in sea surface areas and airspace.

Figure 3.12-1: Simultaneous Activities within the Hawaii-Southern California Training and Testing Study Area

3.12.2.1.1 Sea Space

Most of the sea space in the Study Area is accessible to recreational and commercial activities. However, some activities are prohibited or restricted in certain areas (e.g., danger zones and restricted areas) in accordance with Title 33 Code of Federal Regulations, Part 334 (Danger Zone and Restricted Area Regulations). These restrictions can be permanent or temporary. Nautical charts issued by the National Oceanic and Atmospheric Administration include these federally designated zones and areas. Operators of recreational and commercial vessels have a duty to abide by maritime regulations administered by the U.S. Coast Guard.

In accordance with Title 33 Code of Federal Regulations 72 (Aids to Navigation), the U.S. Coast Guard and the Department of Homeland Security inform private and commercial vessels about temporary closures via Notices to Mariners. These Notices provide information about durations and locations of closures because of activities that are hazardous to surface vessels. Broadcast notices on maritime frequency radio, weekly publications by the appropriate U.S. Coast Guard Navigation Center, and global positioning system navigation charts disseminate these navigational warnings.

3.12.2.1.2 Airspace

Most of the airspace in the Study Area is accessible to general aviation (recreational, private, corporate) and commercial aircraft. Like waterways, however, some areas are temporarily off limits to civilian and commercial use. The Federal Aviation Administration has established Special Use Airspace—airspace of defined dimensions wherein activities must be confined because of their nature or wherein limitations may be imposed upon aircraft operations that are not part of those activities (Federal Aviation Administration 2013). Special Use Airspace in the Study Area includes:

- **Restricted Airspace:** Areas where aircraft are restricted because of unusual (often invisible) hazards to aircraft (e.g., release of ordnance). Some areas are under strict control of the DoD, and some are shared with nonmilitary agencies.
- **Military Operations Areas:** Areas typically below 18,000 feet (ft.) used to separate certain nonhazardous military flight activities from instrument flight rules traffic and to identify visual flight rules traffic where these activities are conducted.
- **Warning Areas:** Areas of defined dimensions, beyond three nm from the coast of the United States, which warn nonparticipating aircraft of potential danger.
- **Air Traffic Controlled Assigned Airspace:** Airspace that is Federal Aviation Administration-defined and is not over an existing operating area. This airspace is used to contain specified activities, such as military flight training, that are segregated from other instrument flight rules air traffic.

Notices to Airmen are created and transmitted by government agencies and airport operators to alert aircraft pilots of any hazards en route to or at a specific location. The Federal Aviation Administration issues Notices to Airmen to disseminate information on upcoming or ongoing military exercises with airspace restrictions. Civilian aircraft are responsible for being aware of restricted airspace and any Notices to Airmen that are in effect. Pilots have a duty to abide by aviation rules as administered by the Federal Aviation Administration.

Weather conditions dictate whether aircraft (general aviation, commercial, or military) can fly under visual flight rules, or whether instrument flight rules are required. Under visual flight rules, the weather is favorable and the pilot is required to remain clear of clouds by specified distances to ensure separation from other aircraft under the concept of see and avoid. Pilots flying under visual flight rules must be able to see outside of the cockpit, control the aircraft's attitude, navigate, and avoid obstacles and other aircraft based on visual cues. Pilots flying under visual flight rules assume responsibility for their separation from all other aircraft, and are generally not assigned routes or altitudes by air traffic control.

During unfavorable weather, pilots must follow instrument flight rules. Factors such as visibility, cloud distance, cloud ceilings, and weather phenomena cause visual conditions to drop below the minimums required to operate by visual flight referencing. Instrument flight rules are the regulations and restrictions a pilot must comply with when flying in weather conditions that restrict visibility. Pilots can

fly under instrument flight rules in visual flight rules weather conditions; however, pilots cannot fly under visual flight rules in instrument flight rules weather conditions.

3.12.2.2 Safety and Inspection Procedures

During training and testing, Navy policy is to ensure the safety and health of personnel and the general public (U.S. Department of the Navy 2011c). The Navy achieves these conditions by considering a location when planning activities, scheduling and notifying potential users of an area, and ensuring that an area is clear of nonparticipants. The Navy also has a proactive and comprehensive program of compliance with applicable standards and implementation of safety management systems.

As previously stated, the greatest potential for a training or testing activity to affect the public is in coastal areas because of the concentration of public activities. When planning a training or testing event, the Navy considers proximity of the activity to public areas in choosing a location. Important factors considered include the ability to control access to an area; schedule (time of day, day of week); frequency, duration, and intensity of activities; range safety procedures; operational control of activities or events; and safety history.

The Navy's Fleet Area Control and Surveillance Facilities actively manage assigned airspace, operating areas, ranges, and training and testing resources to enhance combat readiness of U.S. Pacific Fleet units. The Navy schedules activities through the Fleet Area Control and Surveillance Facilities, which coordinate air and surface use of the operating areas (OPAREAs) with the Federal Aviation Administration and the U.S. Coast Guard, which issue Notices to Airmen and Notices to Mariners, respectively.

During training and testing activities in the Study Area, the Navy ensures that the appropriate safety zone is clear of non-participants before engaging in certain activities, such as firing weapons. Inability to obtain a "clear range" could cause an event to be delayed, cancelled, or relocated. Navy procedures ensure public safety during Navy activities that otherwise could harm nonparticipants. Navy practices employ the use of sensors and other devices (e.g., radar) to ensure public health and safety while conducting training and testing activities. The following subsections outline the current requirements and practices for human safety as they pertain to range safety procedures, range inspection procedures, exercise planning, and scheduling and coordinating procedures for the Navy.

Training activities comply with Fleet Area Control and Surveillance Facility procedures. Fleet Area Control and Surveillance Facilities San Diego and Hawaii have published safety procedures for activities on the offshore and nearshore areas (U.S. Department of the Navy 2011a, b). These guidelines (and others) apply to range users as follows:

- Navy personnel are responsible for ensuring that impact areas and targets are clear before commencing hazardous activities.
- The use of underwater ordnance must be coordinated with submarine operational authorities. The coordination also applies to towed sound navigation and ranging (sonar) arrays and torpedo decoys.
- Aircraft or vessels expending ordnance shall not commence firing without permission of the Range Safety Officer for their specific range area.
- Firing units and targets must remain in their assigned areas, and units must fire in accordance with current safety instructions.

- Aircraft carrying ordnance to or from ranges shall avoid populated areas to the maximum extent possible.
- Strict on-scene procedures include the use of ship sensors, visual surveillance of the range from aircraft and range safety boats, and radar and acoustic data to confirm the firing range and target area are clear of civilian vessels, aircraft, or other nonparticipants.

Testing activities have their own comprehensive safety planning instructions (U.S. Department of the Navy 2008b, 2009). These instructions provide guidance on how to identify the hazards, assess the potential risk, analyze risk control measures, implement risk controls, and review safety procedures. They apply to all testing activities including ground, waterborne, and airborne testing activities involving personnel, aircraft, inert minefields, equipment, and airspace. The guidance applies to system program managers, program engineers, test engineers, test directors, and aircrews that are responsible for incorporating safety planning and review when conducting test programs.

The following safety and inspection procedures are implemented for training activities. Each commanding officer is responsible for implementing safety and inspection procedures for activities inside and outside established ranges. In the absence of specific guidance on matters of safety, the Navy follows the most prudent course of action. The following section contains information on the Navy's program of compliance with applicable standards and implementation of safety management systems.

3.12.2.2.1 Aviation Safety

Navy procedures on planning and managing Special Use Airspace are provided in Chief of Naval Operations Instruction 3770.2K, *Airspace Procedures and Planning Manual* (U.S. Department of the Navy 2007). Scheduling and planning procedures for air operations on range complexes are issued through the Navy's Fleet Area Control and Surveillance Facilities San Diego and Hawaii (U.S. Department of the Navy 2011b). Testing ranges have their own procedures for aviation safety, like the Naval Surface Warfare Center Instruction (U.S. Department of the Navy 2008b) and Naval Undersea Warfare Center Division Instruction (U.S. Department of the Navy 2009).

Aircrews involved in a training or testing exercise must be aware that nonparticipating aircraft and ships are not precluded from entering the area and may not comply with Notices to Airmen or Notices to Mariners. Aircrews are required to maintain a continuous lookout for nonparticipating aircraft while operating in warning areas under visual flight rules. In general, aircraft carrying ordnance are not allowed to fly over surface vessels.

3.12.2.2.2 Submarine Navigation Safety

Submarine crews use various methods to avoid collisions while they are surfaced, including visual and radar scanning, acoustic depth finders, and state-of-the-art satellite navigational systems. When transiting submerged, submarines use all available ocean navigation tools, including inertial navigation charts that calculate position based on the submerged movements of the submarine. Areas with surface vessels can then be avoided to protect both the submarines and surface vessels.

3.12.2.2.3 Surface Vessel Navigational Safety

The Navy practices the fundamentals of safe navigation. While in transit, Navy surface vessel operators are alert at all times, use extreme caution, use state-of-the-art satellite navigational systems, and are trained to take proper action if there is a risk. Surface vessels are also equipped with trained and

qualified Navy Lookouts. Individuals trained as lookouts have the necessary skills to detect objects or activity in the water that could be a risk for the vessel.

For specific testing activities, like unmanned surface vehicle testing, a support boat would be used near the testing to ensure safe navigation. Before firing or launching a weapon or radiating a non-eyesafe laser, Navy surface vessels are required to determine that all safety criteria have been satisfied. When applicable, the surface vessel would use aircraft and other boats to aid in navigation. In accordance with Navy instructions presented in this chapter, safety and inspection procedures ensure public health and safety.

3.12.2.2.4 Sound Navigation and Sounding (Sonar) Safety

Surface vessels and submarines may use active sonar in the pierside locations listed in Chapter 2 (Description of Proposed Action and Alternatives) and during transit to the training or testing exercise location. To ensure safe and effective sonar use, the Navy applies the same safety procedures for pierside sonar use as described in Section 3.12.2.2 (Safety and Inspection Procedures).

Naval Sea Systems Command Instruction 3150.2, Appendix 1A, *Safe Diving Distances from Transmitting Sonar*, is the Navy's governing document for protecting divers during active sonar use (U.S. Department of the Navy 2011d). This instruction provides procedures for calculating safe distances from active sonar. These procedures are derived from experimental and theoretical research conducted at the Naval Submarine Medical Research Laboratory and the Navy Experimental Diving Unit. Safety distances vary based on conditions that include diver attire, type of sonar, and duration of time in the water. Some safety procedures include on-site measurements during testing activities to identify an exclusion area for nonparticipating swimmers and divers.

3.12.2.2.5 Electromagnetic Energy Safety

All frequencies (or wavelengths) of electromagnetic energy are referred to as the electromagnetic spectrum, and include electromagnetic radiation and radio frequency radiation. Communications and electronic devices such as radar, electronic warfare devices, navigational aids, two-way radios, cell phones, and other radio transmitters produce electromagnetic radiation. While such equipment emits electromagnetic energy, some of these systems are the same as, or similar to, civilian navigational aids and radars at local airports and television weather stations. Radio waves and microwaves emitted by transmitting antennas are a form of electromagnetic energy collectively referred to as radio frequency radiation. Radio frequency energy includes frequencies ranging from 0 to 3,000 gigahertz. Exposure to radio frequency energy of sufficient intensity at frequencies between 3 kilohertz and 300 gigahertz can adversely affect people, ordnance, and fuel.

To avoid excessive exposures to electromagnetic energy, military aircraft are operated in accordance with standard operating procedures that establish minimum separation distances between electromagnetic energy emitters and people, ordnance, and fuels (U.S. Department of Defense 2009). Thresholds for determining hazardous levels of electromagnetic energy to humans, ordnance, and fuel have been determined for electromagnetic energy sources based on frequency and power output, and current practices are in place to protect the public from electromagnetic radiation hazards (U.S. Department of Defense 2002, 2009). These procedures include setting the heights and angles of electromagnetic energy transmissions to avoid direct exposure, posting warning signs, establishing safe operating levels, activating warning lights when radar systems are operational, and not operating some platforms that emit electromagnetic energy within 15 nm of shore. Safety planning instructions provide clearance procedures for nonparticipants in operational areas prior to conducting training

(U.S. Department of the Navy 2011a, b) and testing (U.S. Department of the Navy 2008b, 2009) activities that involve underwater electromagnetic energy (e.g., mine warfare).

Mine warfare devices are analyzed under other resource topics in this Environmental Impact Statement (EIS)/Overseas EIS (OEIS) because they emit electromagnetic energy. The electromagnetic effects of mine warfare devices are very local, however, unlike radars and radios. Measures to avoid public interaction with mine warfare devices are effective in protecting the public from these effects.

3.12.2.2.6 Laser Safety

Lasers produce light energy. The Navy uses tactical lasers for precision range finding, as target designation and illumination devices for engagement with laser-guided weapons, and for mine detection and mine countermeasures. Laser safety procedures for aircraft require an initial pass over the target prior to laser activation to ensure that target areas are clear. The Navy observes strict precautions, and has written instructions in place for laser users to ensure that nonparticipants are not exposed to intense light energy. During actual laser use, aircraft run-in headings are restricted to avoid unintentional contact with personnel or nonparticipants. Personnel participating in laser training activities are required to complete a laser safety course (U.S. Department of the Navy 2008a).

3.12.2.2.7 High-Explosive Ordnance Detonation Safety

Pressure waves from underwater detonations can pose a physical hazard in surrounding waters. Before conducting an underwater training or testing activity, Navy personnel establish an appropriately sized exclusion zone to avoid exposure of nonparticipants to the harmful intensities of pressure. Naval Sea Systems Command Instruction 3150.2, Chapter 2, *Safe Diving Distances from Transmitting Sonar*, provides procedures for determining safe distances from underwater explosions (U.S. Department of the Navy 2011d). In accordance with training and testing procedures for safety planning related to detonations (see Section 3.12.2.2.8, Weapons Firing and Ordnance Expenditure Safety), the Navy uses the following general and underwater detonation procedures:

- Navy personnel are responsible for ensuring that impact areas and targets are clear before commencing hazardous activities.
- The use of underwater ordnance must be coordinated with submarine operational authorities.
- Aircraft or vessels expending ordnance shall not commence firing without permission of the Range Safety Officer or Test Safety Officer for their specific range area.
- Firing units and targets must remain in their assigned areas, and units must fire in accordance with current safety instructions.
- Detonation activities will be conducted during daylight hours.

3.12.2.2.8 Weapons Firing and Ordnance Expenditure Safety

In accordance with safety and inspection procedures (U.S. Department of the Navy 2011b), any unit firing or expending ordnance shall ensure that all possible safety precautions are taken to prevent accidental injury or property damage. The Officer Conducting the Exercise shall permit firing or jettisoning of aerial targets only when the area is confirmed to be clear of nonparticipating units, both civilian and military.

Safety is a primary consideration for all training and testing activities. The range must be able to safely contain the hazard area of the weapons and equipment employed. The hazard area is based on the size and net explosive weight of the weapon. The type of activity determines the size of the buffer zone. For

activities with a large hazard area, special sea and air surveillance measures are implemented to ensure that the area is clear before activities commence. Before aircraft can drop ordnance, they are required to make a preliminary pass over the intended target area to ensure that it is clear of boats, divers, or other nonparticipants. Aircraft carrying ordnance are not allowed to fly over surface vessels.

Training and testing activities are delayed, moved, or cancelled if there is a question about the safety of the public. Target areas must be clear of nonparticipants before conducting training and testing. When using ordnance with flight termination systems (which terminate the flight of airborne missiles or launch vehicles when they veer from their targeted path), the Navy is required to follow standard operating procedures to ensure public health and safety. In those cases where a weapons system does not have a flight termination system, the size of the target area that needs to be clear of nonparticipants is based on the flight distance of the weapon plus an additional distance beyond the system's performance capability.

3.12.3 Environmental Consequences

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) could impact public health and safety. In this section, each public health and safety stressor is introduced, analyzed by alternative, and analyzed for training activities and testing activities. Tables 2.8-1 through 2.8-5 present the baseline and proposed training and testing activity locations for each alternative (including the number of events and ordnance expended). Tables F-1 and F-2 in Appendix F describe all of the warfare areas and associated stressors that were considered for analysis of public health and safety. The stressors vary in intensity, frequency, duration, and location within the Study Area. The stressors applicable to public health and safety are:

- underwater energy
- in-air energy
- physical interactions
- secondary

Alternatives 1 and 2 include an expansion of the Study Area and pierside training areas, as described in Chapter 2 (Description of the Proposed Action and Alternatives). Alternatives 1 and 2 would adjust locations and tempo of training and testing activities, but existing safety procedures and standard operating procedures would be employed such that no new or additional impacts to public health and safety would occur. Therefore, the Study Area expansion will not be addressed in the analysis below.

Potential public health and safety impacts were evaluated assuming continued implementation of the Navy's current safety procedures for each training and testing activity or group of similar activities. Generally, the greatest potential for the proposed activities to be co-located with public activities would be in coastal areas because most commercial and recreational activities occur close to the shore.

Training and testing activities in the Study Area are conducted in accordance with guidance provided in Fleet Area Control and Surveillance Facility Instructions (U.S. Department of the Navy 2011a, b) and Test and Safety Planning Instructions (U.S. Department of the Navy 2008b, 2009). These instructions provide operational and safety procedures for all normal range events. They also provide information to range users that is necessary to operate safely and avoid affecting nonmilitary activities such as shipping, recreational boating, diving, and commercial or recreational fishing. Ranges are managed in accordance with standard operating procedures that ensure public health and safety. Current requirements and

practices (e.g., standard operating procedures) designed to prevent public health and safety impacts are identified in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring).

3.12.3.1 Underwater Energy

Underwater energy can come from acoustic sources or from electromagnetic devices. Active sonar, underwater explosions, airguns, and vessel movements all produce underwater acoustic energy. Sound will travel from air to water during aircraft overflights. Electromagnetic energy can enter the water from mine warfare training devices and from unmanned underwater systems. The potential for the public to be exposed to these stressors would be limited to individuals, such as recreational swimmers or self-contained underwater breathing apparatus (SCUBA) divers, that are underwater and within unsafe proximity of a training or testing event.

Many of the proposed activities generate underwater acoustic energy; however, not all sources rise to the level of consideration in this EIS/OEIS. Swimmers or divers might intermittently hear ship noise or underwater acoustic energy from aircraft overflights if they are near a training or testing event, but public health and safety would not be affected because these events would be infrequent and short in duration. Pierside integrated swimmer defenses are tested with underwater airguns during swimmer defense and diver deterrent training and testing activities; public health and safety would be ensured for these local activities because access to pierside locations by nonparticipants is controlled for safety and security reasons. Because of the infrequency and short duration of the events, underwater acoustic energy from vessel movements, aircraft overflights, and airguns is not analyzed in further detail. Active sonar and underwater explosions are the only sources of underwater acoustic energy evaluated for potential impacts on public health and safety.

The proposed activities that would result in underwater acoustic energy include anti-surface warfare, anti-submarine warfare, mine warfare, surface warfare testing, littoral combat ship testing, sonar maintenance, pierside sonar testing, and unmanned vehicle testing. A limited amount of active sonar would be used during transit between range complexes and training and testing locations.

The effect of active sonar on humans varies with the sonar frequency. Of the four types of sonar (very high-, high-, mid-, and low-frequency), mid-frequency and low-frequency sonar have the greatest potential to impact humans because of the range of human hearing. Underwater explosives cause a physical shock front that compresses the explosive material, and the pressure wave then passes into the surrounding water. Generally, the pressure wave would be the primary cause of injury. The effects of an underwater explosion depend on several factors, including the size, type, and depth of the explosive charge and where it is in the water column.

Systems like the Organic Airborne and Surface Influence Sweep emit an electromagnetic field and sound to simulate the presence of a ship. Unmanned underwater vehicles, some unmanned surface vehicles, and towed devices use electromagnetic energy. Electronic warfare activities involve aircraft, surface ship, and submarine crews attempting to control portions of the electromagnetic spectrum to degrade or deny the enemy's ability to take defensive actions. An electromagnetic signal dissipates quickly with increasing distance from its source. The literature lacks evidence to conclude that any adverse health effects result from exposure to electromagnetic energy, which is why no federal standards have been set for occupational exposures to this type of energy. Because standard operating procedures require an exercise area to be clear of participants, the public would not be exposed to electromagnetic energy the way a worker could experience long-term, occupational exposures. In the unlikely event that the public

was exposed, the level of electromagnetic energy associated with the Proposed Action would not be enough to pose a health or safety risk.

As previously stated, the potential for the public to be exposed to these stressors would be limited to divers within unsafe proximity of an event. SCUBA diving is a popular recreational activity that is typically concentrated around known dive attractions such as reefs and shipwrecks. In general, recreational divers should not exceed 130 ft. (39.6 m) (Professional Association of Diving Instructors 2012). This depth limit typically limits this activity's distance from shore. Therefore, training and testing activities closest to shore have the greatest potential to co-occur with the public.

Swimmers and recreational SCUBA divers are not expected to be near Navy pierside locations (which include shipyards) because access to these areas is controlled for safety and security reasons. Locations of popular offshore diving spots are well documented, and dive boats (typically well marked) and diver-down flags would be visible from the ships conducting the training and testing. Therefore, co-occurrence of recreational divers and Navy activities is unlikely. Swimmers and recreational divers are not expected to be near training and testing locations where active sonar, underwater explosions, and electromagnetic activities would occur because of the strict procedures for clearance of nonparticipants before conducting activities.

The U.S. Navy Dive Manual (U.S. Department of the Navy 2011d) prescribes safe distances for divers from active sonar sources and underwater explosions. Safety precautions for use of electromagnetic energy are specified in DoD Instruction 6055.11 (U.S. Department of Defense 2002, 2009) and Military Standard 464A (U.S. Department of Defense 2002). These distances would be used as the standard safety buffers for underwater energy to protect public health and safety. If unauthorized personnel were detected within the exercise area, the activity would be temporarily halted until the area was again cleared and secured. Therefore, the public is unlikely to be exposed to underwater energy at Navy pierside locations, in training or testing areas, or in ports.

3.12.3.1.1 No Action Alternative

3.12.3.1.1.1 Training

Under the No Action Alternative, active sonar training activities such as anti-submarine warfare, mine warfare, and sonar maintenance would continue at current levels and within established ranges and training locations, including the Hawaii Range Complex and the SOCAL Range Complex, and other HSTT areas. Most of the sonar training events would be in the SOCAL and HRC range complexes.

Activities involving underwater explosions, such as anti-surface warfare and mine warfare, also would continue at current levels and within established ranges and training locations. Current locations for underwater explosions include specific training areas in the HRC, in the SOCAL Range Complex, and in Silver Strand Training Complex (SSTC).

The analysis indicates that no impact on public health and safety would result from training activities using underwater energy, based on the Navy's implementation of strict operating procedures that protect public health and safety. These operating procedures include ensuring clearance of the area before commencing training activities involving underwater energy. Because of the Navy's safety procedures, the potential for training activities using underwater energy to impact public health and safety under the No Action Alternative would be low.

3.12.3.1.1.2 Testing

Under the No Action Alternative, active sonar testing activities such as anti-submarine warfare, mine warfare, pierside sonar testing, unmanned vehicle testing, and sonar maintenance would continue at current levels and in current locations, including areas such as the Hawaii and SOCAL OPAREAs. Pierside testing of active sonar would continue in Pearl Harbor and in San Diego Bay. Most of these activities would occur in the SOCAL Range Complex.

Testing activities involving underwater explosions, such as anti-air warfare, anti-surface warfare, anti-submarine warfare, mine warfare, and surface combatant sea trials also would continue at current levels and within established ranges and locations. Current locations for underwater explosions include specific training areas in HRC (Puuloa Underwater Range, Marine Corps Base Hawaii, Marine Corps Training Area Bellows, Barbers Point Underwater Range, Ewa Training Minefield, and Lima Landing) and in the SOCAL Range Complex (San Clemente Island's Northwest Harbor and Horse Beach Cove, Shallow Water Training Range), and SSTC's Boat Lanes 1–14.

The analysis indicates that no impact on public health and safety would result from testing activities using underwater energy, based on the Navy's implementation of strict operating procedures that protect public health and safety. These operating procedures include ensuring clearance of the area before commencing testing activities involving underwater energy. Because of the Navy's safety procedures, the potential for testing activities to impact public health and safety under the No Action Alternative would be low.

3.12.3.1.2 Alternative 1

Alternative 1 consists of the activities in the No Action Alternative plus the expansion of the Study Area and adjustments in the locations and tempos of training and testing activities. Alternative 1 includes changes in force structure (personnel, weapons and assets), new or upgraded weapons and platforms, and the training and testing required for proficiency with these systems. Alternative 1 includes the expansion of the Study Area to include the Transit Corridor and pierside activities in San Diego Bay and Pearl Harbor. This expansion would not increase the potential for public exposure over the No Action Alternative because the same safety procedures would be in place to assure that these areas were clear of nonparticipants.

3.12.3.1.2.1 Training

Active sonar training would continue at current locations under Alternative 1. In many instances, however, the potential activity areas would be expanded (see tables in Chapter 2). Locations for active sonar training include the same areas as described under the No Action Alternative, as well as the Transit Corridor and pierside areas in San Diego Bay and Pearl Harbor. While Alternative 1 would expand the locations and increase the tempos of active sonar training activities, the Navy would continue to implement standard operating and safety procedures; therefore, the potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely to increase.

Activities involving underwater explosions, such as anti-surface warfare, mine warfare, and civilian port defense, would also continue within established ranges and training locations, as described under the No Action Alternative. While Alternative 1 would adjust locations and tempos of underwater explosives training activities, the Navy would continue to implement standard operating and safety procedures; therefore, an increased potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely. The Navy's safety procedures would ensure that the potential for training activities to impact public health and safety under Alternative 1 would be low.

3.12.3.1.2.2 Testing

The locations and tempo of active sonar testing activities would increase over the No Action Alternative. Alternative 1 also includes the expansion of the Study Area, plus changes in force structure (personnel, weapons, and assets), new or upgraded weapons and platforms, and the testing required for these systems.

Under Alternative 1, active sonar testing activities such as anti-submarine warfare, mine warfare, pierside sonar testing, unmanned vehicle testing, and sonar maintenance would increase. These activities would occur in established locations and ranges, as described under the No Action Alternative. Pierside testing of active sonar would continue to occur in San Diego Bay and Pearl Harbor. While Alternative 1 would increase the locations and tempo of active sonar testing activities, the Navy would continue to implement standard operating and safety procedures, so the potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely to increase.

Testing activities involving underwater explosions, such as anti-air warfare, anti-surface warfare, anti-submarine warfare, mine warfare, surface combatant sea trials, littoral combat ship testing, combat ship qualifications, and at-sea explosive testing would occur within established ranges and locations. Proposed locations for underwater explosions are the same as described under the No Action Alternative. While Alternative 1 would increase the tempo of underwater explosives testing activities, the Navy would continue to implement standard operating and safety procedures; therefore, the potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely to increase. Because of the Navy's safety procedures, the potential for testing activities to impact public health and safety under Alternative 1 would be negligible.

3.12.3.1.3 Alternative 2 (Preferred Alternative)

Alternative 2 consists of the activities in the No Action Alternative, plus adjustments to locations and tempo of training and testing activities. Alternative 2 includes changes in force structure (personnel, weapons, and assets), new or upgraded weapons and platforms, and the training and testing required for proficiency with these systems. Alternative 2 includes the expansion of the Study Area and pierside areas of San Diego Bay and Pearl Harbor. This expansion would not increase the potential for public exposure over the No Action Alternative because the same safety procedures would be in place to make sure these areas are clear of nonparticipants.

3.12.3.1.3.1 Training

Alternative 2 is similar to Alternative 1 in the increase in active sonar, underwater explosions, and electromagnetic activities over the No Action Alternative. Alternative 2 is identical to Alternative 1 in the proposed locations for these activities. As concluded under Alternative 1, because of the Navy's safety procedures, the potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely to increase.

3.12.3.1.3.2 Testing

Similar to Alternative 1, Alternative 2 would increase active sonar testing activities such as anti-submarine warfare, mine warfare, pierside sonar testing, unmanned vehicle testing, and sonar maintenance. These activities would continue in established locations and ranges, as described under the No Action Alternative. Pierside testing of active sonar would continue in Pearl Harbor and in San Diego Bay. Changes in the locations and tempo of active sonar testing activities would not impact public health or safety because the safety procedures used under the No Action Alternative would still be in place.

Testing activities involving underwater explosions, such as anti-air warfare, anti-surface warfare, anti-submarine warfare, mine warfare, surface combatant sea trials, littoral combat ship testing, combat ship qualifications, and at-sea explosive testing would occur within established ranges and locations, as described under the No Action Alternative. Changes in the locations and tempo of underwater explosion testing activities could not impact public health or safety because the safety procedures used under the No Action Alternative would still be in place. Because of the Navy's safety procedures, the potential for underwater testing activities to impact public health and safety under Alternative 2 would be negligible.

3.12.3.2 In-Air Energy

In-air energy stressors include sources of electromagnetic energy and lasers. The sources of electromagnetic energy include radar, navigational aids, and electronic warfare systems. These systems operate similarly to other navigational aids and radars at local airports and television weather stations throughout the United States. Electronic warfare systems emit electromagnetic energy similar to that from cell phones, hand-held radios, commercial radio stations, and television stations. Current practices protect Navy personnel and the public from electromagnetic energy hazards. These procedures include setting the heights and angles of electromagnetic energy transmissions to avoid direct human exposure, posting warning signs, establishing safe operating levels, and activating warning lights when radar systems are operational. Procedures also are in place to limit public and participant exposure from electromagnetic energy emitted by military aircraft. As stated in Section 3.12.3.1 (Underwater Energy), the level of electromagnetic energy associated with the Proposed Action would not be enough to pose a health or safety risk to the public.

A comprehensive safety program exists for the use of lasers. Current Navy practices protect individuals from the hazard of severe eye injury caused by laser energy. Laser safety requires pilots to verify that target areas are clear prior to commencement of an exercise. In addition, during actual laser use, the aircraft run-in headings are restricted to preclude inadvertent lasing of areas where the public may be present.

Training and testing activities involving electromagnetic energy include electronic warfare activities that use airborne and surface electronic jamming devices to defeat tracking and communications systems. Training activities involving low-energy lasers include anti-surface warfare, mine warfare, and Homeland Security/Anti-Terrorism Force Protection with Unmanned Vehicles. Testing activities involving low-energy lasers include surface warfare, air exercises at the test range, and mine warfare testing.

3.12.3.2.1 No Action Alternative

3.12.3.2.1.1 Training

Under the No Action Alternative, electronic warfare training activities involving electromagnetic energy sources would continue at current levels and locations, including the Hawaii OPAREA and the SOCAL Range Complex's Electronic Warfare Range. Laser targeting activities and mine detection activities using lasers also would continue at current levels and within established ranges and training locations, including the HRC's Warning Area 188 and the SOCAL Range Complex's Southern California Anti-Submarine Warfare Range and San Clemente Island Shore Bombardment Range.

The public would not likely be exposed to electromagnetic energy sources or lasers under the No Action Alternative. Based on the Navy's strict safety procedures for use of lasers and electronic warfare, these activities would not likely be conducted close enough to the public to pose an increased risk. Because of the Navy's safety procedures, the potential for these training activities to impact public health and safety under the No Action Alternative would be negligible.

3.12.3.2.1.2 Testing

Under the No Action Alternative, electronic warfare testing activities involving electromagnetic energy sources would continue at current levels and within established ranges and testing locations. Laser targeting activities and mine detection activities using lasers would continue at current levels and within established ranges and locations.

The public would not likely be exposed to electromagnetic energy sources or lasers from testing activities under the No Action Alternative. Based on the Navy's strict safety procedures for use of lasers and electronic warfare, these activities would not likely be conducted close enough to the public to pose an increased risk. Because of the Navy's safety procedures, the potential for these testing activities to impact public health and safety under the No Action Alternative would be negligible.

3.12.3.2.2 Alternative 1

Alternative 1 consists of the activities in the No Action Alternative plus adjustments to locations and tempos of training and testing activities. Alternative 2 includes changes in force structure (personnel, weapons, and assets), new or upgraded weapons and platforms, and the training and testing required for proficiency with these systems. Alternative 1 includes the expansion of the Study Area to include the Transit Corridor, and Navy piers in San Diego Bay and Pearl Harbor. This expansion would not increase the potential for public exposure over the No Action Alternative because the same safety procedures would be in place to ensure that these areas are clear of nonparticipants.

3.12.3.2.2.1 Training

Under Alternative 1, the number of training activities that use electromagnetic energy would increase, and would continue to occur within established ranges and training locations, as described under the No Action Alternative. Laser targeting activities and mine detection activities using lasers would increase but also would occur within established ranges and training locations.

While Alternative 1 would increase locations and tempos of training activities involving electromagnetic energy and lasers, the Navy would continue to implement standard operating and safety procedures. Therefore, the potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely to increase.

3.12.3.2.2.2 Testing

Under Alternative 1, the number of testing activities that use electromagnetic energy would increase, and would continue to occur within established ranges and testing locations. Testing activities that use electromagnetic energy would take place in the same areas as described under the No Action Alternative. Additional locations proposed under this alternative include pierside locations in San Diego and in Pearl Harbor.

While Alternative 1 would increase locations and tempos of testing activities involving electromagnetic energy and lasers, the Navy would continue to implement standard operating and safety procedures. Therefore, an increased potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely.

3.12.3.2.3 Alternative 2 (Preferred Alternative)

Alternative 2 consists of the activities in the No Action Alternative plus adjustments to locations and tempo of training and testing activities. This alternative includes changes in force structure (personnel, weapons, and assets), new or upgraded weapons and platforms, and the training and testing required

for proficiency with these systems. Alternative 2 includes the expansion of the Study Area to include the Transit Corridor and Navy piers in San Diego Bay and Pearl Harbor. This expansion would not increase the potential for public exposure over the No Action Alternative because the same safety procedures would be in place to make sure these areas are clear of nonparticipants.

3.12.3.2.3.1 Training

Alternative 2 is similar to Alternative 1 in the increase in electromagnetic energy and laser training activities over the No Action Alternative. Alternative 2 is identical to Alternative 1 in the proposed locations for these activities. As concluded under Alternative 1, impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely.

While Alternative 2 would adjust locations and tempo of training activities involving electromagnetic energy and lasers, the Navy would continue to implement standard operating and safety procedures; therefore, the potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely to increase.

3.12.3.2.3.2 Testing

Similar to Alternative 1, Alternative 2 would increase electromagnetic energy and laser testing activities. Electromagnetic energy activities would continue to occur in established location and ranges, as described under the No Action Alternative, and at pierside locations in San Diego and Pearl Harbor. Laser targeting activities would occur in the HRC's Warning Area 188 and the SOCAL Range Complex's Southern California Anti-Submarine Warfare Range and San Clemente Island's Shore Bombardment Range. Changes in the locations and tempo of in-air testing activities and the addition of new activities would not impact public health or safety because safety procedures would be in place.

While Alternative 2 would adjust locations and tempos of testing activities involving electromagnetic energy and lasers, the Navy would continue to implement standard operating and safety procedures; therefore, the potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely to increase.

3.12.3.3 Physical Interactions

Public health and safety could be impacted by direct physical interactions with Navy activities. Navy aircraft, vessels, targets, munitions, towed devices, seafloor devices, and other training and testing expended materials could have a direct physical encounter with recreational, commercial, institutional, and governmental aircraft, vessels, and users such as swimmers, divers, and anglers.

Both Navy and public aircraft operate under visual flight rules requiring them to observe and avoid other aircraft. In addition, Notices to Airmen advise pilots about when and where Navy training and testing activities are scheduled. Finally, Navy personnel are required to verify that the range is clear of nonparticipants before initiating any potentially hazardous activity. Together, these procedures would minimize the potential for adverse interactions between Navy and nonparticipant aircraft. The Navy's standard operating procedures assure that private and commercial aircraft traversing the Study Area during training or testing activities do not interact with Navy aircraft, ordnance, or aerial targets.

Both Navy and public vessels operate under maritime navigational rules requiring them to observe and avoid other vessels. In addition, Notices to Mariners advise vessel operators about when and where Navy training and testing activities are scheduled. Finally, Navy personnel are required to verify that the range is clear of nonparticipants before initiating any potentially hazardous activity. Together, these

procedures minimize the potential for adverse interactions between Navy and nonparticipant vessels. The Navy's standard operating procedures assure that private and commercial vessels traversing the Study Area during training or testing activities do not interact with Navy vessels, ordnance, or surface targets.

Recreational diving within the Study Area takes place primarily at known diving sites such as shipwrecks and reefs. The locations of these popular dive sites are well documented, dive boats are typically well-marked, and diver-down flags are visible from a distance. As a result, ships conducting training or testing activities would easily avoid dive sites. Interactions between training and testing activities and recreational divers thus would be minimized, reducing the potential for collisions or ship strikes. Similar knowledge and avoidance of popular fishing areas would minimize interactions between training and testing activities and recreational fishing.

Commercial and recreational fishers could encounter military expended materials that could entangle fishing gear and could pose a safety risk. The Navy would continue to recover targets at or near the surface that were used during training or testing to ensure that they would not pose a collision risk. Unrecoverable pieces of military expended materials are typically small (such as sonobuoys), constructed of soft materials (such as target cardboard boxes or tethered target balloons), or intended to sink to the bottom after their useful function was completed, so they would not be a collision risk to civilian vessels or equipment. Thus, these targets do not pose a safety risk to individuals using the area for recreation because the public would not likely be exposed to these items before they sank to the seafloor.

As discussed in Sediments and Water Quality (Section 3.1), a west coast study categorized types of marine debris collected by a trawler during a groundfish survey. Military expended materials were categorized as plastic, metal, fabric and fiber, and rubber comprising 7.4, 6.2, 13.2, and 4.7 percent of the total count of items collected, respectively. The footprint of military expended materials in the Study Area is discussed in Marine Habitats (Section 3.3), which concluded that if all military expended materials were located side by side in the Study Area, the footprint would be approximately 0.05 square nautical miles. Because the footprint of military expended materials in the Study Area is small, recreational and commercial fishers probably would not encounter military expended materials.

Section 3.1 (Sediments and Water Quality) also discussed the low failure rates of munitions, which indicate that most munitions function as intended. While fish trawls may encounter undetonated ordnance lying on the ocean floor, such an encounter would be unlikely because the density of munitions in the Study Area is low. The Army Corps of Engineers prescribes the following procedure if military munitions are encountered: recognize when you may have encountered a munition, retreat from the area without touching or disturbing the item, and report the item to local law enforcement by calling 911 or the U.S. Coast Guard.

The analysis focuses on the potential for a direct physical interaction with an aircraft, vessel, target, or expended training item. All proposed activities have some potential for a direct physical interaction that could pose a risk to public health or safety, so the following analysis is not activity-specific. While some of the activities may not pose a potential for a direct physical interaction (like pierside testing) the platforms used in the activity (aircraft, vessel, towed device) could have a direct physical interaction that could pose a risk. The greatest potential for a physical interaction would be along the coast because of the high concentration there of public activities.

3.12.3.3.1 No Action Alternative

3.12.3.3.1.1 Training

Under the No Action Alternative, training activities would continue at current levels and within established locations. The potential for a direct physical interaction between the public and aircraft, vessels, targets, or expended materials would not change from the baseline. The Navy implements strict operating procedures that protect public health and safety. These operating procedures include ensuring clearance of the area prior to commencing training activities.

The analysis indicates that public health and safety would not be affected by physical interactions with training activities, based on the Navy's implementation of strict operating procedures that protect public health and safety. These operating procedures include ensuring clearance of the area before commencing training activities involving physical interactions. Because of the Navy's safety procedures, the potential for training activities to impact public health and safety under the No Action Alternative would be negligible.

3.12.3.3.1.2 Testing

Because the potential for a physical interaction is not activity-specific or location-specific, the analysis of the training activities above applies to testing activities under the No Action Alternative. As concluded above, because of the Navy's safety procedures, the potential for testing activities to impact public health and safety under the No Action Alternative would be negligible.

3.12.3.3.2 Alternative 1

Alternative 1 consists of the activities included in the No Action Alternative, plus adjustments in the locations and tempos of training and testing activities. This alternative includes changes in force structure (personnel, weapons, and assets), new or upgraded weapons and platforms, and the training and testing required for proficiency with these systems. Alternative 1 includes the expansion of the Study Area to include the Transit Corridor, and Navy piers in San Diego Bay and Pearl Harbor. This expansion would not increase the potential for public exposure over the No Action Alternative because the same safety procedures would be in place to make sure these areas are clear of nonparticipants.

3.12.3.3.2.1 Training

Under Alternative 1, the number of training activities would increase, but would continue within established locations. However, the increased number of aircraft and vessel movements or use of targets and expended materials would be conducted under the same safety and inspection procedures as under the No Action Alternative. While Alternative 1 would adjust locations and tempos of training activities, the Navy would continue to implement standard operating and safety procedures. Therefore, the potential for impacts on public health and safety, beyond those identified under the No Action Alternative, would be negligible.

3.12.3.3.2.2 Testing

Because the potential for a physical interaction is not activity-specific or location-specific, the analysis of the training activities presented above also applies to testing activities under Alternative 1. As concluded above, because of the Navy's safety procedures, the potential for testing activities to impact public health and safety under Alternative 1 would be negligible.

3.12.3.3.3 Alternative 2 (Preferred Alternative)

Alternative 2 consists of the activities included in the No Action Alternative plus adjustments to locations and tempos of training and testing activities. This alternative includes changes in force structure (personnel, weapons, and assets), new or upgraded weapons and platforms, and the training and testing required for proficiency with these systems. Alternative 2 includes the expansion of the Study Area to include the Transit Corridor and Navy piers in San Diego Bay and Pearl Harbor. This expansion would not increase the potential for public exposure over the No Action Alternative because the same safety procedures would be in place to make sure these areas are clear of nonparticipants.

3.12.3.3.3.1 Training

Under Alternative 2, the number of training activities would increase. The potential for a direct physical interaction between the public and aircraft, vessels, targets, or expended materials would also increase. While Alternative 2 would adjust locations and tempos of training activities, the Navy would continue to implement standard operating and safety procedures. Therefore, the potential for impacts on public health and safety beyond those identified under the No Action Alternative would be negligible.

3.12.3.3.3.2 Testing

The potential for a physical interaction is not activity-specific or location-specific, so the analysis of the training activities presented above also applies to testing activities under Alternative 2. As concluded above, because of the Navy's safety procedures, the potential for testing activities to impact public health and safety under Alternative 1 would be negligible.

3.12.3.4 Secondary Impacts

Public health and safety could be impacted if sediment or water quality were degraded. Section 3.1 (Sediments and Water Quality) considered the impacts on marine sediments and water quality of explosives and explosive byproducts, metals, chemicals other than explosives, and other materials (marine markers, flares, chaff, targets, and miscellaneous components of other materials). The analysis determined that neither state nor federal standards or guidelines would be violated by the No Action Alternative, Alternative 1, or Alternative 2. Because these standards and guidelines are structured to protect human health, and the proposed activities do not violate them, no secondary impacts on public health and safety would result from the training and testing activities proposed by the No Action Alternative, Alternative 1, or Alternative 2.

3.12.4 Summary of Potential Impacts (Combined Impacts of All Stressors) on Public Health and Safety

Activities described in this EIS/OEIS that could affect public health or safety include those that release underwater energy, in-air energy, or physical interactions, or that have secondary impacts from changes in sediment or water quality. Under the No Action Alternative, Alternative 1, or Alternative 2, these activities would be widely dispersed throughout the Study Area. Such activities also are dispersed temporally (i.e., few stressors would be present at the same time). For these reasons, no greater impacts from the combined operation of more than one stressor are expected. The aggregate impact on public health and safety would not observably differ.

REFERENCES

Federal Aviation Administration. (2013). Air Traffic Organization Policy: Special Use Airspace Federal Aviation Administration (Ed.). (FAA Order JO 7400.8V).

Professional Association of Diving Instructors. (2012). Scuba Certification Frequently Asked Questions Professional Association of Diving Instructors. Retrieved from http://www.padi.com/scuba/scuba-diving-guide/start-scuba-diving/scuba-certification-faq/default.aspx as accessed on 2011, March 08.

U.S. Department of Defense. (2002). Electromagnetic environmental effects: Requirements for systems. (MIL-STD-464A).

U.S. Department of Defense. (2009). Protecting personnel from electromagnetic fields. (DOD Instruction 6055.11).

U.S. Department of the Navy. (2007). Airspace procedures and planning manual. (OPNAV INSTRUCTION 3770.2K).

U.S. Department of the Navy. (2008a). Navy laser hazard control program. (OPNAVINST 5100.27B).

U.S. Department of the Navy. (2008b). Test and safety planning. (NSWC PCD Instruction 5100.30D).

U.S. Department of the Navy. (2009). Narragansett Bay shallow water test facility. (NUWCDIVNPTINST 8590.1E).

U.S. Department of the Navy. (2011a). Fleet Area Control and Surveillance Facility. (FACSFACJAX INSTRUCTION 3000.1F).

U.S. Department of the Navy. (2011b). Manual for the utilization of Fleet Area Control and Surveillance Facility, Virginia Capes Operations Areas. (FACSFACVACAPESINST 3120.1L).

U.S. Department of the Navy. (2011c). Navy safety and occupational health program manual. (OPNAVINST 5100.23G CH-1).

U.S. Department of the Navy. (2011d). U.S. Navy dive manual. (Vol. 1–5).

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4 Cumulative Impacts

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4 CUMULATIVE IMPACTS

4.1 INTRODUCTION

The analysis of cumulative impacts (or cumulative effects)[1] presented in this section follows the requirements of the National Environmental Policy Act (NEPA) and Council on Environmental Quality guidance (Council on Environmental Quality 1997). The Council on Environmental Quality regulations (40 Code of Federal Regulations [C.F.R.] §§ 1500-1508) provide the implementing regulations for NEPA. The regulations define cumulative impacts as

> "…the impact on the environment which results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 C.F.R. § 1508.7)."

While a single project may have minor impacts, overall impacts may be collectively significant when the project is considered together with other projects on a regional scale. A cumulative impact is the additive effect of all projects in the geographic area. The Council on Environmental Quality provides guidance on cumulative impact analysis in *Considering Cumulative Impacts under the National Environmental Policy Act* (Council on Environmental Quality 1997). This guidance further identifies cumulative impacts as those environmental impacts resulting "from spatial and temporal crowding of environmental perturbations. The impacts of human activities will accumulate when a second perturbation occurs at a site before the ecosystem can fully rebound from the impacts of the first perturbation." This guidance observes that "no universally accepted framework for cumulative impacts analysis exists…" while noting that certain general principles have gained acceptance. The Council on Environmental Quality provides guidance on the extent to which agencies of the federal government are required to analyze the environmental impacts of past actions when they describe the cumulative environmental effect of an action. This guidance provides that an analysis of cumulative impacts might encompass geographic boundaries beyond the immediate area of an action and a timeframe that includes past actions and foreseeable future actions. Thus, the Council on Environmental Quality guidelines observe, "[it] is not practical to analyze cumulative impacts of an action on the universe; the list of environmental impacts must focus on those that are truly meaningful."

4.2 APPROACH TO ANALYSIS

4.2.1 OVERVIEW

Cumulative impacts were analyzed for each resource addressed in Chapter 3 (Affected Environment and Environmental Consequences) for the No Action Alternative, Alternative 1, and Alternative 2 (the alternatives) in combination with past, present, and reasonably foreseeable future actions. The cumulative impacts analysis included the following steps, described in more detail below:

1. Identify appropriate level of analysis for each resource.
2. Define the geographic boundaries and timeframe for the cumulative impacts analysis.
3. Describe current resource conditions and trends.

[1] Council on Environmental Quality Regulations provide that the terms "cumulative effects" and "cumulative impacts" are synonymous (40 C.F.R. § 1508.8[b]); the terms are used interchangeably by various sources, but the term "cumulative impacts" will be used in this document except for quotations, for continuity.

4. Identify potential impacts of each alternative that might contribute to cumulative impacts.
5. Identify past, present, and other reasonably foreseeable future actions that affect each resource.
6. Analyze potential cumulative impacts.

4.2.2 Identify Appropriate Level of Analysis for Each Resource

In accordance with Council on Environmental Quality guidance (Council on Environmental Quality 1997), the cumulative impacts analysis focused on impacts that are "truly meaningful." The level of analysis for each resource was commensurate with the intensity of the impacts identified in Chapter 3 (Affected Environment and Environmental Consequences). The rationale for the level of analysis applied to each resource is described in Section 4.4 (Resource-Specific Cumulative Impacts).

4.2.3 Define the Geographic Boundaries and Timeframe for Analysis

The geographic boundaries for the cumulative impacts analysis included the entire Hawaii-Southern California (SOCAL) Training and Testing (HSTT) Study Area (Study Area) (Figure 2.1-1). The geographic boundaries for cumulative impacts analysis for marine mammals and sea turtles were expanded to include activities outside the Study Area that might impact migratory marine mammals and sea turtles. Primary considerations from outside the Study Area include impacts associated with maritime traffic (e.g., vessel strikes and underwater noise) and commercial fishing (e.g., bycatch and entanglement).

Determining the timeframe for the cumulative impacts analysis requires estimating the length of time the impacts of the Proposed Action would last (Council on Environmental Quality 1997) and considering the specific resource in terms of its history of degradation. The Proposed Action includes ongoing and anticipated future training and testing activities. While Navy training and testing requirements change over time in response to world events and several other factors, the general types of activities addressed by this Environmental Impact Statement (EIS)/Overseas EIS (OEIS) are expected to continue indefinitely, and the associated impacts would occur indefinitely. Likewise, some reasonably foreseeable future actions and other environmental considerations addressed in the cumulative impacts analysis are expected to continue indefinitely (e.g., oil and gas production, maritime traffic, commercial fishing). Therefore, the cumulative impacts analysis is not bounded by a specific future timeframe. For past actions, the cumulative impacts analysis only considers those actions or activities that have ongoing impacts.

While the cumulative impacts analysis is not limited by a specific timeframe, it should be recognized that available information, uncertainties, and other practical constraints limit the ability to analyze cumulative impacts for the indefinite future. Navy environmental planning and compliance for training and testing activities is an ongoing process. The Navy intends to submit applications to the National Marine Fisheries Service (NMFS) for Marine Mammal Protection Act (MMPA) authorizations supported by this EIS/OEIS. The anticipated effective dates for these MMPA authorizations would be a 5-year period from January 2014 through December 2018. Future environmental planning documents will include cumulative impacts analysis based on information available at that time.

4.2.4 Describe Current Resource Conditions and Trends

The Affected Environment sections of Chapter 3 (Affected Environment and Environmental Consequences) describe current resource conditions and trends, and they discuss how past and present human activities influence each resource. The current aggregate impacts of past and present actions are reflected in the baseline information presented in Chapter 3 (Affected Environment and Environmental

Consequences). This information is used in the cumulative impacts analysis to understand how past and present actions are currently impacting each resource and to provide the context for the cumulative impacts analysis.

4.2.5 Identify Potential Impacts of The Alternatives That Might Contribute to Cumulative Impacts

Direct and indirect impacts of the alternatives, presented in Chapter 3 (Affected Environment and Environmental Consequences), were reviewed to identify impacts relevant to the cumulative impacts analysis. Key factors considered included the current status and sensitivity of the resource and the intensity, duration, and spatial extent of the impacts for each stressor. In general, long-term rather than short-term impacts and widespread rather than localized impacts were considered more likely to contribute to cumulative impacts. For example, for biological resources, population-level impacts were considered more likely to contribute to cumulative impacts than were individual-level impacts. Negligible impacts were not considered further in the cumulative impacts analysis. For marine mammals, any stressor that is expected to result in Level A harassment or Level B harassment, as defined by MMPA, was considered in the cumulative impacts analysis. For Endangered Species Act (ESA)-listed species, any stressor that may affect and is likely to adversely affect the species was considered in the cumulative impacts analysis. Stressors that were determined by the Navy to have no effect or that may affect but are not likely to adversely affect ESA-listed species were not analyzed in detail in the cumulative impacts analysis. A determination of “may affect, not likely to adversely affect” indicates that the impacts would be discountable (extremely unlikely) or insignificant.

4.2.6 Identify Other Actions and Other Environmental Considerations That Affect Each Resource

A list of other actions was compiled for the Study Area and surrounding areas based on information obtained during the scoping process (Appendix E [Public Participation]), communications with other agencies, a review of other military activities, literature review, previous NEPA analyses for some of the other actions, and other available information. Identified future actions were reviewed to determine if they should be considered further in the cumulative impacts analysis. Factors considered when identifying other actions to be included in the cumulative impacts analysis included the following:

- Whether the other action is likely or probable (i.e., reasonably foreseeable), rather than merely possible or speculative.
- The timing and location of the other action in relationship to proposed training and testing activities.
- Whether the other action and each alternative would affect the same resources.
- The current conditions, trends, and vulnerability of resources affected by the other action.
- The duration and intensity of the impacts of the other action.
- Whether the impacts have been truly meaningful, historically significant, or identified previously as a cumulative impact concern.

In addition to identifying reasonably foreseeable future actions, other environmental considerations for the cumulative impacts analysis were identified and described. These other considerations include major environmental stressors or issues (e.g., ocean pollution, ocean noise, coastal development, etc.) that tend to be widespread and arise from routine human activities and multiple past, present, and future actions. Including these other environmental considerations allows an analysis of the current aggregate impacts of past and present actions, as well as reasonably foreseeable actions.

4.2.7 Analyze Potential Cumulative Impacts

The current impacts of past and present actions and the anticipated impacts of reasonably foreseeable future actions were characterized and summarized. The incremental impacts of each alternative were then added to the combined impacts of all other actions to describe the cumulative impacts that would result if the No Action Alternative, Alternative 1, or Alternative 2 were implemented. The cumulative impacts analysis considered additive, synergistic, and antagonistic impacts. A qualitative analysis was conducted in most cases based on the available information. The analysis in Chapter 3 (Affected Environment and Environmental Consequences) indicates that the direct and indirect impacts of the No Action Alternative, Alternative 1, and Alternative 2 would be similar for many of the stressors. Therefore, much of the cumulative impacts discussion applies to all three alternatives. Specific differences between the alternatives are discussed when appropriate.

4.3 Other Actions Analyzed in the Cumulative Impacts Analysis

4.3.1 Overview

Table 4.3-1 lists the other actions and other environmental considerations identified for the cumulative impacts analysis. Descriptions of each action and environmental consideration carried forward for analysis are provided in the following sections.

4.3.2 Oil and Natural Gas Exploration, Extraction, and Production

4.3.2.1 Proposed Outer Continental Shelf Oil and Gas Leasing Program 2012–2017

Military activities and oil and gas operations have been conducted concurrently offshore in southern and south-central California for more than 50 years. During that period there have been no major incidents or accidents involving military and outer continental shelf oil and gas operations. Oil and gas resources of the Outer Continental Shelf are governed by the Outer Continental Shelf Lands Act which requires a 5-year leasing program. Areas off the Pacific coast are not included in the 2012–2017 Outer Continental Shelf Oil and Gas Leasing Program finalized by the U.S. Department of the Interior Bureau of Ocean Energy Management.

4.3.2.2 Liquefied Natural Gas Terminals

Liquefied natural gas facilities have been proposed at several locations throughout North America in recent years in response to the quickly escalating domestic demand for this fuel. Currently the only existing terminal near the Study Area is in Baja California, Mexico and only one additional terminal is proposed for the area immediately north of the Study Area (Federal Energy Regulatory Commission 2011).

Potential environmental impacts include those associated with additional ship traffic, underwater noise from construction and operation, and potential releases of liquefied natural gas. Releases of liquefied natural gas can result from equipment leaks or spills during operations. Releases can be accidental (e.g., ship collision) or intentional (e.g., sabotage or terrorist acts).

Table 4.3-1: Other Actions and Other Environmental Considerations Identified for the Cumulative Impacts Analysis

#	Name of Action	Lead Agency or Proponent	Location in the Study Area/LME	Timeframe	Retained for Further Analysis?
Oil and Natural Gas Exploration, Extraction, and Production					
1	Outer Continental Shelf Oil and Gas Leasing Program 2012–2017	Bureau of Ocean Energy Management	All LMEs	Past, present, and foreseeable future	Dismissed, as this leasing program does not include any Pacific Region areas and it therefore poses no potential impact within the Study Area.
2	Liquefied Natural Gas Terminals	Bureau of Ocean Energy Management, Regulation and Enforcement	California Current LME	Past, present, and foreseeable future	Retained.
Offshore Power Generation					
3	Marine Hydrokinetic Projects	Federal Energy Regulatory Commission	All LMEs	Foreseeable future	Retained.
Dredge Disposal, Beach Nourishment, and Mining					
4	Offshore Dredge Disposal Program	U.S. Army Corps of Engineers	All LMEs	Past, present, and future	Dismissed because action involves programs related to dredging and beach nourishment projects. These activities (if applicable) would be analyzed on an individual basis for cumulative impacts.
5	Beach Nourishment Programs	U.S. Army Corps of Engineers	All LMEs	Past, present, and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action.
Other Military Activities					
6	Scripps Pier Replacement at Point Loma	U.S. Department of the Navy	California Current LME	Present and future	Retained.
7	Naval Base Point Loma Fuel Pier	U.S. Department of the Navy	California Current LME	Past, present, and future	Retained.
9	Submarine Drive-In Magnetic Silencing Facility Beckoning Point, Oahu, Hawaii	U.S. Department of the Navy	Insular Pacific-Hawaiian LME	Past, present, and future	Retained.

Table 4.3-1: Other Actions and Other Environmental Considerations Identified for the Cumulative Impacts Analysis (continued)

#	Name of Action	Lead Agency or Proponent	Location in the Study Area/LME	Timeframe	Retained for Further Analysis?
Other Military Activities (continued)					
10	Establishment and Realignment of Navy Helicopter Squadrons on the West Coast	U.S. Department of the Navy	California Current LME	Future	Retained.
11	San Clemente Island Fuel Storage and Distribution System	U.S. Department of the Navy	California Current LME	Past, present, and future	Retained.
12	Wave Energy Test Site	U.S. Department of the Navy University of Hawaii U.S. Department of Energy	Insular Pacific-Hawaiian LME	Future	Retained.
13	Pier 12 Replacement and Dredging Naval Base San Diego	U.S. Department of the Navy	California Current LME	Future	Retained.
14	Homeporting Littoral Combat Ships on the West Coast	U.S. Department of the Navy	California Current LME	Future	Retained for activities associated with homeporting. While NEPA has not been completed and a decision has not been made, the Navy's envisaged homeporting location for the west coast Littoral Combat Ships is Naval Base San Diego. Impacts from Littoral Combat Ship training are considered under Alternatives 1 and 2 and are not considered in cumulative impacts.
15	Surveillance Towed Array Sensor System Low Frequency Active Sonar	U.S. Department of the Navy	All LMEs	Future	Retained
16	Space and Naval Warfare Systems Command Electronic Harbor Security System	U.S. Department of the Navy	California Current LME	Current	Retained.

Table 4.3-1: Other Actions and Other Environmental Considerations Identified for the Cumulative Impacts Analysis (continued)

#	Name of Action	Lead Agency or Proponent	Location in the Study Area/LME	Timeframe	Retained for Further Analysis?
Other Military Activities (continued)					
17	Construction of SEAL Delivery Vehicle Team One Waterfront Operations Facility	U.S. Department of the Navy	Insular Pacific-Hawaiian LME	Current	Retained.
18	Basing of MV-22 and H-1 Aircraft in Support of III Marine Expeditionary Force Elements in Hawaii	U.S. Department of the Navy	Insular Pacific-Hawaiian LME	Future	Retained.
19	Marine Corps Base Hawaii Pyramid Beach Cottage Construction	U.S. Department of the Navy	Insular Pacific-Hawaiian LME	Future	Retained.
20	U.S. Marine Corps Joint Strike Fighter	U.S. Marine Corps	All LMEs	Future	Dismissed. Homebasing activities such as new construction and personnel relocation are not expected to impact marine resources. Joint Strike Fighter training activities are addressed under Alternatives 1 and 2.
21	U.S. Navy Climate Change Roadmap	U.S. Department of the Navy	All LMEs	Present and future	Retained.
22	Hawaii Air National Guard F-22 Beddown	U.S. Air Force	All LMEs	Future	Retained.
23	U.S. Coast Guard Training Activities in Southern California and Hawaii	U.S. Coast Guard	California Current LME Insular Pacific-Hawaiian LME	Past, present, and future	Retained.
24	Joint Logistics Over-the-Shore Training	U.S. Department of the Navy, Marine Corps	California Current LME	Future	Retained.

Table 4.3-1: Other Actions and Other Environmental Considerations Identified for the Cumulative Impacts Analysis (continued)

#	Name of Action	Lead Agency or Proponent	Location in the Study Area/LME	Timeframe	Retained for Further Analysis?
Other Military Activities (continued)					
	Environmental Regulations and Planning				
23	Coastal and Marine Spatial Planning	Regional Planning Bodies	All LMEs	Future	Dismissed because action involves only planning and policy-related activities (discussed in Chapter 6 [Additional Regulatory Considerations]).
24	Marine Mammal Protection Act Incidental Take Authorizations	National Marine Fisheries Service	All LMEs	Past, present, and future	Retained.
	Other Environmental Considerations				
25	Commercial and Recreational Fishing	National Marine Fisheries Service and private industry	All LMEs and open ocean areas	Past, present, and future	Retained.
26	Maritime Traffic	Not applicable	All LMEs and open ocean areas	Past, present, and future	Retained.
27	Development of Coastal Lands	Local regulatory agencies	All LMEs	Past, present, and future	Retained.
28	Oceanographic Research	Numerous	All LMEs and open ocean areas	Past, present, and future	Retained.
29	Ocean Noise	Not applicable	All LMEs and open ocean areas	Past, present, and future	Retained.
30	Ocean Pollution	U.S. Environmental Protection Agency Applicable State Agencies	All LMEs and open ocean areas	Past, present, and future	Retained.
31	Marine Tourism	Numerous	All LMEs	Past, present, and future	Retained.
32	Commercial and General Aviation	Not applicable	All LMEs and open ocean areas	Past, present, and future	Retained.

Notes: LME = large marine ecosystem, U.S. = United States, EA = Environmental Assessment, MDA = Missile Defense Agency

4.3.3 OFFSHORE POWER GENERATION

4.3.3.1 Outer Continental Shelf Renewable Energy Program

The Outer Continental Shelf (OCS) Renewable Energy Program was finalized in 2009. These regulations provide a framework for leases, easements, and rights-of-way for activities on the OCS that support production and transmission of energy from sources other than oil and natural gas.

4.3.3.2 Offshore Wind Energy

Despite tremendous offshore wind capacity, the United States has no offshore wind energy production to date.

4.3.3.3 Marine Hydrokinetic Projects

Emerging water power technologies offer the potential to capture energy from waves, thermal gradients, tides, and ocean currents. These new technologies once developed will offer alternatives to fossil fuels. At the present time, there is significant research into the performance and economic viability of hydropower technologies. Because no fully developed marine hydrokinetic projects exist in the North American or Polynesia region, the impact on marine species and ecosystems in the region remains largely speculative. Concerns raised include the potential for collisions, noise, physical disturbance, disruption of marine species' behavioral patterns, impacts to local community and fishing industry, ability to monitor projects, cumulative impacts of multiple hydrokinetic projects along the coasts, habitat alteration due to anchors and cables, and release of toxins and chemicals by the projects or by vessels servicing the project. Other considerations include habitat disturbance and the displacement of benthic organisms. These concerns provide the potential for habitat loss and changes to the ecology of a region (Pacific Fishery Management Council 2011); however, initial studies have indicated that with appropriate protocols for siting and design indicates that these impacts are likely to be minimal (Union of Concerned Scientists 2008).

As of June 2011, the Federal Energy Regulatory Commission has issued 70 preliminary permits for hydrokinetic projects and 147 preliminary permits are pending. In California there are four wave preliminary permits and one tidal preliminary permit. In Hawaii there is one wave preliminary permit that has been issued (Center for Climate and Energy Solutions 2012).

4.3.4 DREDGE DISPOSAL, BEACH NOURISHMENT, AND MINING

4.3.4.1 Offshore Dredge Disposal Program

The offshore dredge disposal program is dismissed from analysis because the action involves programs related to dredging and beach nourishment projects. These activities (if applicable) would be analyzed on an individual basis for cumulative impacts.

4.3.4.2 Beach Nourishment Programs

Beach nourishment programs are dismissed from analysis because they result in negligible to minor impacts on resources in the area affected by this activity and the Proposed Action.

4.3.5 OTHER MILITARY ACTIVITIES

4.3.5.1 Scripps Pier Replacement at Point Loma

The proposed project is a joint project between the Navy and University of California San Diego that involves the replacement of the existing Scripps Pier. The project is proposed to begin in the fall of 2013.

4.3.5.2 Naval Base Point Loma Fuel Pier

The proposed project involves the replacement of the existing fuel pier at Point Loma, which will likely require the temporary relocation of the marine mammals from the Space and Naval Warfare Systems Command mammal program and dredging approximately 87,000 cubic yards of sediment to facilitate navigation in the vicinity of the fuel pier.

4.3.5.3 Submarine Drive-In Magnetic Silencing Facility Beckoning Point, Oahu, Hawaii

Construction of a new drive-in submarine magnetic silencing facility was completed on 31 December 2010, at Joint Base Pearl Harbor-Hickam's Beckoning Point. The project was a 2-year effort that replaced existing submarine deperming piers and structures and construction of land-based facilities to include a new rectifier building, back-up generator building, and renovations to the existing control building. Deperming (also known as degaussing) is accomplished by wrapping heavy gauge copper cables around the hull and superstructure of the vessel; very high electrical currents are pulsed through the cables in order to erase the permanent magnetism from ships and submarines to camouflage them against magnetic detection vessels and interference with communications and navigation equipment (U.S. Department of the Navy 2008a, b).

4.3.5.4 Establishment and Realignment of Navy Helicopter Squadrons on the West Coast

The Navy will add four helicopter squadrons on the west coast: establishing three new squadrons and relocating one squadron from the east coast. The realignment will increase the number of helicopters homebased at North Island by 52, from the current number of 151, to 203 helicopters by 2016. Most helicopter squadrons homebased at North Island will transition to the MH-60R and MH-60S helicopters to gradually replace older model H-60 helicopters. A new organizational maintenance hangar and supporting facilities will be constructed and 800 personnel (738 military and 62 civilian) will be added at North Island to support the additional squadrons (U.S. Department of the Navy 2011c).

4.3.5.5 San Clemente Island Fuel Storage and Distribution System

An Environmental Assessment has been implemented to replace the aging underground JP-5 jet fuel tanks and improve the receipt, storage, and delivery capabilities at San Clemente Island.

4.3.5.6 Navy, University of Hawaii, and United States Department of Energy Wave Energy Test Site

Naval Facilities Engineering Command Engineering Services Center proposes to construct and operate a deep-water wave energy test site for offshore wave energy conversion devices at a water depth of up to 328 feet (ft.) (100 meters [m]), roughly 8,200 ft. (2,500 m) offshore from North Beach of MCBH. Upon completion of deep-water test site construction, two additional wave energy conversion devices would be installed and operated at the deep test site, and the existing site (one) operating at about 98 ft. (30 m) depth (known as the medium depth site would remain. Therefore, the existing and expanded test sites would accommodate a maximum of three wave energy conversion devices (U.S. Department of the Navy 2012a).

4.3.5.7 Pier 12 Replacement and Dredging Naval Base San Diego

An Environmental Assessment has been implemented to evaluate the potential environmental consequences for a project at Naval Base San Diego, California that would involve demolition of Pier 12, dredging in berthing and approach for a new pier, dredged material disposal at an approved ocean disposal site and permitted upland landfill, construction of a new pier and associated pier utilities,

including upgrades to the electrical infrastructure at the adjacent Pier 13, and re-use of demolition concrete to create fish enhancement structures (artificial reefs) (U.S. Department of the Navy 2011d).

4.3.5.8 Homeporting Littoral Combat Ships on the West Coast

An Environmental Assessment has been implemented to evaluate the potential environmental effects of a naval proposal to homeport up to 16 Littoral Combat Ships and unmanned aerial systems at Naval Base Ventura County Point Mugu and Naval Base San Diego. No in-water construction is proposed and the homeporting would take place between Fiscal Year (FY) 2013 and FY 2020 (U.S. Department of the Navy 2012b).

4.3.5.9 Surveillance Towed Array Sensor System Low Frequency Active Sonar

In August 2011, the Navy released a Draft Supplemental EIS/Supplemental OEIS that evaluated the potential environmental impacts of employing the Surveillance Towed Array Sensor System Low Frequency Active Sonar (U.S. Department of the Navy 2011b). The Navy currently plans to operate up to four Surveillance Towed Array Sensor System Low Frequency Active Sonar systems for routine training, testing, and military operations. Based on current Navy national security and operational requirements, routine training, testing, and military operations using these sonar systems could occur in the Pacific Ocean (including the Study Area), Atlantic Ocean, Indian Ocean, and Mediterranean Sea.

4.3.5.10 Space and Naval Warfare Systems Command – Electronic Harbor Security System Environmental Assessment

A swimmer detection system is to be installed near Naval Base Point Loma and Naval Base San Diego.

4.3.5.11 Construction of Sea, Air, Land Delivery Vehicle Team One Waterfront Operations Facility

This project will construct a 20,000-square-foot addition to Building 987 for Sea, Air, Land (SEAL) Delivery Vehicle Team One platoon operators, divers, and support technicians. Work is expected to begin in 2013.

4.3.5.12 Basing of MV-22 and H-1 Aircraft in Support of III Marine Expeditionary Force Elements in Hawaii

An EIS is currently being prepared for the proposed basing and operation of MV-22 Osprey tiltrotor aircraft and H-1 helicopters in Hawaii. The Proposed Action includes basing and operating up to two Marine Medium Tiltrotor squadrons with a total of 24 MV-22 Osprey aircraft and one Marine Light Attack Helicopter squadron with 15 AH-1 Cobra and 12 UH-1 Huey attack and utility helicopters and conducting aviation training, readiness, and special exercise operations at training facilities statewide. Demolition, new construction, and renovation are proposed to develop basing facilities at Marine Corps Base Hawaii, Kaneohe Bay for the squadrons. Personnel increases would occur from 2012 through 2018 (U.S. Department of the Navy 2011e). The EIS analyzes the impacts of developing basing facilities at Marine Corps Base Hawaii Kaneohe Bay; conducting aviation operations at training areas on the islands of Kauai, Oahu, Molokai, Maui, and Hawaii; and constructing improvements at three existing training facilities.

4.3.5.13 Marine Corps Base Hawaii Pyramid Beach Cottage Construction

Construction of 10 new beach cottages is expected to begin in FY 2015.

4.3.5.14 United States Marine Corps Joint Strike Fighter

This project has been dismissed from further analysis as the homebasing activities included new construction and personnel relocation which are not expected to impact marine resources. Joint Strike Fighter training activities are addressed under Alternatives 1 and 2.

4.3.5.15 United States Department of the Navy Climate Change Roadmap

The Navy Climate Change Roadmap outlines the Navy's approach to observing, predicting, and adapting to climate change by providing a chronological list of Navy-associated action items, objectives and desired effects for FY 2010–2014 (U.S. Department of the Navy 2010).

4.3.5.16 Hawaii Air National Guard F-22 Beddown

The Hawaii Air National Guard and the U.S. Air Force will be conducting "joint" training with the F-22 aircraft which will be a replacement of the existing F-15 aircraft. Training in the F-22 aircraft will be similar to the training currently conducted with the F-15 aircraft (U.S. Department of the Navy 2011a).

4.3.5.17 United States Coast Guard Training Activities in Southern California and Hawaii

Coast Guard Sector San Diego, a shore command within the Coast Guard 11th District, carries out its mission to serve, protect, and defend the American public, maritime infrastructure, and the environment. The Sector San Diego Area of Responsibility extends southward from the Dana Point harbor to the border with Mexico. Equipment utilized by the Coast Guard includes 25 ft. (8 m) response boats, 41 ft. (12 m) utility boats, and 87 ft. (27 m) patrol boats, as well as HH-60 helicopters. Training events include search and rescue, maritime patrol training, boat handling, and helicopter and surface vessel live-fire training with small arms.

Similarly, the Coast Guard's 14th District carries out its mission and conducts unit training in and around Hawaii. U.S. Coast Guard training in Hawaii includes surface vessel live-fire training with small- and medium-caliber weapons, primarily conducted in Warning Areas 189, 193, and 194 within the Hawaii Range Complex.

4.3.5.18 Joint Logistics Over-the-Shore Training

Joint Logistics Over-The-Shore training consists of loading/unloading ships without fixed port facilities. This training may be conducted jointly by the Navy, Marine Corps, and Army at Marine Corps Base Camp Pendleton, California, and includes in-water and land-based activities. Training activities associated with elevated causeway set up and break down in the Camp Pendleton Amphibious Assault Area are addressed under Alternatives 1 and 2 of this EIS/OEIS. Land-based training will be addressed in a separate NEPA document.

4.3.6 Environmental Regulations and Planning

4.3.6.1 Coastal and Marine Spatial Planning

Dismissed because action involves only planning and policy-related activities.

4.3.6.2 Marine Mammal Protection Act Incidental Take Authorizations

The MMPA generally prohibits "take" of marine mammals in U.S. waters by any person and by U.S. citizens in international waters. The National Oceanic and Atmospheric Administration can authorize "take" for specific activities (National Oceanic and Atmospheric Administration 2012).

4.3.7 OTHER ENVIRONMENTAL CONSIDERATIONS

4.3.7.1 Commercial and Recreational Fishing

Commercial and recreational fishing constitutes an important and widespread use of the ocean resources throughout the Study Area. Fishing can adversely affect fish populations, other species, and habitats. Potential impacts of fishing include overfishing of targeted species and bycatch, both of which negatively affect fish stocks and other marine resources. Bycatch is the capture of fish, marine mammals, sea turtles, seabirds, and other nontargeted species that occur incidental to normal fishing operations. Use of mobile fishing gear such as bottom trawls disturbs the seafloor and reduces habitat structural complexity. Indirect impacts of trawls include increased turbidity, alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (i.e., lost fishing gear continuing to ensnare fish and other marine animals), and generation of marine debris. Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats and have the potential to entangle or be ingested by marine animals.

Fishing can have a profound influence on individual targeted species populations. In a study of retrospective data, Jackson et al. (2001) analyzed paleoecological records of marine sediments from 125,000 years ago to present, archaeological records from 10,000 years before the present, historical documents, and ecological records from scientific literature sources over the past century. Examining this longer-term data and information, they concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance of coastal ecosystems, including pollution and anthropogenic climatic change. Fisheries bycatch has been identified as a primary driver of population declines in several marine species, including sharks, mammals, seabirds, and sea turtles (Wallace et al. 2010).

4.3.7.2 Maritime Traffic

Portions of the Study Area are heavily traveled by commercial, recreational, and government marine vessels, with several commercial ports occurring in or near the Study Area. The United States has grown increasingly dependent on international trade over the past 50 years. Section 3.11 (Socioeconomic Resources) provides additional information for marine vessel traffic in the Study Area. Primary concerns for the cumulative impacts analysis include vessels striking marine mammals and sea turtles, introduction of non-native species through ballast water, and underwater sound from ships and other vessels.

4.3.7.3 Development of Coastal Lands

Coastal land development adjacent to the Study Area is both intensive and extensive. Development has impacted and continues to impact coastal resources through point and nonpoint source pollution; concentrated recreational use; and intensive ship traffic using major port facilities. The Study Area coastline also includes extensive coastal tourism development (hotels, resorts, restaurants, food industry, residential homes, etc.) and the infrastructure supporting coastal development (retail businesses, marinas, fishing tackle stores, dive shops, fishing piers, recreational boating harbors, beaches, recreational fishing facilities, etc.).

Coastal development intensifies use of coastal resources, resulting in potential impacts on water quality, marine habitat, and air quality. Coastal development is therefore closely regulated by California and Hawaii through the Coastal Zone Management Act. New development in the coastal zone requires a permit from the state or local government to which permitting authority has been delegated (Chapter 6,

Additional Regulatory Considerations) provides additional information on coastal zone management in each state).

4.3.7.4 Oceanographic Research

The Auxiliary General Purpose Oceanographic Research (AGOR) 28 research vessel is entering a final design and construction phase and is anticipated to be launched in 2015. The vessel is owned by the U.S. Office of Naval Research for the U.S. Department of the Navy and operated by Scripps. The AGOR 28 is designed to operate globally and support both U.S. Department of the Navy and national oceanographic research objectives to include exploring science and technology in the areas of oceanographic and meteorological observations, modeling and prediction in the battlespace environment, submarine detection and classification and mine warfare application for detecting and neutralizing mines in the ocean and littoral environment. The vessel will be based in the Scripps Nimitz Marine Facility in San Diego Port Loma (Scripps Institution of Oceanography 2012a, c).

Projects are under development to deploy seismometers, pressure gauges, and temperature sensors to measure the size and direction of tsunamis. Future use of the cables could include installation of climate instruments to measure acoustic tomography and water column temperature and conductivity to measure ocean warming. The initial project will focus along a cable route spanning 12,950 kilometers (8,105 miles) from Sydney to Auckland and across the Pacific Ocean to Los Angeles (Scripps Institution of Oceanography 2012b).

The Ocean Conservation Society has three ongoing projects in the Study Area. The Los Angeles Dolphin Project 1 (Ocean Conservation Society 2012a) studies the ecology, social structure and contaminant load comparison of inshore/offshore bottlenose dolphins in the Southern California Bight; the Los Angeles Dolphin Project 2 (Ocean Conservation Society 2012b) studies dolphin, sea lion and seabird aggregations during foraging and feeding activities in the Santa Monica Bay; and the Los Angeles Dolphin Project 3 (Ocean Conservation Society 2012c) studies the effects of coastal pollution and importance of oceanographic features for marine mammals in the waters off Los Angeles, California.

The National Oceanic and Atmospheric Administration has ongoing projects involving such projects as integrated ocean mapping, laser line scanning for habitat assessment, locating and mapping deep-sea coral habitats, species inventory, growth and reproductive studies and food web and species interaction studies, studies designed to understand the use of specific deep-sea species of corals as indicators of climatic change, and the effects on the oceans of deep-sea volcanoes and hydrothermal systems (National Oceanic and Atmospheric Administration 2011b).

4.3.7.5 Ocean Noise

Noise is generally described as unwanted sound—sound that clutters and masks other sounds of interest (Richardson et al. 1995). Anthropogenic sources of noise that are most likely to contribute to increases in ocean noise are vessel noise from commercial shipping and general vessel traffic, oceanographic research, oil and gas exploration, underwater construction, and naval and other use of sound navigation and ranging (sonar).

Any potential for cumulative impact should be put into the context of recent changes to ambient sound levels in the world's oceans as a result of anthropogenic activities. However, there is a large and variable natural component to the ambient noise level as a result of events such as earthquakes, rainfall, waves breaking, and lightning hitting the ocean as well as biological noises such as those from snapping shrimp and the vocalizations of marine mammals.

Andrew et al. (2002) compared ocean ambient sound from the 1960s to the 1990s from a receiver off the California coast. The data showed an increase in ambient noise of approximately 10 decibels (dB) in the frequency ranges of 20 to 80 hertz (Hz) and 200 to 300 Hz, and about 3 dB at 100 Hz over a 33-year period. Each 3 dB increase is noticeable to the human ear and a doubling in sound level. A possible explanation for the rise in ambient noise is the increase in shipping noise. There are approximately 11,000 supertankers worldwide, each operating 300 days per year, producing constant broadband noise at source levels of 198 dB (Hildebrand 2004). Generally the most energetic regularly operated sound sources are seismic airgun arrays from approximately 90 vessels with typically 12 to 48 individual guns per array, firing about every 10 seconds (Hildebrand 2004).

Section 3.0.4 (Acoustic and Explosives Primer), provides additional information about sources of anthropogenic sound in the ocean and other background information about underwater noise. This section describes the different types of effects that are possible and the potential relationships between sound stimuli and long-term consequences for individual animals and populations. A variety of impacts may result from exposure to sound-producing activities. The severity of these impacts can vary greatly between minor impacts that have no real cost to the animal, to more severe impacts that may have lasting consequences. The major categories of potential impacts are: behavioral reactions, physiological stress, auditory fatigue, auditory masking, and direct trauma.

4.3.7.6 Ocean Pollution

Pollution is the introduction of harmful contaminants that are outside the norm for a given ecosystem. Ocean pollution has and will continue to have serious impacts on the marine ecosystems. Common ocean pollutants include toxic compounds such as metals, pesticides, and other organic chemicals; excess nutrients from fertilizers and sewage; detergents; oil; plastics; and other solids. Pollutants enter oceans from non-point sources (i.e., stormwater runoff from watersheds), point sources (i.e., wastewater treatment plant discharges), other land-based sources (i.e., windblown debris), spills, dumping, vessels, and atmospheric deposition.

4.3.7.6.1 Non-Point Sources, Point Sources, and Atmospheric Deposition

Polluted runoff, or nonpoint source pollution, is considered the major cause of impairment of ocean waters. Stormwater runoff from coastal urban areas and beaches carries waste such as plastics and Styrofoam into coastal waters. Sewer outfalls also are a source of ocean pollution. Sewage can be treated to eliminate potentially harmful releases of contaminants; however, releases of untreated sewage occur due to malfunctions or overloads to the infrastructure, resulting in releases of bacteria usually associated with feces, such as *Escherichia coli* and *Enterococci spp*. Bacteria levels are used routinely to determine the quality of water at recreational beaches and as indicators of the possible presence of other harmful microorganisms. In the past, toxic chemicals have been released into sewer systems. While such dumping has long been forbidden by law, the practice left ocean outflow sites contaminated. Sewage treatment facilities generally do not treat or remove persistent organic pollutants, such as polychlorinated biphenyl (PCB) and dichlorodiphenyltrichloroethane (DDT), or other toxins.

Hypoxia (low dissolved oxygen concentration) is a major impact associated with point and non-point sources of pollution. Hypoxia occurs when waters become overloaded with nutrients such as nitrogen and phosphorus, which enter oceans from non-point source runoff, wastewater treatment plants, and atmospheric deposition. Too many nutrients can stimulate algal blooms—the rapid expansion of microscopic algae (phytoplankton). When excess nutrients are consumed, the algae population dies off and the remains are consumed by bacteria. Bacterial consumption causes dissolved oxygen in the water

to decline to the point where marine life that depend on oxygen can no longer survive (Boesch et al. 1997).

Harmful algal blooms are proliferations of marine and freshwater algae (including cyanobacteria and non-photosynthetic algae-like organisms) that can produce toxins, causing human illness and massive animal mortalities. They also can accumulate in sufficient numbers to alter ecosystems in detrimental ways.

Non-point sources, point sources, and atmospheric deposition also contribute toxic pollutants such as metals, pesticides, and other organic compounds to the marine environment. Toxic pollutants may cause lethal or sublethal effects if present in high concentrations, and can build up in tissues over time and suppress immune system function, resulting in disease and death.

4.3.7.6.2 Marine Debris

Marine debris is any anthropogenic object intentionally or unintentionally discarded, disposed of, or abandoned that enters the marine environment. Common types of marine debris include various forms of plastic and abandoned fishing gear. Marine debris degrades marine habitat quality and poses ingestion and entanglement risks to marine life and bird (National Marine Fisheries Service 2006).

Plastic marine debris is a major concern because it degrades slowly and many plastics float, allowing the debris to be transported by currents throughout the oceans. Currents in the oceanic convergence zone in the North Pacific Subtropical Gyre act to accumulate the floating plastic marine debris. Additionally, plastic waste in the ocean chemically attracts hydrocarbon pollutants such as PCB and DDT, which accumulate up to one million times more in plastic than in ocean water (Mato et al. 2001). Fish, marine animals, and birds can mistakenly consume these wastes containing elevated levels of toxins instead of their prey. In the North Pacific Subtropical Gyre it is estimated that the fishes in this area are ingesting 12,000 to 24,000 U.S. tons (10,886,216 to 21,772,433 kilograms [kg]) of plastic debris a year (Davison and Asch 2011).

Marine debris has been discovered to be accumulating in gyres throughout the oceans. Law et al. (2010) presented a time series of plastic content at the surface of the western North Atlantic Ocean and Caribbean Sea from 1986 to 2008. More than 60 percent of 6,136 surface plankton net tows collected small, buoyant plastic pieces. The data identified an accumulation zone east of Bermuda that is similar in size to the accumulation zone in the eastern Pacific Ocean.

4.3.7.7 Marine Tourism

Between 1990 and 2000, the ocean-related gross state product for California grew by 10.64 percent, with one of the largest growth trends experienced in coastal recreation and tourism. California's trend reflects the international trend of coastal tourism and recreation growth which has continued in past decades while other industries have declined. Additionally, the growth is seen in the development of "services" rather than "goods-related" activities (Kildow and Colgan 2005). Stakeholders in tourism services have economical motivation to ensure positive management of marine resources on which their industries are based therefore the impacts of marine tourism are generally localized and of small magnitude; however, rapid expansion of tourism could increase pressure for additional coastal and urban development which would result in potential indirect and cumulative effects on marine resources (Harriott 2002). The Marine Institute found that the issues relating to tourism included visitor pressures on coastal ecology; carrying capacity; information gap (i.e., insufficient data to assess impacts of tourism); anthropogenic impacts (i.e., displacement of seabirds, habitat and roosting opportunities,

conflicts with users and wildlife, altering food sources); threats to ecology; development pressure; infrastructural support; user conflicts; and motorized crafts (Connolly et al. 2001).

4.3.7.8 Commercial and General Aviation

Commercial and general aviation are retained for analysis and discussion in Section 4.4.4.1 (Greenhouse Gases).

4.4 Resource-Specific Cumulative Impacts

4.4.1 Resource Areas Dismissed from Current Impacts Analysis

In accordance with Council on Environmental Quality guidance (Council on Environmental Quality 2010), the cumulative impacts analysis focused on impacts that are "truly meaningful." The level of analysis for each resource was commensurate with the intensity of the impacts identified in Chapter 3 (Affected Environment and Environmental Consequences). The analysis focused on marine mammals, sea turtles, and cultural resources. While each of the following resources is discussed in the following section, detailed analysis of cumulative impacts was not necessary for the following resources as the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be low. Further analysis of cumulative impacts is not warranted on the following resources:

- Sediments and water quality
- Marine habitats
- Seabirds
- Marine vegetation
- Marine invertebrates
- Fish
- Socioeconomic resources
- Public health and safety

4.4.2 Sediments and Water Quality

The analysis in Section 3.1 (Sediments and Water Quality) indicates that the alternatives could result in local, short- and long-term changes in sediment and water quality. However, chemical, physical, or biological changes to sediments or water quality would be below applicable standards, regulations, and guidelines and would be within existing conditions or designated uses (Section 3.1.1.2, Methods, lists applicable standards, regulations, and guidelines). The short-term impacts would arise from explosions and the byproducts of explosions and combusted propellants. It is unlikely these short-term impacts would overlap in time and space with other future actions that produce similar constituents. For example, training and testing with explosives would not be expected to occur near an oil rig structure-removal operation that could use explosives. Therefore, the short-term impacts described in Section 3.1 (Sediments and Water Quality) are not expected to contribute to cumulative impacts.

The long-term impacts would arise from unexploded ordnance, noncombusted propellant, metals, and other materials. Long-term impacts of each alternative would be cumulative with other actions that cause increases in similar constituents. However, the incremental contribution of the No Action Alternative, Alternative 1, or Alternative 2 to long-term cumulative impacts would be negligible because

- Most training and testing activities are widely dispersed in space and time;
- Most components of expended materials are inert or corrode slowly;

- Numerically, most of the metals expended are small- and medium-caliber projectiles, metals of concern comprise a small portion of the alloys used in expended materials, and metal corrosion is a slow process that allows for dilution;
- Most of the components are subject to a variety of physical, chemical, and biological processes that render them benign; and
- Potential areas of impacts would be limited to small zones immediately adjacent to the explosive, metals, or chemicals other than explosives.

Furthermore, none of the alternatives would result in long-term and widespread changes in environmental conditions, such as nutrient loading, turbidity, salinity, or pH (a measure of the degree to which a solution is either acidic [pH less than 7.0] or basic [pH greater than 7.0]). Based on the analysis presented in Section 3.1 (Sediments and Water Quality) and the reasons summarized above, the changes in sediment or water quality would be measurable, but would still be below applicable standards and guidelines; therefore the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be low and further analysis of cumulative impacts is not warranted.

4.4.3 AIR QUALITY

As detailed in Section 3.2 (Air Quality), increased training and testing activities conducted under Alternatives 1 and 2 would result in increased criteria pollutant emissions and hazardous air pollutant emissions throughout the Study Area. Sources of the increased emissions would include vessels and aircraft, and to a lesser extent munitions. Potential impacts include localized and temporarily elevated pollutant concentrations. Recovery would occur quickly as emissions disperse, and there would be no significant impact on air quality. The impacts of Alternatives 1 or 2 would be cumulative with other actions that involve criteria air pollutant and hazardous air pollutant emissions. However, the incremental contribution of Alternatives 1 or 2 to cumulative impacts would be low for the following reasons:

- Prevailing winds along the Pacific coast generally trend east to west, thus reducing the likelihood that offshore emissions would impact air quality control regions ashore.
- For those proposed activities occurring at latitudes consistent with air quality control region nonattainment or maintenance areas in the Southern California region, most training and testing-related emissions are projected to occur at distances greater than 12 nautical miles (nm) from shore.
- Few stationary offshore air pollutant emission sources exist within the Study Area and few are expected in the foreseeable future.
- International regulations by the International Maritime Organization require commercial shipping vessels to switch to lower-sulfur fuel near U.S. and international coasts beginning in 2012 (National Oceanic and Atmospheric Administration 2011a). The Department of Defense has released the Operational Energy Strategy: Implementation Plan which will reduce demand, diversify energy sources, and integrate energy consideration into planning (Department of Defense 2012). The U.S. Department of the Navy policy commits to a reduction of oil consumption by 50 percent by 2015, 40 percent of the Navy's total energy will come from fossil fuel alternatives and 50 percent of its onshore energy will come from renewable sources by 2020 (Environmental and Energy Study Institute 2009, Paige 2009). Similar low-sulfur fuel regulations in California, including a voluntary state slowdown policy, were found to reduce several pollutants, including sulfur dioxide and particulate matter by as much as 90 percent (Lack et al. 2011).

Based on the analysis presented in Section 3.2 (Air Quality) and the reasons summarized above, the incremental contribution of Alternatives 1 or 2 to cumulative impacts would be low. Further analysis of cumulative impacts on air quality is not warranted.

4.4.4 CLIMATE CHANGE

This section provides background information and an analysis of the cumulative impacts of climate change and greenhouse gas emissions for the Proposed Action. Climate change is also considered in the overall cumulative impacts analysis as another environmental consideration. The Intergovernmental Panel on Climate Change (2007) reports that physical and biological systems on all continents and in most oceans are already being affected by recent climate changes. Global-scale assessment of observed changes shows that it is likely that anthropogenic warming over the last three decades has had a discernible influence on many physical and biological systems. Some of the major potential concerns for the marine environment include

- Sea temperature rise
- Melting of polar ice
- Rising sea levels
- Changes to major ocean current systems
- Ocean acidification

4.4.4.1 Greenhouse Gases

Greenhouse gases are compounds that contribute to the greenhouse effect. The greenhouse effect is a natural phenomenon in which these gases trap heat within the surface-troposphere (lowest portion of the earth's atmosphere) system, causing heating (radiative forcing) at the surface of the earth. Scientific evidence indicates a trend of increasing global temperature over the past century due to an increase in greenhouse gas emissions from human activities (U.S. Environmental Protection Agency 2012). Without greenhouse gases the planet's surface would be about 60 degrees Fahrenheit (°F) cooler than present, according to the National Oceanic and Atmospheric Administration and National Aeronautics and Space Administration data the average surface temperature has increase by about 1.2 to 1.4°F since 1900. If greenhouse gases continue to increase, models predict that the average temperature at the earth's surface could increase from 2.0 to 11.5°F above the 1990 levels by the end of this century (Le Treut et al. 2007).

Predictions of long-term negative environmental impacts due to global warming include sea level rise, changing weather patterns with increases in the severity of storms and droughts, changes to local and regional ecosystems (including the potential loss of species), shrinking glaciers and sea ice, thawing permafrost, a longer growing season, and shifts in plant and animal ranges.

Over the next several decades, temperatures are projected to rise. The projected warming and more extensive climate-related changes could dramatically alter the region's economy, landscape, character, and quality of life (Le Treut et al. 2007).

In 2009, the United States generated about 6,633.2 teragrams (Tg) (or million metric tons) of carbon dioxide (CO_2) equivalents (U.S. Environmental Protection Agency 2012). The 2009 inventory data (U.S. Environmental Protection Agency 2012) show that CO_2, methane (CH_4), and nitrous oxide (N_2O) contributed from fossil fuel combustion processes from mobile and stationary sources (all sectors) include approximately:

- 5,505.2 Tg of CO_2
- 686.3 Tg CH_4
- 295.6 Tg N_2O

The 6,633.2 Tg CO_2 equivalent (CO_2e) generated in 2009 is a decrease from the 7,263.4 Tg CO_2e generated in 2007 (U.S. Environmental Protection Agency 2011). Among domestic transportation sources, light-duty vehicles (including passenger cars and light-duty trucks) represented 64 percent of CO_2 emissions, medium- and heavy-duty trucks 20 percent, commercial aircraft 6 percent, and other sources 9 percent. Across all categories of aviation, CO_2 emissions decreased by 21.6 percent (38.7 Tg) between 1990 and 2009. This includes a 59 percent (20.3 Tg) decrease in emission from domestic military operations. To place military aircraft in context with other aircraft CO_2 emissions, in 2009, commercial aircraft generated 111.4 Tg CO_2e, military aircraft generated 14.1 Tg CO_2e, and general aviation aircraft generated 13.3 Tg CO_2e. Military aircraft represent roughly 10 percent of emissions from the overall jet fuel combustion category (U.S. Environmental Protection Agency 2012).

This section begins by providing the background and regulatory framework for greenhouse gases. It then provides a quantitative evaluation of changes in greenhouse gas emissions that would occur under the Proposed Action and analyzes the cumulative impacts of greenhouse gas emissions.

4.4.4.1.1 Regulatory Framework

Federal agencies address emissions of greenhouse gases by reporting and meeting reductions mandated in laws, executive orders and policies. The most recent of these are Executive Order (EO) 13514 *Federal Leadership in Environmental, Energy, and Economic Performance* of 5 October 2009 and EO 13423 *Strengthening Federal Environmental, Energy, and Transportation Management* of 26 January 2007.

Executive Order 13514 shifts the way the government operates by (1) establishing greenhouse gases as the integrating metric for tracking progress in federal sustainability; (2) requiring a deliberative planning process; and (3) linking to budget allocations and Office of Management and Budget scorecards to ensure goal achievement.

The targets for reducing greenhouse gas emissions discussed in EO 13514 for Scope 1 (direct greenhouse gas emissions from sources that are owned or controlled by a federal agency) and Scope 2 (direct greenhouse gas emissions resulting from the generation of electricity, heat, or steam purchased by a federal agency) have been set for the Department of Defense at a 34 percent reduction of greenhouse gas from the 2008 baseline by 2020. Scope 3 targets (greenhouse gas emissions from sources not owned or directly controlled by a federal agency but related to agency activities such as vendor supply chains, delivery services, and employee travel and commuting) were set at a 13.5 percent reduction. Executive Order 13514 *Strategic Sustainability Performance Plan* submitted to the Council on Environmental Quality on 2 June 2010 contains a guide for meeting these goals.

Executive Order 13423 established a policy that federal agencies conduct their environmental, transportation, and energy-related activities in support of their respective missions in an environmentally economic way. It included a goal of improving energy efficiency and reducing greenhouse gas emissions of the agency through reduction of energy intensity by 3 percent annually through the end of FY 2015, or 30 percent by the end of FY 2015, relative to the baseline of the agency's energy use in FY 2003.

The *Draft NEPA Guidance on Consideration of the Impacts of Climate Change and Greenhouse Gas Emissions* (Council on Environmental Quality 2010) states that "if a proposed action would be reasonably anticipated to cause direct emissions of 25,000 metric tons or more of CO_2e greenhouse gas emissions on an annual basis, agencies should consider this an indicator that a quantitative and qualitative assessment may be meaningful to decision makers and the public." Because the impact of the Navy's Proposed Action exceeds 25,000 metric tons, a quantitative and quantitative assessment follows.

The Navy is committed to improving energy security and environmental stewardship by reducing reliance on fossil fuels. The Navy is actively developing and participating in energy, environmental, and climate change initiatives that will increase use of alternative energy and help conserve the world's resources for future generations. The Navy Climate Change Roadmap identifies actions the Environmental Readiness Division is taking to implement EO 13514 (U.S. Department of the Navy 2010). The Navy's Task Force Energy is responding to the Secretary of the Navy Energy Goals through energy security initiatives that reduce the Navy's carbon footprint. The Climate Change Roadmap (5-year roadmap) action items, objectives, and desired impacts are organized to focus on strategies, policies and plans; operations and training; investments; strategic communications and outreach; and environmental assessment and prediction.

4.4.4.1.2 Cumulative Greenhouse Gas Impacts

Climate change is a global issue, and greenhouse gas emissions are a concern from a cumulative perspective because individual sources of greenhouse gas emissions are not large enough to have an appreciable impact on climate change. This greenhouse gas analysis considers the incremental contribution of Alternatives 1 and 2 to total estimated U.S. greenhouse emissions and their significance on climate change as compared to the No Action Alternative.

To estimate total greenhouse gas emissions, each greenhouse gas was assigned a global warming potential; that is, the ability of a gas or aerosol to trap heat in the atmosphere. The global warming potential rating system is standardized to CO_2, which has a value of one. For example, CH_4 (methane) has a global warming potential of 21, which means that it has a global warming effect 21 times greater than CO_2 on an equal-mass basis (Intergovernmental Panel on Climate Change 2007). To simplify greenhouse gas analyses, total greenhouse gas emissions from a source are often expressed as CO_2e. The CO_2e is calculated by multiplying the emissions of each greenhouse gas by its global warming potential and adding the results together to produce a single, combined emission rate representing all greenhouse gases. While CH_4 and N_2O (nitrous oxide) have much higher global warming potentials than CO_2, CO_2 is emitted in much higher quantities, so it is the overwhelming contributor to CO_2e from both natural processes and human activities. Global warming potential-weighted emissions are presented in terms of equivalent emissions of CO_2, using units of Tg (1 million metric tons, or 1 billion kilograms) of carbon dioxide equivalents (Tg CO_2e).

Greenhouse gas emissions were calculated (Appendix D Air Quality Calculations) for ships and aircraft, which contribute the majority of emissions associated with training and testing in the Study Area. Greenhouse gas emissions from minor sources such as munitions, weapons platforms, and auxiliary equipment are considered negligible and were not calculated. Ship greenhouse gas emissions were estimated by determining annual ship fuel (typically diesel) use based on proposed activities and multiplying total annual ship fuel consumption by the corresponding emission factors for CO_2, CH_4, and N_2O. Aircraft greenhouse gas emissions were calculated by multiplying jet fuel use rates by the total operating hours, by the corresponding jet fuel emission factors for CO_2, CH_4, and N_2O, and by the total

annual sorties. Ship and aircraft greenhouse gas emissions are compared to U.S. 2009 greenhouse gas emissions in Table 4.4-1. The estimated CO_2e emissions from the No Action Alternative and Alternative 1 are 0.030 percent of the total CO_2e emissions generated by the United States in 2009. The estimated CO_2e emissions from Alternative 2 would increase as a result of increased training and testing activities to about 0.031 percent of the total CO_2e emissions generated by the United States in 2009.

Based on the analysis presented in Section 3.2 (Air Quality) and the reasons summarized above, the changes in air quality would be measurable, but would still be below applicable standards and guidelines; therefore the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be low and further analysis of cumulative impacts is not warranted.

Table 4.4-1: Comparison of Ship and Aircraft Greenhouse Gas Emissions to United States 2009 Greenhouse Gas Emissions

Alternative	Annual Greenhouse Gas Emissions (teragrams CO_2e)	Increase over the No Action Alternative	Percentage of U.S. 2009 Greenhouse Gas Emissions
No Action Alternative	1.89	N/A	0.030%
Alternative 1	1.94	2.6%	0.031%
Alternative 2	1.93	2.1%	0.031%
U.S. 2009 Greenhouse Gas Emissions	6,633.2		

Notes: CO_2e = carbon dioxide equivalent, N/A = Not Applicable, U.S. = United States
Source: U.S. Environmental Protection Agency 2011

4.4.5 MARINE HABITATS

The analysis presented in Section 3.3 (Marine Habitats) indicates that marine habitats could be affected by acoustic stressors (underwater detonations) and physical disturbance or strikes (interactions with vessels and in-water devices, military expended materials, or seafloor devices). Potential impacts include localized disturbance of the seafloor, cratering of soft bottom sediments, and structural damage to hard bottom habitats. Impacts on soft bottom habitats would be short-term, and impacts on hard bottom would be long-term. The impacts of Alternatives 1 and 2 would be cumulative with other actions that cause similar disturbances. However, the incremental contribution of Alternatives 1 or 2 to cumulative impacts would be low for the following reasons:

- Most of the proposed activities that might affect marine habitats would occur in areas where hard bottom does not occur.
- Impacts on soft bottom habitats would be confined to a limited area, and recovery would occur quickly.

Based on the analysis presented in Section 3.3 (Marine Habitats) and the reasons summarized above, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be low. Further analysis of cumulative impacts on marine habitats is not warranted.

4.4.6 MARINE MAMMALS

4.4.6.1 Impacts of Alternatives 1 and 2 That May Contribute to Cumulative Impacts

Based on the analysis presented in Section 3.4 (Marine Mammals) impacts of Alternatives 1 and 2 that might contribute to cumulative impacts on marine mammals include mortality, injury (Level A harassment under the MMPA), and disturbance or behavioral modification (MMPA Level B harassment). Mortality or injury could be caused by underwater explosions or vessel strikes. Injury, in the form of permanent threshold shift (PTS), could also be caused by sonar use. Underwater explosions, pile driving, swimmer defense airguns, and sonar use would result in disturbance that meets the definition of MMPA Level A and B harassment. The remaining stressors analyzed in Section 3.4 (Marine Mammals) are not expected to result in mortality or Level A or B harassment. The incremental contribution of these remaining stressors to cumulative impacts on marine mammals would be negligible. These stressors are discussed in Section 3.4.3.1 through 3.4.3.7. The impacts of Alternatives 1 and 2 considered in the cumulative impacts analysis are summarized in Chapter 3, Section 3.4 (Marine Mammals).

4.4.6.2 Impacts of Other Actions

4.4.6.2.1 Overview

The potential impacts of other actions that are relevant to the cumulative impact analysis for marine mammals include the following:

- Mortality associated with vessel strikes, bycatch in fisheries, and entanglement in fishing and other gear
- Injury associated with vessel strikes, bycatch, entanglement, and underwater sound
- Disturbance, behavioral modifications, and reduced animal fitness associated with underwater noise
- Reduced animal fitness associated with water pollution

Most of the other actions and considerations retained for analysis in Table 4.3-1 would include operation of marine vessels. Exceptions include the actions listed under environmental regulations and permitting. Stressors associated with marine vessel operations that are of primary concern for the cumulative impacts analysis includes vessel strikes and underwater noise. Many of the actions would also result in underwater noise from sources other than vessels, including use of explosives for oil rig removal, seismic surveys, and construction activities. Rather than discussing these stressors for individual actions, their aggregate impacts are considered below as “other environmental considerations” in the maritime traffic and ocean noise subsections. Similarly, many of the actions would result in water pollution. The aggregate impacts of water pollution are addressed below in the ocean pollution section (Section 4.4.6.2.5). Bycatch is associated with commercial fishing, and the primary cause of entanglement is commercial fishing. Therefore, these stressors are discussed below in the commercial fishing section (Section 4.4.6.2.6).

4.4.6.2.2 Surveillance Towed Array Sensor System Low Frequency Active Sonar

Potential impacts on marine mammals from Surveillance Towed Array Sensor System Low Frequency Active Sonar operations include (1) nonauditory injury,[2] (2) permanent loss of hearing, (3) temporary loss of hearing, (4) behavioral change, and (5) masking. The potential effects from Surveillance Towed

[2] Nonauditory injury can be defined as not relating to or functioning in hearing (Merriam-Webster 2012); this includes mortality, strike, and lung injury.

Array Sensor System Low Frequency Active Sonar operations on any stock of marine mammals from injury (nonauditory or permanent loss of hearing) are considered negligible, and the potential effects on the stock of any marine mammal from temporary loss of hearing or behavioral change (significant change in a biologically important behavior) are considered minimal. Any auditory masking in marine mammals due to low-frequency active sonar signal transmissions is not expected to be severe and would be temporary. The operation of Surveillance Towed Array Sensor System Low Frequency Active Sonar with monitoring and mitigation would result in no mortality. The likelihood of low-frequency active sonar transmissions causing marine mammals to strand is negligible (U.S. Department of the Navy 2011b).

4.4.6.2.3 Maritime Traffic and Vessel Strikes

Vessel strikes have been and will continue to be a cause of marine mammal mortality and injury throughout the Study Area. A review of the impacts of vessel strikes on marine mammals is presented in Section 3.4.3.4.1 (Impacts from Vessels). In particular, certain large whales, such as the blue whale, are more prone to vessel strikes (Berman-Kowalewski et al. 2010; Betz et al. 2011). The most vulnerable marine mammals are thought to be those that spend extended periods at the surface or species whose unresponsiveness to vessel sound makes them more susceptible to vessel collisions (Gerstein 2002; Laist and Shaw 2006; Nowacek et al. 2004). Marine mammals such as dolphins, porpoises, and pinnipeds that can move quickly throughout the water column are not as susceptible to vessel strikes. Most vessel strikes of marine mammals reported involve commercial vessels and occur over or near the continental shelf (Laist et al. 2001). The literature review by Laist et al. (2001) concluded that vessel strikes likely have a negligible impact on the status of most whale populations, but that for small populations, vessel strikes may have considerable population-level impacts. The conservation status and abundance of the species struck would determine in large part whether the injury would have population-level impacts on that species (Laist et al. 2001; Vanderlaan and Taggart 2009).

In August 2011, the NMFS Southwest Regional Office provided the Navy with a data summary of all known or suspected ship strikes to marine mammals within California for the period 1988 to June 2011 (National Marine Fisheries Service 2011a). In order to look at a standardized period for the California data, a 20-year subset of the Southwest Regional Office stranding data from 1991 to 2010 was used for this analysis. Similar data for Hawaii was provided by the NMFS' Pacific Island Regional Office in the fall of 2011, and subsequently updated by the Pacific Island Regional Office in March 2012 to cover the period from 2003 to 2010.

In California, there were 86 large whale ship strikes over the 20-year period of the Southwest Regional Office data set analyzed (1991–2010). In looking at the 15-year interval from 1991 to 2005, however, average ship strikes were reported at the rate of three per year. Since 2006, and for the 5-year period from 2006 to 2010, there was an average of eight strikes reported per year.

It is unclear if the differences in pre and post 2006 averages are the result of increasing commercial ship traffic, increasing animal populations, changes in reporting, a statistical anomaly, or any combination of these factors. Some of this pattern of increase must be cautiously viewed in terms of how ship strike data is reported to the NMFS in California. NMFS stranding data is all reported via either self-reporting or from the California stranding network. Vessel-based reporting provides information about the type of ship and exact location where a strike occurred, but may potentially be lacking biological information on the whale struck (species, sex, length/age class, etc.). Stranding network reporting may provide more detailed biological information about the whale struck with determination of ship strike made based on injuries noted during necropsy, but not much may be known about the strike event itself (vessel type,

location, ship speed, etc.). Additional temporal variation may arise from increased necropsies over the 20-year interval as more research is conducted to determine large whale mortality from stranded carcasses and from increased interest in the impacts of ship strike as a mortality source.

The California stranding network is composed of up to 17 regional partners throughout the state each with its own area of response and availability of resources. For instance, due to personnel staffing and resources on-hand, necropsies to determine ship strike may be more likely in one geographic region over another. In general, NMFS Southwest Regional Office believes that the state of interest is such that now most if not all of the California stranding network responders will attempt a large whale necropsy. But again over the 20-year time frame of the strike dataset, the percentages of ship strike reporting may have changed (i.e., increased) in some locations (Ms. Sarah Wilkin, Southwest Regional Office stranding coordinator; personal communication February 2012).

The most common species reported struck in the Southwest Regional Office data for all of California include gray whales (35 percent), blue whales (16 percent), fin whales (13 percent), humpback whales (9 percent), and sperm whales (1 percent). However, 25 percent of strikes were to species not identified (either unknown species or unidentified Balaenopterid) and these strikes could have been any of the above species including other large whale species (Bryde's whale, minke whale, sei whale).

Within the portion of California containing the Navy's SOCAL Range Complex and for the most part equivalent to Southwest Regional Office's county listing for San Diego County, there were 23 whale strikes in the period from 1993 to 2010. There were no reported whale strikes from 1991 to 1992. Unknown whale species was the largest percentage of strikes (43 percent or n=10). Gray whales were the second most common (39 percent or n=9). Two fin whales were struck in 2009 by a Navy ship, but there have been no Navy ship strikes in the SOCAL Range Complex since 2009. Of the two blue whale strikes, one was struck by a research vessel in 2003 and the other by a Navy ship in 2004. The number and percentage of ship strikes to large whales in all of California by vessel category were: unknown type (43 percent or n= 37); Navy ship (19 percent or n=16); commercial ship (10 percent or n=9); recreational boat (7 percent or n=6); Coast Guard boat (6 percent or n=5); research vessel or tug (5 percent or n=4); ferry (3 percent or n=3); cruise ship (2 percent or n=2); whale watching boat (2 percent or n=2); and fishing boat (2 percent or n=2). It should be noted that U.S. Navy reports 100 percent of all Navy ship strikes to the NMFS. Only the Navy and the U.S. Coast Guard report vessel strike in this manner.

Therefore, these statistics are skewed by a lack of comprehensive reporting from all non-Navy vessels that may experience vessel strike. For instance, many of the unknown strikes (n=37 or 43 percent of total) may have been from commercial vessels or other non-Navy vessel types. Of the 16 reported Navy ship strikes, 15 occurred within the SOCAL Range Complex (San Diego County).

The Navy stratified the Southwest Regional Office 20-year data set to reflect the relative sub-region along the California coast where a given whale ship strike was reported. Four strata were used and strikes assigned to the most appropriate strata: SOCAL (area only containing SOCAL Range Complex which was mostly equivalent to San Diego County); SOCAL NORTH (area from SOCAL Range Complex northern boundary, including Orange County, Los Angeles County, and Ventura County to Point Conception—areas still within the Southern California Bight, but north and outside of the Study Area); Central California (area from Point Conception to San Francisco); and Northern California (from Marin County to the California-Oregon boundary).

Approximately 74 percent of all reported whale ship strikes occurred north and outside of the Study Area. By geographic sub-strata, the highest percentage of strikes (37 percent) was reported off the northern portion of Southern California (SOCAL NORTH), an area north of the HSTT boundary to Point Conception. This region includes the high volume commercial ship traffic ports of Los Angeles/Long Beach. The second highest percentage of ship strikes (31 percent) was off of central California which includes the commercial ship traffic ports of San Francisco/Oakland.

For the period from 2003 to 2010, there were 53 reported whale ship strikes in Hawaii. Approximately 94 percent of the 2003–2010 Hawaii ship strikes were to humpback whales (n=50), 4 percent to unknown species (n=2), and 2 percent to sperm whale (n=1). The number and percentage of ship strikes to large whales in Hawaii by vessel category were: unknown (34 percent or n=18); tour boat (26 percent or n=14); whale watching boat (9 percent or n=5); Navy ship (8 percent or n=4); research boat (6 percent or n=3); ferry (4 percent or n=2), fishing boat (4 percent or n=2); other non-specified boat (4 percent or n=2); recreational boat (2 percent or n=1); commercial ship (2 percent or n=1); and U.S. Coast Guard boat (2 percent or n=1). Island-specific ship strikes in Hawaii for the years 2003–2010 were: Maui (55 percent or n=29); Hawaii (13 percent or n=7); Kauai (9 percent or n=5); Lanai (9 percent or n=5); Oahu (8 percent or n=4) and at-sea within 300 nm of Hawaii (6 percent or n=3).

4.4.6.2.4 Ocean Noise

As summarized by the National Academies of Science, the possibility that anthropogenic sound could harm marine mammals or significantly interfere with their normal activities is an issue of concern (National Research Council of the National Academies 2005). Noise is of particular concern to marine mammals because many species use sound as a primary sense for navigating, finding prey, and communicating with other individuals. Noise can cause behavioral disturbances, mask other sounds (including their own vocalizations), result in injury, and in some cases, even lead to death (Tyack 2009a; Tyack 2009b, Würsig and Richardson 2008). Human-caused noises in the marine environment come from shipping, seismic and geologic exploration, military training, and other types of pulses produced by government, commercial, industry, and private sources. In addition, noise from whale-watching vessels near marine mammals has received a great deal of attention (Wartzok 2009).

Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present near the sound, and the effects that sound may have on the physiology and behavior of those marine mammals. Although it is known that sound is important for marine mammal communication, navigation, and foraging (National Research Council of the National Academies 2003, 2005), there are many unknowns in assessing the specific effects and significance of responses by marine mammals to sound exposures such as what activity the animal is engaged in at the time of the exposure (Nowacek et al. 2007, Southall et al. 2007). Potential impacts on marine mammals from ocean noise include behavioral reactions, hearing loss in the form of temporary threshold shift (TTS) or PTS, auditory masking, injury, and mortality. Section 3.4.3.1 (Acoustic Stressors) discusses these and other possible impacts of ocean noise on marine mammals.

4.4.6.2.5 Ocean Pollution

As discussed in Section 3.4.3 (Environmental Consequences), pollutants from multiple sources are present in, and continue to be released into, the oceans. Elevated concentrations of certain compounds have been measured in tissue samples from marine mammals. Long-term exposure to pollutants poses potential risks to the health of marine mammals, although for the most part, the impacts are just starting to be understood (Reijnders et al. 2008). Section 3.4.3 (Environmental Consequences) provides

an overview of these potential impacts, which include organ anomalies and impaired reproduction and immune function (Reijnders et al. 2008).

If the health of an individual marine mammal were compromised by long-term exposure to pollutants, it is possible that this condition could alter the animal's expected response to stressors associated with Alternatives 1 and 2. The behavioral and physiological responses of any marine mammal to a potential stressor, such as underwater sound, could be influenced by a number of other factors, including disease, dietary stress, body burden of toxic chemicals, energetic stress, percentage body fat, age, reproductive state, size, and social position. Synergistic impacts are also possible. For example, animals exposed to some chemicals may be more susceptible to noise-induced loss of hearing sensitivity (Fechter 2005). While the response of a previously stressed animal might be different than the response of an unstressed animal, there are no data available at this time to accurately predict how stress caused by various ocean pollutants would alter a marine mammal's response to stressors associated with Alternatives 1 and 2.

4.4.6.2.6 Commercial Fishing

Several commercial fisheries operate in the Study Area. Potential impacts from these activities include marine mammal injury and mortality from bycatch and entanglement. Fisheries have also resulted in profound changes to the structure and function of marine ecosystems that adversely affect marine mammals.

Eleven ports in Southern California contain both commercial and commercial passenger fishing vessel (commercial passenger fishing vessel; i.e., recreational) fishing fleets that use the ocean areas within the SOCAL Range Complex portion of the Study Area (U.S. Department of the Navy 2009). Commercial fishing occurs throughout the SOCAL Range Complex from near shore waters adjacent to the mainland and offshore islands, to offshore banks (e.g., Tanner and Cortes Banks), and waters in between. In recent years, the overall number of commercial fishing vessels has decreased which has been attributed to changes in environmental conditions, fishing regulations, and market forces (California Department of Fish and Game 2008a, b).

Between 1990 and 1999, the annual mean bycatch of marine mammals in U.S. fisheries was more than 6,000 animals, and most of these were killed in gill-net fisheries (Read et al. 2006). The impacts of bycatch on marine mammal populations vary based on removal rates, population size, and reproductive rates. Small populations with relatively low reproductive rates are most susceptible. Bycatch rates for about 12 percent of U.S. marine mammal stocks (almost all cetaceans) exceed their potential biological removal levels (Read 2008). The potential biological removal level is the number of animals that can be removed each year without preventing a stock from reaching or maintaining its optimal sustainable population level.

As discussed in Section 3.4.3.5 (Entanglement Stressors), entanglement in fishing gear is another major threat to marine mammals in the Study Area. In addition, overfishing of many fish stocks has resulted in significant changes in trophic structure, species assemblages, and pathways of energy flow in marine ecosystems (Jackson et al. 2001; Myers and Worm 2003; Pauly et al. 1998). These ecological changes may have important and likely adverse consequences for populations of marine mammals (DeMaster et al. 2001).

In summary, future commercial fishing activities in the Study Area are expected to result in significant impacts on some marine mammal species based on the relatively high injury and mortality rates

associated with bycatch and entanglement. This mortality could result in or contribute to population declines for some species. Ecological changes brought about by commercial fishing are also expected to adversely impact marine mammals in the Study Area.

Along the U.S. west coast from 1982 to 2010 there have been 272 reported entangled whales (Saez et al. 2012). Entanglements were seen throughout the coast with concentrations near areas where there is higher human population. Identified entangling gear types have included: trap/pot, bottom set longline, and gillnets. Gillnets were the entangling gear type in the majority of reports pre-2000 (64 percent) and trap/pot are the majority post-2000 (45 percent). In the late 1990s, California gillnet regulations changed resulting in a shift and reduction of gillnet fishing effort. Gray and humpback whales are the most frequently reported entangled large whale species along the U.S. West. In California, there were a reported 150 gray whales, 47 humpback whales, 27 unidentified whales, 14 sperm whales, 6 minke whales, and 3 fin whales entangled in fishing gear (Saez et al. 2012). National Marine Fisheries Service provided the Navy with a further breakdown of 16 reported whale fishing gear entanglements within parts of Southern California overlapped by the Navy's SOCAL Range Complex from 2000 to 2011: 8 gray whales (50.0 percent), 3 humpback whales (18.8 percent), 2 unidentified whales (12.5 percent), 2 sperm whales (12.5 percent), and 1 fin whale (6.3 percent) (Saez 2012). National Marine Fisheries Service cautioned that these data represent locations where whales were sighted entangled and may or may not be near the actual location where the entanglement first occurred.

4.4.6.3 Cumulative Impacts on Marine Mammals

The current aggregate impacts of past, present actions and reasonably foreseeable future actions are expected to result in significant impacts on some marine mammal species in the Study Area. The impacts are considered significant because vessel strikes, bycatch, and entanglement associated with other actions are expected to result in relatively high rates of injury and mortality that could cause population declines in some species. Alternatives 1 and 2 could also result in injury and mortality to individuals of some marine mammal species from underwater explosions, sonar, and vessel strikes. Injury and mortality that might occur under Alternatives 1 and 2 would be additive to injury and mortality associated with other actions. However, the relative contribution of the Proposed Action to the overall injury and mortality would be low compared to other actions. While quantitative estimates of marine mammal mortality from other actions are not available, bycatch for cetaceans and pinnipeds in the United States accounted for 4,146 mortalities in 1999 (Read et al. 2006). Some of these mortalities likely occurred in the Study Area or affected individuals that used the Study Area seasonally.

Ocean noise associated with other actions (see Section 4.4.6.2.4, Ocean Noise) and acoustic stressors (underwater explosions and sonar) associated with Alternatives 1 and 2 could also result in additive behavioral impacts on marine mammals. Other future actions such as construction and operation of liquefied natural gas terminals, and wave and tidal energy facilities would be expected to result in MMPA Level B harassment. However, it is unlikely that these actions and underwater explosions or sonar use would overlap in time and space because these activities are dispersed and the sound sources are intermittent. Furthermore, most of these other actions are not compatible with or could interfere with training and testing activities that involve underwater explosions and sonar use. The Navy takes appropriate coordination and scheduling steps (described in Section 3.11, Socioeconomic Resources) to avoid activities that interfere with or are not compatible with training and testing.

It is likely that distant shipping noise, which is more universal and continuous, and sound associated with underwater explosions and sonar would overlap in time and space. However, there is no evidence

indicating that the co-occurrence of shipping noise and sounds associated with underwater explosions and sonar use would result in harmful additive impacts on marine mammals.

As discussed in Section 4.4.6.2.5 (Ocean Pollution), the potential also exists for the impacts of ocean pollution and acoustic stressors associated with Alternatives 1 and 2 to be additive or synergistic. It is possible that the response of a previously stressed animal would be more severe than the response of an unstressed animal.

In summary, based on the analysis presented in Section 3.4 (Marine Mammals) the current aggregate impacts of past and present actions and reasonably foreseeable future actions are expected to result in significant impacts on some marine mammal species in the Study Area. Therefore, cumulative impacts on marine mammals would be significant without consideration of the impacts of Alternatives 1 or 2. Alternatives 1 and 2 would contribute to and increase cumulative impacts, but the relative contribution would be low compared to other actions. Further analysis of cumulative impacts on marine mammals is not warranted.

4.4.7 SEA TURTLES

4.4.7.1 Impacts of Alternatives 1 and 2 That May Contribute to Cumulative Impacts

Impacts of Alternatives 1 and 2 that might contribute to cumulative impacts on sea turtles include mortality, injury, and short-term disturbance or behavioral modification. Mortality or injury could be caused by underwater explosions or vessel strikes. Injury, in the form of PTS, could also be caused by sonar use. Noninjurious impacts of underwater explosions and sonar use would include short-term disturbance or behavioral modification. The Navy's Endangered Species Act (ESA) determinations presented in Table 3.5-14 are "no effect" or "may affect, not likely to adversely affect" for the remaining stressors analyzed in Section 3.5 (Sea Turtles). The incremental contribution of these remaining stressors to cumulative impacts on sea turtles would be negligible. Therefore, these stressors are not considered further in the cumulative impacts analysis. The impacts of Alternatives 1 and 2 considered in the cumulative impacts analysis are summarized in Table 3.5-14 (Summary of Effects and Impact Conclusions: Sea Turtles).

4.4.7.2 Impacts of Other Actions

The potential impacts of other actions that are relevant to the cumulative impact analysis for sea turtles include the following:

- Mortality associated with vessel strikes, bycatch in fisheries, entanglement, and stressors associated with coastal development and human use of coastal environments (e.g., beach vehicular driving, power plant entrainment [sea turtles being caught in power plant outflow water], etc.)
- Injury associated with vessel strikes, bycatch, entanglement, and underwater sound
- Disturbance, behavioral modifications, and reduced animal fitness associated with underwater noise
- Reduced animal fitness associated with ocean pollution
- Habitat loss related to coastal development

Most of the other actions and considerations retained for analysis in Chapter 3, Section 3.5 (Sea Turtles) would include operation of marine vessels. Exceptions include the actions listed under environmental regulations and planning. Stressors associated with marine vessel operations that are of primary

concern for the cumulative impacts analysis includes vessel strikes and underwater noise. Many of the actions would also result in underwater noise from sources other than vessels. Rather than discussing these stressors for individual actions, their aggregate impacts are considered below as "other environmental considerations" in maritime traffic (Section 4.4.6.2.3, Maritime Traffic and Vessel Strikes) and ocean noise (Section 4.4.6.2.4, Ocean Noise). Similarly, many of the actions would result in ocean pollution. The aggregate impacts of water pollution are addressed below in the ocean pollution section (see Section 4.4.6.2.5, Ocean Pollution). Bycatch is associated with commercial fishing, and the primary cause of entanglement is commercial fishing. Therefore, these stressors are discussed below in the commercial fishing section (Section 4.4.6.2.6, Commercial Fishing).

4.4.7.2.1 Surveillance Towed Array Sensor System Low Frequency Active Sonar

Sea turtles could be affected if they are inside the mitigation zone (180 dB sound field) during a Surveillance Towed Array Sensor System Low Frequency Active Sonar transmission. However, because received levels from Surveillance Towed Array Sensor System Low Frequency Active Sonar operations would be below 180 dB sound pressure level within 12 nm or greater distance of any coastlines and offshore biologically important areas, effects on a sea turtle stock could occur only if a significant portion of the stock encountered the Surveillance Towed Array Sensor System Low Frequency Active Sonar vessel in the open ocean. The potential for Surveillance Towed Array Sensor System Low Frequency Active Sonar operations to expose sea turtle stocks to injurious (nonauditory or PTS) sound levels or to cause TTS or behavioral changes is considered negligible because
(U.S. Department of the Navy 2011b):

- Most sea turtle species inhabit the earth's oceanic temperate zones, where sound propagation is predominantly characterized by downward refraction (higher transmission loss, shorter range), rather than ducting (lower transmission loss, longer range), which is usually found in cold-water regimes.
- Sea turtle distribution and density are generally low at ranges greater than 12 nm from the coast.
- The Surveillance Towed Array Sensor System Low Frequency Active Sonar signal has a narrow bandwidth (approximately 30 Hz).
- The ship is always moving, and the system has a low duty cycle (estimated 7.5 percent), which means sea turtles would have less opportunity to be in the mitigation zone during a transmission.
- Visual monitoring mitigation is incorporated into the alternatives.

4.4.7.2.2 Maritime Traffic and Vessel Strikes

Maritime traffic has increased over the past 50 years, and continued increases are expected in the future. Vessel strikes have been and will continue to be a cause of sea turtle mortality and injury throughout portions of the Study Area where sea turtles regularly occur. Because of the wide dispersal of large vessels in open ocean areas and the widespread, scattered distribution of turtles at sea, strikes during open-ocean transits are unlikely.

Some vessel strikes would cause temporary reversible impacts, such as diverting the turtle from its previous activity or causing minor injury. A National Research Council report qualitatively ranked the relative importance of various mortality factors for sea turtles. Vessel strikes were ranked 10th, behind leading factors of shrimp trawling and other fisheries (National Research Council 1990). Major strikes would cause permanent injury or death from bleeding, infection, or inability to feed. Apart from the

severity of the physical strike, the likelihood and rate of a turtle's recovery from a strike may be influenced by its age, reproductive state, and general condition. Much of what is written about recovery from vessel strikes is inferred from observing individuals some time after a strike. Numerous living sea turtles bear scars that appear to have been caused by propeller cuts or collisions with vessel hulls (Hazel et al. 2007, Lutcavage et al. 1997), suggesting that not all vessel strikes are lethal. Conversely, fresh wounds on some stranded animals may strongly suggest a vessel strike as the cause of death. The actual incidence of recovery versus death is not known, given available data.

4.4.7.2.3 Ocean Noise

Potential impacts on sea turtles from ocean noise include behavioral reactions, hearing loss in the form of TTS or PTS, auditory masking, injury, and mortality. Section 3.4.3.1 (Acoustic Stressors) discusses these and other possible impacts of ocean noise on marine mammals.

4.4.7.2.4 Ocean Pollution

Marine debris can also be a problem for sea turtles through entanglement or ingestion. Sea turtles can mistake debris for prey; one study found 37 percent of dead leatherbacks to have ingested various types of plastic (Mrosovsky et al. 2009). Other marine debris, including abandoned fishing gear and cargo nets, can entangle and drown turtles in all life stages.

4.4.7.2.5 Commercial Fishing

Bycatch is one of the most serious threats to the recovery and conservation of sea turtle populations (National Research Council 1990, Wallace et al. 2010). Among fisheries that incidentally capture sea turtles, certain types of trawl, gillnet, and longline fisheries generally pose the greatest threat. One comprehensive study estimated that worldwide, 447,000 turtles are killed each year from bycatch in commercial fisheries (Wallace et al. 2010).

Other fisheries that result in sea turtle bycatch in the Study Area include pelagic fisheries for swordfish, tuna, shark, and billfish; purse seine fisheries for tuna; commercial and recreational rod and reel fisheries; gillnet fisheries for shark; driftnet fisheries; and bottom longline fisheries (National Marine Fisheries Service 2009).

4.4.7.2.6 Coastal Development

Coastal development and increased human populations in coastal areas will continue to have impacts on sea turtles such as nesting beach habitat degradation, beach vehicular driving, beach lighting, power plant entrainment, and degradation of nearshore water quality and seagrass beds (see Section 3.5, Sea Turtles, for more information on impacts on sea turtles).

4.4.7.2.7 Cumulative Impacts on Sea Turtles

The current aggregate impacts of past, present and reasonably foreseeable future actions are expected to result in impacts on sea turtles. These aggregate impacts include those from bycatch, vessel strikes, entanglement and other stressors associated with other actions, which are expected to result in high rates of injury and mortality that could cause population declines to ESA-listed species or inhibit species recovery. Alternatives 1 and 2 could also result in injury and mortality to individual sea turtles from underwater explosions, sonar, and vessel strikes. Injury and mortality that might occur under Alternatives 1 and 2 would be additive to injury and mortality associated with other actions. However, the relative contribution of Alternatives 1 and 2 to the overall injury and mortality would be low

compared to other actions. A total of four potential sea turtle mortalities per year are estimated for the No Action Alternative and five for Alternatives 1 and 2 (see Tables 3.5-9 through 3.5-13).

Ocean noise associated with other actions and acoustic stressors (underwater explosions and sonar) associated with Alternatives 1 and 2 could also result in additive behavioral impacts on sea turtles. Other future actions such as construction and operation of liquefied natural gas terminals, and wave and tidal energy facilities would be expected to result in similar impacts. However, it is unlikely that these actions and underwater explosions or sonar use would overlap in time and space because all of these activities are widespread and the sound sources are intermittent. Furthermore, most of these other actions are not compatible with or could interfere with training and testing activities that involve underwater explosions and sonar use. The Navy takes appropriate steps to avoid activities that interfere with or are not compatible with training and testing.

It is likely that distant shipping noise (which is more pervasive and continuous) and sound associated with underwater explosions and sonar would overlap in time and space. However, there is no evidence indicating that the co-occurrence of shipping noise and sounds associated with underwater explosions and sonar use would result in harmful additive impacts on sea turtles.

The potential also exists for the impacts of ocean pollution and acoustic stressors associated with Alternatives 1 and 2 to be additive or synergistic. It is possible that the response of a previously stressed animal would be more severe than the response of an unstressed animal. However, there are no data indicating that a sea turtle affected by ocean pollution would be more susceptible to stressors associated with Alternatives 1 and 2.

In summary, based upon the analysis in Section 3.5 (Sea Turtles) past and present actions and reasonably foreseeable future actions are expected to result in impacts on sea turtles. Therefore, impacts on sea turtles would occur without consideration of the impacts of Alternatives 1 and 2. Alternatives 1 and 2 would contribute to and increase cumulative impacts, but the relative contribution would be low compared to other actions. Further analysis of cumulative impacts on sea turtles is not warranted.

4.4.8 SEABIRDS

The analysis in Section 3.6 (Seabirds) indicates that birds could be affected by acoustic stressors (tactical acoustic sonar, other acoustic devices, pile driving, underwater explosions, weapons firing noise, aircraft noise, vessel noise), energy stressors (electromagnetic, lasers), physical disturbance and strikes (aircraft, vessels and in-water devices, military expended materials), and ingestion (military expended materials). Potential responses would include a startle response, which includes short-term behavioral (i.e., movement) and physiological components (i.e., increased heart rate). Recovery from the impacts of most stressor exposures would occur quickly, and impacts would be localized. Some stressors, including underwater explosions, physical strikes, and ingestion of military expended materials, could result in mortality. However, the number of individual birds affected would be low, and no population-level impacts are expected. The impacts of Alternatives 1 and 2 would be cumulative with other actions that cause short-term behavioral and physiological impacts and mortality to birds, such as ingestion and entanglement in marine debris. However, the incremental contribution of Alternatives 1 or 2 to cumulative impacts on birds would be low for the following reasons:

- Most of the proposed activities would be widely dispersed in offshore areas where bird distribution is patchy and concentrations of individuals are low. Therefore, the potential for

interactions between birds and training and testing activities is low. It is unlikely that training and testing activities would influence nesting because most activities take place in water and away from nesting habitats on land. Alternatives 1 and 2 would not result in destruction or loss of nesting habitat.

- For most stressors, impacts would be short term and localized, and recovery would occur quickly.
- While a limited amount of mortality could occur, no population level impacts would be expected.
- Alternatives 1 and 2 are not likely to adversely affect ESA-listed bird species.

Based on the analysis in Section 3.6 (Seabirds) and the reasons summarized above, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be negligible. Further analysis of cumulative impacts on birds is not warranted.

4.4.9 MARINE VEGETATION

The analysis presented in Section 3.7 (Marine Vegetation) indicates that marine vegetation could be affected by acoustic stressors (underwater explosions) and physical stressors (interactions with vessels and in-water devices, military expended materials, or seafloor devices). Potential impacts include localized disturbance and mortality. Recovery would occur quickly, and population level impacts are not anticipated. The impacts of Alternatives 1 or 2 would be cumulative with other actions that cause disturbance and mortality of marine vegetation. However, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be low for the following reasons:

- Most of the proposed activities would occur in areas where seagrasses and other attached marine vegetation do not grow.
- Impacts would be localized, recovery would occur quickly, and no population level impacts would be expected.
- Alternatives 1 and 2 would not result in impacts that have been historically significant to marine vegetation. For example, Alternatives 1 and 2 would not increase nutrient loading, which can cause algal blooms, decrease light penetration, and impact photosynthesis of seagrasses. Furthermore, Alternatives 1 and 2 would not result in long-term or widespread changes in environmental conditions, such as turbidity, salinity, pH, or water temperature that could impact marine vegetation.
- The Proposed Action would have no effect on ESA-listed species of marine vegetation and would not result in the destruction or adverse modification of critical habitat.

Based on the analysis presented in Section 3.7 (Marine Vegetation) and the reasons summarized above, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be low. Further analysis of cumulative impacts on marine vegetation is not warranted.

4.4.10 MARINE INVERTEBRATES

The analysis presented in Section 3.8 (Marine Invertebrates), indicates that marine invertebrates could be affected by acoustic stressors (tactical acoustic sonar, other acoustic devices, pile driving, underwater explosions, weapons firing noise, aircraft noise, vessel noise), electromagnetic stressors, physical disturbance or strikes (vessels and in-water devices, military expended materials, seafloor devices), entanglement (fiber-optic cables and guidance wires, parachutes), and ingestion (military expended materials). Potential impacts include short-term behavioral and physiological responses. Some stressors

could also result in injury or mortality to a relatively small number of individuals, but not to ESA-listed corals. No population-level impacts are anticipated. Stressors from Alternatives 1 and 2 would have no effect or would be not likely to adversely affect ESA-listed corals.

Based upon the analysis in Section 3.8 (Marine Invertebrates) the invertebrate mortality impacts of Alternatives 1 and 2 would be cumulative with other actions that cause mortality (e.g., commercial fishing). However, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be negligible. Therefore, further analysis of cumulative impacts on marine invertebrates is not warranted.

4.4.11 FISH

The analysis presented in Section 3.9 (Fish) indicates that fishes could be affected by acoustic stressors (tactical acoustic sonar, other acoustic devices, pile driving, underwater explosions, weapons firing noise, aircraft noise, vessel noise), electromagnetic stressors, physical disturbance or strikes (vessels and in-water devices, military expended materials, seafloor devices), entanglement (fiber-optic cables and guidance wires, parachutes), and ingestion (military expended materials). Potential impacts include short-term behavioral and physiological responses. Some stressors could also result in injury or mortality to a relatively small number of individuals, but not to ESA-listed fishes. No population level impacts are anticipated. Stressors from Alternatives 1 and 2 would have no effect or would be not likely to adversely affect ESA-listed fishes.

Based upon the analysis presented in Section 3.9 (Fish), the fish mortality impacts of Alternatives 1 and 2 would be cumulative with other actions that cause mortality (e.g., commercial fishing). However, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be negligible. Therefore, further detailed analysis of cumulative impacts on fishes is not warranted.

4.4.12 CULTURAL RESOURCES

4.4.12.1 Impacts of Alternatives 1 and 2 That May Contribute to Cumulative Impacts

As discussed in Section 3.10 (Cultural Resources), no impacts on submerged prehistoric sites or previously unidentified submerged historic resources are expected. Testing and training would continue only in areas currently utilized for these activities. As a result, effects on cultural resources are not anticipated within U.S. territorial waters because measures have been previously implemented to protect these resources.

The Navy routinely avoids locations of known obstructions to prevent damage to sensitive Navy equipment and vessels and to ensure the accuracy of training and testing exercises. Known obstructions include some historic shipwrecks.

4.4.12.2 Impacts of Other Actions

With a few exceptions, most of the other actions retained for cumulative impacts analysis (see Table 4.3-1) would involve some form of disturbance to the ocean bottom. Exceptions include environmental regulations and planning actions, ocean pollution, and most forms of ocean noise. Actions that would disturb the ocean bottom could impact submerged cultural resources. For example, ocean bottom disturbance would occur from construction related activities such as installation of offshore natural gas terminals and pipelines, ship anchoring, and installation of wind turbine piers and excavation of cable trenches. Any physical disturbance on the continental shelf and ocean floor could inadvertently damage or destroy submerged prehistoric sites and submerged historic resources. Excavation such as pipeline

installation for liquefied natural gas terminals could disrupt the horizontal patterning and vertical stratigraphy of submerged prehistoric sites and submerged historic resources.

The other actions that result in ocean bottom disturbance require some form of federal authorization or permitting. Therefore, requirements of the National Historic Preservation Act apply to actions in territorial waters. Federal agency procedures have been implemented to identify cultural resources, avoid impacts, and mitigate if impacts cannot be avoided. For example, the Bureau of Ocean Energy Management, Regulation and Enforcement has procedures in place to identify the probability for the presence of submerged historic resources and the locations submerged prehistoric sites shoreward from the 148 ft. (45.1 m) isobath, and for project redesign and relocation to avoid identified resources (Minerals Management Service 2007).

4.4.12.3 Cumulative Impacts on Cultural Resources

Impacts on submerged cultural resources from other actions would typically be avoided or mitigated through implementing federal agency programs. Disturbance or destruction of submerged prehistoric sites would diminish the overall archaeological record and decrease the potential for meaningful research on Paleoindian (late Pleistocene) and Early Archaic (early Holocene) occupations. Disturbance or destruction of submerged historic sites, including shipwrecks, would diminish the overall record for these resources and decrease the potential for meaningful research on these resources. Based upon the analysis in Section 3.10 (Cultural Resources), when considered with other actions, Alternatives 1 and 2 would contribute to and increase the cumulative impacts on submerged prehistoric and historic resources. Further analysis of cumulative impacts on cultural resources is not warranted.

4.4.13 Socioeconomics

The analysis in Section 3.11 (Socioeconomic Resources) indicates that the impacts of Alternatives 1 and 2 on socioeconomic resources would be negligible. Alternatives 1 and 2 are not expected to contribute incrementally to cumulative socioeconomic impacts. Therefore, further analysis of cumulative impacts on socioeconomic resources is not warranted.

4.4.14 Public Health and Safety

The analysis presented in Section 3.12 (Public Health and Safety) indicates that the impacts of Alternatives 1 and 2 on public health and safety would be negligible. Alternatives 1 and 2 are not expected to contribute incrementally to cumulative health and safety impacts. Therefore, further analysis of cumulative impacts on public health and safety is not warranted.

4.5 Summary of Cumulative Impacts

Marine mammals and sea turtles are the primary resources of concern for cumulative impacts analysis:

- Past human activities have impacted these resources to the extent that several marine mammal species and all sea turtles species occurring in the Study Area are ESA-listed.
- These resources would be impacted by multiple ongoing and future actions.
- Explosive detonations and vessel strikes under the No Action Alternative, Alternative 1, and Alternative 2 have the potential to disturb, injure, or kill marine mammals and sea turtles.

The aggregate impacts of past, present, and other reasonably foreseeable future actions are expected to result in significant impacts on some marine mammal and all sea turtle species in the Study Area. The No Action Alternative, Alternative 1, or Alternative 2 would contribute to cumulative impacts, but the

relative contribution would be low compared to other actions. Compared to potential mortality, strandings, or injury resulting from Navy training and testing activities, marine mammal and sea turtle mortality and injury from bycatch, commercial vessel ship strikes, entanglement, ocean pollution, and other human causes are estimated to be orders of magnitude greater (hundreds of thousands of animals versus tens of animals) (Culik 2004, International Council for the Exploration of the Sea 2005, Read et al. 2006).

The analyses presented in this chapter and Chapter 3 (Affected Environment and Environmental Consequences) indicate that the incremental contribution of the No Action Alternative, Alternative 1, or Alternative 2 to cumulative impacts on sediments and water quality, air quality, marine habitats, birds, marine vegetation, marine invertebrates, fish, socioeconomic resources, and public health and safety would be negligible. When considered with other actions, the No Action Alternative, Alternative 1, or Alternative 2 might contribute to cumulative impacts on submerged prehistoric and historic resources, if such resources are present in areas where bottom-disturbing training and testing activities take place. The No Action Alternative, Alternative 1, or Alternative 2 would also make an incremental contribution to greenhouse gas emissions, representing approximately 0.030 percent, 0.031 percent, and 0.031 percent of U.S. 2009 greenhouse gas emissions, respectively.

REFERENCES

Andrew, R. K., Howe, B. M. & Mercer, J. A. (2002). Ocean ambient sound: Comparing the 1960s with the 1990s for a receiver off the California coast. *Acoustics Research Letters Online, 3*(2). 10.1121/1.1461915.

Berman-Kowalewski, M., Gulland, F. M. D., Wilkin, S., Calambokidis, J., Mate, B., Cordaro, J., Dover, S. (2010). Association Between Blue Whale (*Balaenoptera musculus*) Mortality and Ship Strikes Along the California Coast. *Aquatic Mammals, 36*(1), 59-66. 10.1578/am.36.1.2010.59

Betz, S., Bohnsack, K., Callahan, A. R., Campbell, L. E., Green, S. E. & Labrum, K. M. (2011). *Reducing the Risk of Vessel Strikes to Endangered Whales in the Santa Barbara Channel: An Economic Analysis and Risk Assessment of Potential Management Scenarios.* (A group project submitted in partial satisfaction of the requirements for the degree of Master of Environmental Science and Management). Bren School of Environmental Science & Management, University of California, Santa Barbara.

Boesch, D., Anderson, D., Horner, R., Shumway, S., Tester, P. & Whitledge, T. (1997). Harmful Algal Blooms in Coastal Waters: Options for Prevention, Control and Mitigation *Special Joint Report with the National Fish and Wildlife Foundation*. (pp. 61) National Oceanic and Atmospheric Administration.

Bureau of Ocean Energy Management. (2011). Proposed Outer Continental Shelf Oil & Gas Leasing Program 2012-2017. (pp. 217) U.S. Department of the Interior.

California Department of Fish and Game. (2008a). Average Annual Commercial Landings of Fish and Invertebrates and Value Within the SOCAL Range (2002-2007).

California Department of Fish and Game. (2008b). Digest of California Fishing Laws and Licensing Requirements.

Center for Climate and Energy Solutions. (2012). Hydrokinetic Electric Power Generation. [Fact Sheet]. Retrieved from http://www.c2es.org/technology/factsheet/Hydrokinetic, March 4, 2012.

Connolly, N., Buchanan, C., O'Connell, M., Cronin, M., O'Mahony, C. & Sealy, H. (2001). Assessment of Human Activity in the Coastal Zone A research project linking Ireland and Wales M. Institute (Ed.), *Maritime INTERREG Series*. (pp. 136) Coastal Resources Centre.

Council on Environmental Quality. (1997). Considering Cumulative Effects Under the National Environmental Policy Act. (pp. 5).

Culik, B. (2004). Review of Small Cetaceans Distribution, Behaviour, Migration and Threats. (pp. 343) United National Environment Programme (UNEP) and the Secretariate of the Convention on the Conservation of Migratory Species of Wild Animals.

Davison, P. & Asch, R. G. (2011). Plastic ingestion by mesopelagic fishes in the North Pacific Subtropical Gyre. *Marine Ecological Progress Series, 432*, 173-180.

DeMaster, D. P., Fowler, C. W., Perry, S. L. & Richlen, M. F. (2001). Predation and competition: The impact of fisheries on marine-mammal populations over the next one hundred years. *Journal of Mammalogy, 82*(3), 641–651.

Department of Defense. (2012). Operational Energy Strategy: Implementation Plan. (pp. 28). Washington, D.C. Prepared by Assistant Secretary of Defense for Operational Energy Plans & Programs.

Environmental and Energy Study Institute. (2009). Navy Announces Goals to Reduce Energy Demand, Increase Renewable Supply. In *Educating Congress on energy efficiency and renewable energy; advancing innovative policy solutions,*. Retrieved from http://www.eesi.org/102609_navy

Fechter, L. D. (2005). Ototoxicity. *Environmental Health Perspectives, 113*(7), 443–444.

Federal Energy Regulatory Commission. (2011). Existing and proposed terminals. Retrieved from http://ferc.gov/industries/gas/indus-act/lng.asp, 2011, September 16.

Gerstein, E. R. (2002). Manatees, bioacoustics and boats: hearing tests, environmental measurements and acoustic phenomena may together explain why boats and animals collide. *American Scientist, 90*(2), 154-163. doi: 10.1511/2002.2.154

Harriott, V. J. (2002). Marine tourism impacts and their management on the Great Barrier Reef C. R. R. Centre (Ed.). (pp. 41). Research Centre, Townsville: James Cook University. Available from www.reef.crc.org.au

Hazel, J., Lawler, I., Marsh, H. & Robson, S. (2007, October). Vessel speed increases collision risk for the green turtle *Chelonia mydas*. [Electronic Version]. *Endangered Species Research, 3*, 105-113. Retrieved from www.int-res.com

Hildebrand, J. (2004). Sources of Anthropogenic Sound in the Marine Environment, *International Policy Workshop on Sound and Marine Mammals* (pp. 38). London.

Intergovernmental Panel on Climate Change. (2007). Technical Summary.

International Council for the Exploration of the Sea. (2005). Ad-Hoc Group on the Impact of Sonar on Cetaceans. (pp. 50).

Jackson, J. B. C., Kirby, M. X., Berger, W. H., Bjorndal, K. A., Botsford, L. W., Bourque, B. J, Warner, R. R. (2001, July 27). Historical Overfishing and the Recent Collapse of Coastal Ecosystems. *Science, 293*. Retrieved from www.sciencemag.org

Kildow, J. & Colgan, C. S. (2005). California's Ocean Economy Report to the Resources Agency, State of California *National Ocean Economics Program*. (pp. 167). Prepared by The National Ocean Economics Program.

Lack, D., Cappa, C. & Langridge, J. (2011). Impact of Fuel Quality Regulation and Speed Reductions on Shipping Emissions: Implications for Climate and Air Quality. *Environmental Science & Technology*. 10.1021/es2013424

Laist, D. W., Knowlton, A. R., Mead, J., Collet, A. & Podesta, M. (2001). Collisions between ships and whales. *Marine Mammal Science, 17*(1), 35-75.

Laist, D. W. & Shaw, C. (2006). Preliminary evidence that boat speed restrictions reduce deaths of Florida manatees. *Marine Mammal Science, 22*(2), 472-479. doi:10.1111/j.1748-7692.2006.00027.x

Law, K. L., Moret-Ferguson, S., Maximenko, N. A., Proskurowski, G., Peacock, E. E., Hafner, J. & Reddy, C. M. (2010, September 3). Plastic accumulation in the North Atlantic subtropical gyre. [Research Support, Non-U.S. Gov't Research Support, U.S. Gov't, Non-P.H.S.]. *Science, 329*(5996), 1185-1188. 10.1126/science.1192321 Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/20724586

Le Treut, H., Somerville, R., Cubasch, U., Ding, Y., Mauritzen, C., Mokssit, A., Prather, M. (2007). Historical Overview of Climate Change Science. In: S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (Eds.), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 36). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Lutcavage, M., Plotkin, P., Witherington, B. & Lutz, P. (1997). Human impacts on sea turtle survival. In P. Lutz and J. A. Musick (Eds.), *The Biology of Sea Turtles* (Vol. 1, pp. 387–409). Boca Raton, FL: CRC Press.

Mato, Y., Isobe, T., Takada, H., Kanehiro, H., Ohtake, C. & Kaminuma, T. (2001). Plastic Resin Pellets as a Tranport Medium for Toxic Chemicals in the Marine Environment. *Environmental Science Technology, 35*, 318-324.

Merriam-Webster. (2012). Definition of NONAUDITORY. Retrieved from www.merriam-webster.com

Minerals Management Service. (2007). Gulf of Mexico OCS oil and gas lease sales: 2007–2012. Volume I: Chapters 1–8 and appendices. MMS 2007-018.

Mrosovsky, N., Ryan, G. D. & James, M. C. (2009). Leatherback turtles: The menace of plastic. *Marine Pollution Bulletin, 58*(2), 287-289. doi: 10.1016/j.marpolbul.2008.10.018

Myers, R. A. & Worm, B. (2003). Rapid worldwide depletion of predatory fish communities. *Nature, 423*, 280–283.

National Marine Fisheries Service. (2006). Marine debris: Impacts in the Gulf of Mexico.

National Marine Fisheries Service. (2009). Endangered Species Act Section 7 consultation: Biological opinion for U.S. Navy activities in the Northeast, Virginia Capes, Cherry Point, and Jacksonville.

National Marine Fisheries Service. (2011a). Unpublished data- California ship strike stranding records 1988-June 2011. Email from Ms. Sarah Wilkin, Regional Stranding Coordinator, Southwest Regional Office, Office of Protected Resources, National Marine Fisheries Service.

National Marine Fisheries Service. (2011b). Unpublished data- Hawaii ship strike stranding records Feb 2009- Feb 2010. Email from Regional Stranding Coordinator, Pacific Islands Regional Office, Office of Protected Resources, National Marine Fisheries Service.

National Oceanic and Atmospheric Administration. (2011a, Last updated September 12). NOAA-led study: Air pollution caused by ships plummets when vessels shift to cleaner, low-sulfur fuels.

National Oceanic and Atmospheric Administration. (2011b, Last updated 21 April 2011). Ocean, Great lakes and Coastal Research. In *Innovate, Incubate, Integrate NOAA Research,*. Retrieved from http://www.research.noaa.gov/oceans/, March 19, 2012.

National Oceanic and Atmospheric Administration. (2012). Overview of Marine Mammal Permits. In *Marine Mammal Permits and Authorizations*. Retrieved from http://www.nmfs.noaa.gov/pr/permits/mmpa_permits.htm, March 16, 2012.

National Research Council. (1990). *Monitoring Southern California's Coastal Waters* (pp. 15). Washington, D.C.: National Academy Press.

National Research Council of the National Academies. (2003). Ocean Noise and Marine Mammals. In Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals (Ed.), *Ocean Noise and Marine Mammals* (pp. 24): National Research Council of the National Academies.

National Research Council of the National Academies. (2005). Marine Mammal Populations and Ocean Noise Determining when Noise Causes Biologically Significant Effects. In National Research Council of the National Academies (Ed.). Washington DC: The National Academies Press.

Nowacek, D., Johnson, M. & Tyack, P. (2004). North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting stimuli. *Proceedings of the Royal Society of London, 271*(B), 227-231. 10.1098/rspb.2003.2570

Nowacek, D., Thorne, L. H., Johnston, D. & Tyack, P. (2007). Responses of cetaceans to anthropogenic noise. *Mammal Review, 37*(2), 81-115.

Ocean Conservation Society. (2012a). L.A. Dolphin Project 1. In *Los Angeles Dolphin Project Bottlenose Studies,*. Retrieved from http://www.oceanconservation.org/research/ladpone.htm, March 19, 2012.

Ocean Conservation Society. (2012b). L.A. Dolphin Project 2. In *Los Angeles Dolphin Project Aggregations,*. Retrieved from http://www.oceanconservation.org/research/ladptwo.htm, March 19, 2012.

Ocean Conservation Society. (2012c). L.A. Dolphin Project 3. In *Los Angeles Dolphin Project Pollution Studies,*. Retrieved from http://www.oceanconservation.org/research/ladpthree.htm, March 19, 2012.

Pacific Fishery Management Council. (2011, Last updated 22 March 2011). Wave, Tidal, and Offshore Wind Energy. In *Habitat and Communities*. Retrieved from http://www.pcouncil.org/habitat-and-communities/wave-tidal-and-offshore-wind-energy/

Paige, P. (2009). SECNAV Outlines Five 'Ambitious' Energy Goals, *U.S. Navy Today*.

Pauly, D., Christensen, V., Guenette, S., Pitcher, T. J., Sumaila, U. R., Walters, C. J., Zeller, D. (1998). Towards sustainability in world fisheries. *Nature, 418*, 689–695.

Read, A. J. (2008). The looming crisis: Interactions between marine mammals and fisheries. *Journal of Mammalogy, 89*(3), 541-548.

Read, A. J., Drinker, P. & Northridge, S. (2006). Bycatch of marine mammals in U.S. and global fisheries. *Conservation Biology, 20*(1), 163–169.

Reijnders, P. J. H., Aguilar, A. & Borrell, A. (2008). Pollution and marine mammals. In W. F. Perrin, B. Wursig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 890-898). San Diego, CA: Academic Press.

Richardson, W. J., Greene, C. R., Jr., Malme, C. I. & Thomson, D. H. (1995). Marine Mammals and Noise (pp. 576). San Diego, CA: Academic Press.

Saez, L. (2012). National Marine Fisheries Service.

Saez, L., Lawson, D., DeAngelis, M., Wilkin, S., Petras, E. & Fahy, C. (2012). Co-occurrence of Large Whales and Fixed Commercial Fishing Gear: California, Oregon, and Washington (Poster), *Southern California Marine Mammal Workshop*. Newport Beach, California.

Scripps Institution of Oceanography. (2012a, Last updated 11 January 2012). Around the Pier: Government Funding Supports New Scripps Ship and Vital Seagoing Research. Retrieved from http://explorations.ucsd.edu/around-th-pier/2012/around-th-pier-government-funding-su... March 19, 2012.

Scripps Institution of Oceanography. (2012b, Last updated 27 February 2012). Cables Spanning Pacific Ocean Seafloor to Give Ocean Science a New Edge. Retrieved from http://scrippsnews.ucsd.edu/Releases/?releaseID-1248, March 19, 2012.

Scripps Institution of Oceanography. (2012c, Last updated 28 February 2012). Navy Selects Shipyard to Build Scripps' New State-of-the-art Research Vessel. Retrieved from http://scrippsnews.ucsd.edu/Releases/?releaseID=1249, March 19, 2012.

Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, R., Greene, C., Tyack, P. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals, 33*(4), 122.

Tyack, P. (2009a). Acoustic playback experiments to study behavioral responses of free-ranging marine animals to anthropogenic sound. *Marine Ecology Progress Series, 395*, 13. 10.3354/meps08363

Tyack, P. (2009b). Human-generated sound and marine mammals. *Physics Today*, 39–44.

U.S. Department of the Navy. (2008a). Fact Sheet - Submarine Drive-In Magnetic Silencing Facility (MSF) Beckoning Point, Oahu, Hawaii: Naval Facilities Engineering Command, Hawaii.

U.S. Department of the Navy. (2008b). Submarine Drive-In Magnetic Silencing Facility (MSF) Beckoning Point, Oahu, Hawaii [Fact Sheet]. Naval Facilities Engineering Command.

U.S. Department of the Navy. (2009). Southern California (SOCAL) Fisheries Study: Catch Statistics (2002-2007), Fishing Access, and Fishermen Perception. Newport. Prepared by N. U. W. Center.

U.S. Department of the Navy. (2010). Navy Climate Change Roadmap Task Force Climate Change and Oceanographer of the Navy (Eds.). (pp. 28).

U.S. Department of the Navy. (2011a). Cumulative Impacts. In *Draft Environmental Impact Statement Basing of MV-22 and H-1 Aircraft in Support of III MEF Elements in Hawaii* (pp. 40).

U.S. Department of the Navy. (2011b). Draft Supplemental Environmental Impact Statement/Supplemental Oversea Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar. (pp. 372).

U.S. Department of the Navy. (2011c). Environmental Assessment and Finding of No Significant Impacts Helicopter Wings Realignment and MH-60R/S Helicopter Transition Naval Base Cornado, California. (pp. 321) U.S. Fleet Forces Command.

U.S. Department of the Navy. (2011d). Environmental Assessment MCON P-327 Pier 12 Replacement and Dredging Naval Base San Diego. (pp. 190). Prepared by Naval Facilities Engineering Command Southwest.

U.S. Department of the Navy. (2011e). Environmental Impact Statement for the Basing of MV-22 and H-1 Aircraft in Support of III Marine Expeditionary Force Elements in Hawaii *Fact Sheet*. (pp. 4).

U.S. Department of the Navy. (2012a). National Environmental Policy Act (NEPA) Environmental Assessment for the Proposed Installation and Operation of a Deep-Water Wave Energy Test Site Off North Beach at Marine Corps Base Hawaii (MCBH) Kaneohe Bay, Oahu, Hawaii. (pp. 7). Prepared by Commander Naval Facilities Engineering Services Center.

U.S. Department of the Navy. (2012b). Navy Publishes Notice of Availability of the Draft Environmental Assesment for Homeporting Littoral Combat Ships on the West Coast. (pp. 2). Prepared by Commander Navy Region Soutwest Public Affairs Office.

U.S. Environmental Protection Agency. (2011). Nonpoint source pollution. Retrieved from http://www.epa.gov/reg3wapd/nps/index.htm, 2011, January 31.

U.S. Environmental Protection Agency. (2012). DRAFT Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010. (pp. 470).

Union of Concerned Scientists. (2008). How Hydrokinetic Energy Works. In *Clean Energy*. Retrieved from http://www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/how_

Vanderlaan, A. S. & Taggart, C. T. (2009). Efficacy of a Voluntary Area to Be Avoided to Reduce Risk of Lethal Vessel Strikes to Endangered Whales. *Conservation Biology, 23*(6), 1467-1474. 10.1111/j.1523-1739.2009.01329x

Wallace, B. P., Lewison, R. L., McDonald, S. L., McDonald, R. K., Kot, C. Y., Kelez, S., Crowder, L. B. (2010). Global patterns of marine turtle bycatch. *Conservation Letters, xx*, 1-12. doi: 10.1111/j.1755-236x.2010.00105.x

Wartzok, D. (2009). Marine mammals and ocean noise. In J. H. Steele, K. K. Turekian and S. A. Thorpe (Eds.), *Encyclopedia of Ocean Sciences* (2nd ed., Vol. 3, pp. 628-634). Boston, MA: Academic Press.

Würsig, B. & Richardson, W. J. (2008). Noise, effects of. In W. F. Perrin, B. Wursig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 765-773). San Diego, CA: Academic Press.

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5 Standard Operating Procedures, Mitigation, and Monitoring

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5 STANDARD OPERATING PROCEDURES, MITIGATION, AND MONITORING

This chapter describes the United States (U.S.) Department of the Navy (Navy) standard operating procedures, mitigation measures, and marine species monitoring and reporting efforts. Standard operating procedures are essential to maintaining safety and mission success, and in many cases have the added benefit of reducing potential environmental impacts. Mitigation measures are designed to help reduce or avoid potential impacts on marine resources. Marine species monitoring efforts are designed to track compliance with take authorizations, evaluate the effectiveness of mitigation measures, and improve understanding of the impacts of training and testing activities on marine resources within the Hawaii-Southern California Training and Testing (HSTT) Study Area (Study Area).

5.1 STANDARD OPERATING PROCEDURES

Effective training, maintenance, research, development, testing, and evaluation (hereafter referred to collectively as the Proposed Action) require that participants utilize their sensors and weapon systems to their optimum capabilities as required by the activity objectives. The Navy currently employs standard practices to provide for the safety of personnel and equipment, including vessels and aircraft, as well as the success of the training and testing activities. For the purpose of this document, the Navy will refer to standard practices as standard operating procedures. Because of their importance for maintaining safety and mission success, standard operating procedures have been considered as part of the Proposed Action under each alternative, and therefore are included in the Chapter 3 (Affected Environment and Environmental Consequences) environmental analyses for each resource.

Navy standard operating procedures have been developed and refined over years of experience, and are broadcast via numerous naval instructions and manuals, including the following sources:

- Ship, submarine and aircraft safety manuals
- Ship, submarine and aircraft standard operating manuals
- Fleet Area Control and Surveillance Facility range operating instructions
- Fleet exercise publications and instructions
- Naval Sea Systems Command test range safety and standard operating instructions
- Navy instrumented range operating procedures
- Naval shipyard sea trial agendas
- Research, development, test and evaluation plans
- Naval gunfire safety instructions
- Navy planned maintenance system instructions and requirements
- Federal Aviation Administration regulations

In many cases there are incidental environmental, socioeconomic, and cultural benefits resulting from standard operating procedures. Standard operating procedures serve the primary purpose of providing for safety and mission success, and are implemented regardless of their secondary benefits. This is what distinguishes standard operating procedures, which are a component of the Proposed Action, from mitigation measures, which are designed entirely for the purpose of reducing environmental impacts resulting from the Proposed Action. Because standard operating procedures are crucial to safety and mission success, the Navy will not modify them as a way to further reduce impacts on environmental resources. Rather, mitigation measures will be used as the tool for avoiding and reducing potential

environmental impacts. Standard operating procedures that are recognized as providing a potential secondary benefit are provided below.

5.1.1 VESSEL SAFETY

For the purposes of this chapter, the term 'ship' is inclusive of surface ships and surfaced submarines. The term 'vessel' is inclusive of ships and small boats (e.g., rigid-hull inflatable boats).

Ships operated by or for the Navy have personnel assigned to stand watch at all times, day and night, when moving through the water (underway). Watch personnel undertake extensive training in accordance with the U.S. Navy Lookout Training Handbook or civilian equivalent, including on-the-job instruction and a formal Personal Qualification Standard program (or equivalent program for supporting contractors or civilians), to certify that they have demonstrated all necessary skills (such as detection and reporting of floating or partially submerged objects). Watch personnel are composed of officers, enlisted men and women, and civilian equivalents. Their duties may be performed in conjunction with other job responsibilities, such as navigating the ship or supervising other personnel. While on watch, personnel employ visual search techniques, including the use of binoculars, using a scanning method in accordance with the U.S. Navy Lookout Training Handbook or civilian equivalent. After sunset and prior to sunrise, watch personnel employ night visual search techniques, which could include the use of night vision devices.

A primary duty of watch personnel is to detect and report all objects and disturbances sighted in the water that may be indicative of a threat to the ship and its crew, such as debris, a periscope, surfaced submarine, or surface disturbance. Per safety requirements, watch personnel also report any marine mammals sighted that have the potential to be in the direct path of the ship as a standard collision avoidance procedure. Because watch personnel are primarily posted for safety of navigation, range clearance, and man-overboard precautions, they are not normally posted while ships are moored to a pier. When anchored or moored to a buoy, a watch team is still maintained but with fewer personnel than when underway. When moored or at anchor, watch personnel may maintain security and safety of the ship by scanning the water for any indications of a threat (as described above).

While underway, Navy ships (with the exception of submarines) greater than 65 feet (ft.) (20 meters [m]) in length have at least two watch personnel; Navy ships less than 65 ft. (20 m) in length, surfaced submarines, and contractor ships have at least one watch person. While underway, watch personnel are alert at all times and have access to binoculars. Due to limited manning and space limitations, small boats do not have dedicated watch personnel, and the boat crew is responsible for maintaining the safety of the boat and surrounding environment.

All vessels use extreme caution and proceed at a "safe speed" so they can take proper and effective action to avoid a collision with any sighted object or disturbance, and can be stopped within a distance appropriate to the prevailing circumstances and conditions.

5.1.2 AIRCRAFT SAFETY

Pilots of Navy aircraft make every attempt to avoid large flocks of birds in order to reduce the safety risk involved with a potential bird strike.

5.1.3 LASER PROCEDURES

The following procedures are applicable to lasers of sufficient intensity to cause human eye damage.

5.1.3.1 Laser Operators

Only properly trained and authorized personnel operate lasers.

5.1.3.2 Laser Activity Clearance

Prior to commencing activities involving lasers, the operator ensures that the area is clear of unprotected or unauthorized personnel in the laser impact area by performing a personnel inspection or a flyover. The operator also ensures that any personnel within the area are aware of laser activities and are properly protected.

5.1.4 WEAPONS FIRING PROCEDURES

5.1.4.1 Notice to Mariners

A Notice to Mariners is routinely issued in advance of missile firing activities. A notice is also issued in advance of explosive bombing activities when they are conducted in an area that does not already have a standing Notice to Mariners. For activities involving large-caliber gunnery, the Navy evaluates the need to publish a Notice to Mariners based on the scale, location, and timing of the activity. More information on the Notices to Mariners is found in Section 3.12.2.1.1 (Sea Space).

5.1.4.2 Weapons Firing Range Clearance

The weapons firing hazard range must be clear of non-participating vessels and aircraft before firing activities will commence. The size of the firing hazard range is based on the farthest firing range capability of the weapon being used. All missile and rocket firing activities are carefully planned in advance and conducted under strict procedures that place the ultimate responsibility for range safety on the Officer Conducting the Exercise or civilian equivalent. All weapons firing is secured when cease fire orders are received from the Range Safety Officer or when the line of fire is endangering any object other than the designated target.

Pilots of Navy aircraft are not authorized to expend ordnance, fire missiles, or drop other airborne devices through extensive cloud cover where visual clearance of the air and surface area is not possible. The two exceptions to this requirement are: (1) when operating in the open ocean, air, and surface clearance through visual means or radar surveillance is acceptable; and (2) when the operational commander conducting the exercise accepts responsibility for the safeguarding of airborne and surface traffic.

During activities that involve recoverable targets (e.g., aerial drones), the Navy recovers the target and any associated parachutes to the maximum extent practicable consistent with operational requirements and personnel safety.

5.1.4.3 Target Deployment Safety

Firing exercises involving the integrated maritime portable acoustic scoring system are typically conducted in daylight hours in Beaufort number 4 conditions or better to ensure safe operating conditions during buoy deployment and recovery. The Beaufort sea state scale is a standardized measurement of the weather conditions, based primarily on wind speed. The scale is divided into levels from 0 to 12, with 12 indicating the most severe weather conditions (e.g., hurricane force winds). At Beaufort number 4, wave heights typically range from 3.5 to 5 ft. (1 to 1.5 m).

5.1.5 Swimmer Defense Testing Procedures

5.1.5.1 Notice to Mariners

A Notice to Mariners is issued in advance of all swimmer defense testing.

5.1.5.2 Swimmer Defense Testing Clearance

A daily in situ calibration of the source levels is used to establish a clearance area to the 145 decibels (dB) referenced to (re) 1 micro (µ) Pascal (Pa) sound pressure level threshold for non-participant personnel safety. A hydrophone is stationed during the calibration sequences in order to confirm the clearance area. Small boats patrol the 145 dB re 1 µPa sound pressure level area during all test activities. Boat crews are equipped with binoculars and remain vigilant for non-participant divers and boats, swimmers, snorkelers, and dive flags. If a non-participating swimmer, snorkeler, or diver is observed entering into the area of the swimmer defense system, the power levels of the defense system are reduced. An additional 100-yard (yd.) (91 m) buffer is applied to the initial sighting location of the non-participant as an additional precaution. If the area cannot be maintained free of non-participating swimmers, snorkelers, and divers, testing will cease until the non-participant has moved outside the area.

5.1.6 Unmanned Aerial and Underwater Vehicle Procedures

For activities involving unmanned aerial and underwater vehicles, the Navy evaluates the need to publish a Notice to Airmen or Mariners based on the scale, location, and timing of the activity. Unmanned aerial vehicles and unmanned aerial systems are operated in accordance with Federal Aviation Administration air traffic organization policy as issued in Office of the Chief of Naval Operations Instructions 3710, 3750, and 4790.

5.1.7 Towed In-Water Device Procedures

Prior to deploying a towed device from a manned platform, there is a standard operating procedure to search the intended path of the device for any floating debris (e.g., driftwood) or other potential obstructions (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies] and animals), which have the potential to cause damage to the device.

5.2 Introduction to Mitigation

The Navy recognizes that the Proposed Action has the potential to impact the environment. Unlike standard operating procedures, which are established for reasons other than environmental benefit, mitigation measures are modifications to the Proposed Action that are implemented for the sole purpose of reducing a specific potential environmental impact on a particular resource. The procedures discussed in this chapter, most of which are currently or were previously implemented as a result of past environmental compliance documents, Endangered Species Act (ESA) Biological Opinions, Marine Mammal Protection Act (MMPA) Letters of Authorization, or other formal or informal consultations with regulatory agencies, have been coordinated with the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service through the consultation and permitting processes.

5.2.1 Regulatory Requirements for Mitigation

An Environmental Impact Statement (EIS) must analyze the affected environment, discuss the environmental impacts of the Proposed Action and each alternative, and assess the significance of the impacts on the environment. Mitigation measures are designed to help reduce the severity or intensity of impacts of the Proposed Action. Assessment of mitigation measures can occur early in the planning

process. An agency may choose not to take the action or to move the location of the action. Mitigation measure development also occurs throughout the analysis process whenever an impact is minimized by limiting the degree or magnitude of the action or its implementation. Mitigation measures can also include actions that repair, rehabilitate, or restore the affected environment or reduce impacts over time through constant monitoring and corrective adjustments.

In accordance with the National Environmental Policy Act (NEPA) requirement, the environmental benefit of all Navy recommended proposed mitigation measures will apply to all alternatives analyzed in this Final EIS, and according to Navy policy, will also apply to the Final Overseas Environmental Impact Statement (OEIS) where applicable and appropriate. Additionally, the White House Council on Environmental Quality issued guidance for mitigation and monitoring on 14 January 2011. This guidance affirms that federal agencies, including the Navy, should:

- commit to mitigation in decision documents when they have based environmental analysis upon such mitigation (by including appropriate conditions on grants, permits, or other agency approvals, and making funding or approvals for implementing the Proposed Action contingent on implementation of the mitigation commitments);
- monitor the implementation and effectiveness of mitigation commitments;
- make information on mitigation and monitoring available to the public, preferably through agency web sites; and
- remedy ineffective mitigation when the federal action is not yet complete.

The Council on Environmental Quality guidance encourages federal agencies to develop internal processes for post-decision monitoring to ensure the implementation and effectiveness of the mitigation. It also states that federal agencies may use adaptive management as part of an agency's action. Adaptive management, when included in the NEPA analysis, allows for the agency to take alternate mitigation actions if mitigation commitments originally made in the planning and decision documents fail to achieve projected environmental outcomes. Adaptive management generally involves four phases: plan, act, monitor, and evaluate. This process allows the use of the results to update knowledge and adjust future management actions accordingly. Through implementing mitigation measures from the Navy's previous planning, consultations, permits, and monitoring of those efforts, the Navy has collected data to further refine its recommended mitigation measures.

Through the planning, consultation, and permitting processes, federal regulatory agencies suggested that the Navy analyze additional mitigation measures for inclusion in this Final EIS/OEIS and associated consultation and permitting documents. Proposals for additional mitigation measures were based on the federal agency's assessment of the likelihood that such measures will contribute to a notable reduction of the environmental impact. As additional measures were identified, the effectiveness and operational assessment protocols discussed in Section 5.3 (Mitigation Assessment) were applied to determine whether the Navy would recommend the additional measures for implementation. The final suite of mitigations resulting from the ongoing planning, consultation, and permitting processes will be documented in the Navy and NMFS Records of Decision, the MMPA Letters of Authorization, and the ESA Biological Opinions.

5.2.2 Overview of Mitigation Approach

This section describes the approach the Navy took to develop its recommended mitigation measures. The Navy's overall approach to assessing potential mitigation measures was based on two principles: (1) mitigations will be effective at reducing potential impacts on the resource, and (2) from a military

perspective, the mitigations are practical to implement, executable, and personnel safety and readiness will not be impacted. The assessment process involved using information directly from Chapter 3 (Affected Environment and Environmental Consequences) and assessing all existing mitigation and proposals for new or modified mitigation in order to determine if recommending a mitigation measure for implementation would be appropriate.

This document organized, and where appropriate, analyzed training and testing activities separately. This separation was needed because the training and testing communities perform activities for differing purposes, and in some cases, with different personnel and in different locations. For example, there is a fundamental difference between the testing of a new mine warfare system with civilian scientists and engineers, and the eventual training of sailors and aviators with that same system. As such, mitigations that the Navy recommends for both training and testing activities are presented together, while mitigations that are designed for and executable only by the training or testing community are presented separately.

5.2.2.1 Lessons Learned from Previous Environmental Impact Statements/Overseas Environmental Impact Statements

In an effort to improve upon past processes, the Navy considered all mitigations previously implemented and adapted its mitigation assessment approach based on lessons learned from previous EISs, ESA Biological Opinions, MMPA Letters of Authorizations, and other formal or informal consultations with regulatory agencies. For example, one lesson learned during the development of the Hawaii Range Complex EIS/OEIS was that relocation of activities was not possible due to a number of factors. The Navy considered reduction or elimination of training in the Hawaii Range Complex, but determined that the amount and cost of travel to other range complexes to fulfill training requirements would result in an unacceptable increase in time away from the homeport. Additionally, the Hawaii Range Complex offers an invaluable facility on which to conduct training and testing in a realistic environment.

Navy planners, scientists, and the operational community assessed the effectiveness of a full suite of potential mitigation measures (a portion of which were specific mitigation areas) on a case-by-case basis, using information and lessons learned from the Navy's internal adaptive management process. The resulting assemblage of recommended measures is comprised of currently implemented measures, modifications of currently implemented measures, and newly proposed measures. Details on the assessment methods are provided in Section 5.2.3 (Assessment Method). The rationale for recommending, modifying, adding, or discontinuing each measure is provided in Section 5.3 (Mitigation Assessment).

5.2.2.2 Protective Measures Assessment Protocol

The Protective Measures Assessment Protocol is a decision support and situational awareness software tool that the Navy uses to facilitate compliance with mitigation measures when conducting certain training and testing activities at sea. The Navy runs the Protective Measures Assessment Protocol program during the event planning process to ensure that personnel involved in the activity are aware of the mitigation requirements and to help ensure that all mitigations are implemented appropriately. In addition to providing notification of the required mitigation, the tool also provides a visual display of the activity location, unit's position in relation to the target area, and any relevant environmental data. The final suite of mitigation measures contained in the Navy and NMFS Records of Decision, the MMPA Letters of Authorization, and the ESA Biological Opinions will be integrated into the Protective Measures Assessment Protocol. Section 5.3.1.1.1.1 (United States Navy Afloat Environmental Compliance Training

Series) contains information about the newly developed Protective Measures Assessment Protocol training module.

5.2.3 ASSESSMENT METHOD

As shown in Figure 5.2-1, the Navy undertook an effectiveness assessment and operational assessment for each potential mitigation measure to ensure its compatibility with Section 5.2.2 (Overview of Mitigation Approach). The Navy used information from published and readily available sources, as well as Navy after-action and monitoring reports. When available, these data were used when they represented the best available science and if they were generally accepted by the scientific community to ensure that they were applicable and contributed to the analysis.

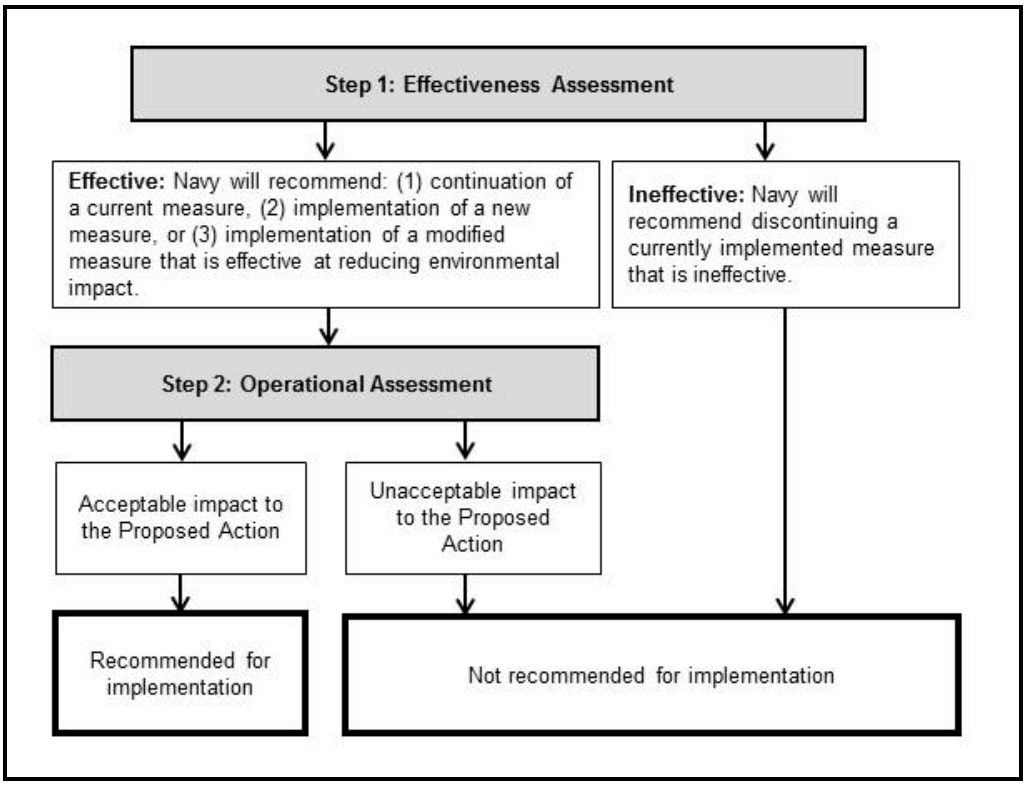

Figure 5.2-1: Flowchart of Process for Determining Recommended Mitigation Measures

5.2.3.1 Effectiveness Assessment

5.2.3.1.1 Procedural Measures

Procedural measures could involve employing techniques or technology during a training or testing activity in order to avoid or reduce a potential impact on a particular resource. For the purposes of organization, procedural measures are discussed within two subcategories: Lookouts and mitigation zones.

A proposed procedural measure was deemed effective if implementing the measure was likely to result in avoidance or reduction of an impact on a resource. The level of avoidance or reduction of the impact gained from implementing a procedural measure was weighed against the potential for a shift in impacts resulting from the activity modification. For example, if predictive modeling results indicate that the use of underwater explosives could cause unacceptable impacts on a particular resource; those

impacts could possibly be reduced by substituting non-explosive activities for explosive activities. However, if the increased use of non-explosive activities would consequently produce an unacceptable impact on habitats due to an associated physical disturbance or strike risk from military expended materials, the measure would not necessarily be justifiable.

A proposed procedural measure was deemed ineffective if its implementation would not result in avoidance or reduction of an impact on a resource, or if an unacceptable impact will simply be shifted from one resource to another. For ineffective procedural measures that are currently being implemented, the rationale for terminating, modifying, or continuing to carry out the measure is included in the discussion.

5.2.3.1.2 Mitigation Areas

In order to avoid or reduce a potential impact on a particular resource the Navy would either limit the time of day or duration in which a particular activity could take place, or move or relocate a particular activity outside of a specific geographic area. Within mitigation areas, the measures would only apply to the specific activity that resulted in the requirement for mitigation, and would not prevent or restrict other activities from occurring during that time or in that area.

A proposed mitigation area was deemed effective if implementing the measure would likely result in avoidance or reduction of the impact on the resource. The specific season, time of day, or geographic area must be important to the resource. In determining importance, special consideration was given to time periods or geographic areas having characteristics such as especially high overall density or percent population use, seasonal bottlenecks for a migration corridor, and identifiable key foraging and reproduction areas.

Avoidance or reduction of the impact in the specific time period or geographic area was weighed against the potential for causing new impacts in alternative time periods or geographic areas. For example, if the use of underwater explosives was predicted to cause unacceptable impacts on a particular resource in a known foraging location, those impacts could possibly be reduced by relocating those activities to a new location. However, if the use of explosives at the new location would consequently produce an unacceptable impact on the same or a different resource at the new location, the measure would not necessarily be justifiable.

A proposed mitigation area was deemed ineffective if implementing the measure would not result in avoidance or reduction of an impact on a resource, or if an unacceptable impact would simply be shifted from one time period or location to another. For ineffective mitigation areas that are currently being implemented, the rationale for terminating, modifying, or continuing to carry out the measure is included in the discussion.

5.2.3.2 Operational Assessment

The Navy conducted the operational assessment for procedural measures and proposed mitigation areas using the criteria described below. The Navy deemed procedural and mitigation area measures to have acceptable operational impacts on a particular proposed activity if the following conclusions were reached:

1. Implementation of the measure will not increase safety risks to Navy personnel and equipment.

2. Implementation of the measure is practical. Practicality was defined by the following factors:
    - The measure does not result in an unacceptable increase in resource requirements (e.g., wear and tear on equipment, additional fuel, additional personnel, increased training or testing requirements, or additional reporting requirements).
    - The measure does not result in an unacceptable increase in time away from homeport for Navy personnel.
    - The measure does not result in national security concerns. Should national security require conducting more than the designated number of activities, or a change in how the Navy conducts those activities, the Navy reserves the right to provide the regulatory federal agency with prior notification and include the information in any associated exercise or monitoring reports.
    - The measure is consistent with Navy policy. Navy policy requires that mitigation measures are developed through consultation with regulatory agencies (e.g., the MMPA and ESA processes), would likely result in avoidance or reduction of an impact on a resource as determined by the effectiveness assessment, and would not negatively impact training and testing fidelity. This policy applies to the full suite of potential mitigation measures that the Navy assessed, including measures that were considered but eliminated, and as appropriate, to currently implemented measures that the Navy is no longer recommending to implement.

3. Implementation of the measure will not result in an unacceptable impact on the effectiveness of the military readiness activity. A primary factor that was considered for all mitigation measures is that the measure must not modify the activity in a way that no longer allows the activity to meet the intended objectives, and ultimately must not interfere with the Navy meeting all of its military readiness requirements. Specifically, for mitigation area measures, the following additional factors were considered:
    - The activity is not dependent on a specific range or range support structure within the mitigation area and there are alternate areas with the necessary environmental conditions (e.g., oceanographic conditions).
    - The mitigation area does not hold any current or foreseeable future readiness value. This assessment will be revisited if Navy operations or national security interests conclude that training or testing needs to occur within the mitigation area.
    - Implementation of the measure will not prohibit conducting shipboard maintenance, repair, and testing pierside prior to at-sea operations.

4. The Navy has legal authority to implement the measure.

If all four of the conditions above can be achieved, then the Navy will recommend the mitigation measure for implementation.

5.3 Mitigation Assessment

The effectiveness and operational assessments resulted in potential mitigation measures being organized into the following four sections:

- Section 5.3.1 (Lookout Procedural Measures) includes recommended measures specific to the use of Lookouts or trained marine species observers.

- Section 5.3.2 (Mitigation Zone Procedural Measures) includes recommended measures specific to visual observations with a mitigation zone.
- Section 5.3.3 (Mitigation Areas) includes recommended measures specific to particular locations.
- Section 5.3.4 (Mitigation Measures Considered but Eliminated) includes measures that the Navy does not recommended for implementation due to the measure being ineffective at reducing environmental impacts, having an unacceptable operational impact, or being incompatible with Section 5.2.2 (Overview of Mitigation Approach).

A summary of the Navy recommended measures is provided in Table 5.4-1.

5.3.1 LOOKOUT PROCEDURAL MEASURES

As described in Section 5.1 (Standard Operating Procedures), ships have personnel assigned to stand watch at all times while underway. Watch personnel may perform watch duties in conjunction with job responsibilities that extend beyond looking at the water or air (such as supervision of other personnel). This section will introduce Lookouts, who perform similar duties to watch personnel and whose duties satisfy safety of navigation and mitigation requirements.

The Navy will have two types of Lookouts for the purposes of conducting visual observations: (1) those positioned on ships, and (2) those positioned in aircraft or on small boats. Lookouts positioned on ships will be dedicated solely to diligent observation of the air and surface of the water. They will have multiple observation objectives, which include but are not limited to detecting the presence of biological resources and recreational or fishing boats, observing the mitigation zones described in Section 5.3.2 (Mitigation Zone Procedural Measures), and monitoring for vessel and personnel safety concerns.

Due to aircraft, small boat manning and space restrictions, Lookouts positioned in aircraft or on small boats may include the aircraft crew, pilot, or boat crew. Lookouts positioned in aircraft and small boats may be responsible for tasks in addition to observing the air or surface of the water (e.g., navigation of a helicopter or small boat). However, aircraft and small boat Lookouts will, considering personnel safety, practicality of implementation, and impact on the effectiveness of the activity, comply with the observation objectives described above for Lookouts positioned on ships.

The procedural measures described below primarily consist of having Lookouts during specific training and testing activities.

5.3.1.1 Specialized Training

5.3.1.1.1 Training for Navy Personnel and Civilian Equivalents

5.3.1.1.1.1 United States Navy Afloat Environmental Compliance Training Series

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to continue implementing the Marine Species Awareness Training for watch personnel and Lookouts, and to add the requirement for additional Navy personnel and civilian equivalents to complete one or more environmental training modules.

The Navy has developed the U.S. Navy Afloat Environmental Compliance Training Series to help ensure Navy-wide compliance with environmental requirements, and to help Navy personnel gain a better understanding of their personal roles and responsibilities. The training series contains four interactive

multimedia training modules. Personnel will be required to complete all modules identified in their career path training plan.

The first module is the Introduction to the U.S. Navy Afloat Environmental Compliance Training Series. The introduction module provides information on environmental laws (e.g., ESA and MMPA) and responsibilities relevant to Navy training and testing activities. The material is put into context of why environmental compliance is important to the Navy, from the most junior sailor to Commanding Officers. All personnel completing the U.S. Navy Marine Species Awareness Training will also be required to take this module.

The second module is the U.S. Navy Marine Species Awareness Training. Consistent with current requirements, all bridge watch personnel, Commanding Officers, Executive Officers, maritime patrol aircraft aircrews, anti-submarine warfare helicopter crews, civilian equivalents, and Lookouts will successfully complete the Marine Species Awareness Training prior to standing watch or serving as a Lookout. The module contained within the U.S. Navy Environmental Compliance Training Series is an update to the current Marine Species Awareness Training version 3.1. The updated training is designed to improve the effectiveness of visual observations for marine resources, including marine mammals and sea turtles. The Marine Species Awareness Training provides information on sighting cues, visual observation tools and techniques, and sighting notification procedures.

The third module is the U.S. Navy Protective Measures Assessment Protocol. The Protective Measures Assessment Protocol is a decision support and situational awareness software tool that the Navy uses to facilitate compliance with worldwide mitigation measures during the conduct of training and testing activities at sea. The module provides instruction for generating and reviewing Protective Measures Assessment Protocol reports. Section 5.2.2.2 (Protective Measures Assessment Protocol) contains additional information on the benefits of the software tool.

The fourth module is the U.S. Navy Sonar Positional Reporting System and marine mammal incident reporting. The Navy developed the Sonar Positional Reporting System as its official record of underwater sound sources (e.g., active sonar) used under its MMPA permits. Marine mammal incidents include vessel strikes and animal strandings. The module provides instruction on the reporting requirements and procedures for both the Sonar Positional Reporting System and marine mammal incident reporting.

Effectiveness and Operational Assessment

Navy personnel undergo extensive training in order to stand watch. Standard training includes on-the-job instruction under the supervision of experienced personnel, followed by completion of the Personal Qualification Standard program. The Personal Qualification Standard program certifies that personnel have demonstrated the skills needed to stand watch, such as detecting and reporting floating or partially submerged objects.

The U.S. Navy Afloat Environmental Compliance Training Series, including the updated Marine Species Awareness Training, is a specialized multimedia training program designed to help Navy operational and test communities best avoid potentially harmful interactions with marine species. The program provides training on how to sight marine species, focusing on marine mammals. The training also includes instruction for visually identifying sea turtles, concentrations of floating vegetation (*Sargassum* or kelp paddies), jellyfish aggregations, and flocks of seabirds, which are often indicators of marine mammal or sea turtle presence. The Marine Species Awareness Training also addresses the role that watch

personnel and Lookouts play in helping the Navy maintain compliance with environmental protection requirements, as well as supporting Navy environmental stewardship commitments.

In summary, the Navy believes that the U.S. Navy Afloat Environmental Compliance Training Series, including the updated Marine Species Awareness Training, is the best and most appropriate forum for teaching watch personnel and Lookouts about their responsibilities for helping reduce impacts on the marine environment. The Marine Species Awareness Training provides the Navy with invaluable training for a relatively large number of personnel. Constantly shifting personnel assignments presents a real challenge; however, the format and structure of the U.S. Navy Afloat Environmental Compliance Training Series will help the Navy reduce costs during fiscally constrained periods and provide constant access to training. Overall, the Marine Species Awareness Training is an effective tool for improving the potential for Lookouts to detect marine species while on duty.

Implementation of the Marine Species Awareness Training has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.1.2 Lookouts

The Navy proposes to use one or more Lookouts during the training and testing activities described below, which are organized by stressor category. A comparison of the currently implemented mitigation measures and recommended mitigation measures are provided where applicable. The effectiveness and operational assessments are discussed for all Lookout measures collectively in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts) and Section 5.3.1.2.5 (Operational Assessment for Lookouts). A number of training and testing activities involve the participation of multiple vessels and aircraft, which could ultimately increase the cumulative number of personnel standing watch per standard operating procedures or Lookouts posted in the vicinity of the activity (e.g., sinking exercises). The following sections discuss the minimum number of Lookouts that the Navy will use during each activity.

5.3.1.2.1 Acoustic Stressors – Non-Impulsive Sound

5.3.1.2.1.1 Low-Frequency and Hull-Mounted Mid-Frequency Active Sonar

Mitigation measures do not currently exist for low-frequency active sonar sources analyzed in this Final EIS/OEIS, or new platforms or systems. The Navy is proposing to (1) add mitigation measures for low-frequency active sonar and new platforms and systems, and (2) maintain the number of Lookouts currently implemented for ships using hull-mounted mid-frequency active sonar. The recommended measures are provided below.

Ships using low-frequency or hull-mounted mid-frequency active sonar sources associated with anti-submarine warfare and mine warfare activities at sea (with the exception of ships less than 65 ft. [20 m] in length and ships that are minimally manned) will have two Lookouts at the forward position. For the purposes of this document, low-frequency active sonar does not include Surveillance Towed Array Sensor System (SURTASS) Low-Frequency Active (LFA) sonar.

While using low-frequency or hull-mounted mid-frequency active sonar sources associated with anti-submarine warfare and mine warfare activities at sea, ships less than 65 ft. (20 m) in length, and ships that are minimally manned will have one Lookout at the forward position due to space and manning restrictions.

Ships conducting active sonar activities while moored or at anchor (including pierside) will maintain one Lookout.

5.3.1.2.1.2 High-Frequency and Non-Hull Mounted Mid-frequency Active Sonar

Mitigation measures do not currently exist for high-frequency active sonar activities associated with anti-submarine warfare and mine warfare, or for new platforms, such as the Littoral Combat Ship; therefore, the Navy is proposing to add a new measure for these activities or platforms. The Navy is proposing to continue using the number of Lookouts currently implemented for ships or aircraft conducting non-hull mounted mid-frequency active sonar, such as helicopter dipping sonar systems. The recommended measure is provided below.

The Navy will have one Lookout on ships or aircraft conducting high-frequency or non-hull mounted mid-frequency active sonar activities associated with anti-submarine warfare and mine warfare activities at sea.

5.3.1.2.2 Acoustic Stressors – Explosives and Impulsive Sound

5.3.1.2.2.1 Improved Extended Echo Ranging Sonobuoys

The Navy is proposing to continue using the number of Lookouts currently implemented for this activity. The Navy will have one Lookout in aircraft conducting improved extended echo ranging sonobuoy activities.

5.3.1.2.2.2 Explosive Sonobuoys Using 0.6–2.5 Pound Net Explosive Weight

Lookout measures do not currently exist for explosive sonobuoy activities using 0.6–2.5 pound (lb.) net explosive weight. The Navy is proposing to add this measure. Aircraft conducting explosive sonobuoy activities using 0.6–2.5 lb. net explosive weight will have one Lookout.

5.3.1.2.2.3 Anti-Swimmer Grenades

The Navy is proposing to continue using the number of Lookouts currently implemented for this activity. The Navy will have one Lookout on the vessel conducting anti-swimmer grenade activities.

5.3.1.2.2.4 Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices

As background, mine countermeasure and neutralization activities can be divided into two main categories: (1) general activities that can be conducted from a variety of platforms and locations, and (2) activities involving the use of diver-placed charges that typically occur close to shore. When either of these activities are conducted using a positive control firing device, the detonation is controlled by the personnel conducting the activity and is not authorized until the area is clear at the time of detonation.

The Navy is proposing to modify the number of Lookouts currently implemented for general mine countermeasure and neutralization activities using positive control firing devices to account for additional categories of net explosive weights. The recommended measures are provided below.

- During general mine countermeasure and neutralization activities under positive control using up to a 500 lb. net explosive weight detonation (bin E10 and below), vessels greater than 200 ft. (61 m) will have two Lookouts, while vessels less than 200 ft. (61 m) or aircraft will have one Lookout.

- During general mine countermeasure and neutralization activities under positive control using a 501–650 lb. net explosive weight (bin E11) detonation, the Navy will have two Lookouts (one positioned in an aircraft and one in a small boat.

The Navy is proposing to (1) continue using the number of Lookouts currently implemented for mine neutralization activities involving positive control diver-placed charges up to a 29 lb. or 250–500 lb. net explosive weight, and (2) extend the implementation of its current mitigation to all additional categories of net explosive weights. Mitigation measures for activities involving diver-placed charges under positive control do not currently exist for 30–249 lb. net explosive weight detonations. The recommended measures are provided below.

- During activities involving diver-placed mines under positive control, activities using up to a 500 lb. net explosive weight (bin E10) detonation will have a total of two Lookouts (one Lookout positioned on two small boats, or one small boat in combination with either a helicopter or shore-based. The shore-based observer would be stationed at an elevated on-shore position and would only be used during activities conducted in very shallow waters.
- All divers placing the charges on mines will support the Lookouts while performing their regular duties. The divers will report all marine mammal and sea turtle sightings to their supporting small boat or Range Safety Officer.

5.3.1.2.2.5 Mine Neutralization Activities Using Diver-Placed Time-Delay Firing Devices

As background, when mine neutralization activities using diver-placed charges (up to a 29 lb. net explosive weight) are conducted with a time-delay firing device, the detonation is fused with a specified time-delay by the personnel conducting the activity and is not authorized until the area is clear at the time the fuse is initiated. During these activities, the detonation cannot be terminated once the fuse is initiated due to human safety concerns.

Current mitigation involves the use of six Lookouts and three small boats (two Lookouts positioned in each of the three boats) for mitigation zones equal to or larger than 1,400 yd. (1,280 m), or four Lookouts and two small boats for mitigation zones smaller than 1,400 yd. (1,280 m). The Navy is proposing to modify the number of Lookouts currently used for mine neutralization activities using diver-placed time-delay firing devices because the measure is impractical to implement and is currently resulting in an unacceptable impact on military readiness. The Navy does not have the resources to maintain six Lookouts and three small boats during mine neutralization activities using diver-placed time-delay firing devices. Due to a lack of personnel and small boats available for this activity, the requirement for six Lookouts and three small boats would require reassigning personnel from other assigned duties or training activities, thus impacting the ability of the reassigned personnel to complete his or her assigned duties or other training requirements. Therefore, the Navy is currently unable to conduct the activities that require six Lookouts and three small boats, which is reducing the Navy's ability to maintain military readiness for these activities. Four Lookouts and two small boats represent the maximum level of effort that the Navy can commit to observing mitigation zones for this activity given the number of personnel and assets available. To prevent these unacceptable impacts, the Navy recommends the following measures:

During activities using up to a 29 lb. net explosive weight (bin E7) detonation, the Navy will have four Lookouts and two small boats (two Lookouts positioned in each of the two boats). In addition, when aircraft are used, the pilot or member of the aircrew will serve as an additional Lookout. All divers placing the charges on mines will support the Lookouts while performing their regular duties. The divers

will report all marine mammal and sea turtle sightings to their supporting small boat or Range Safety Officer.

5.3.1.2.2.6 Gunnery Exercises – Small- and Medium-Caliber Using a Surface Target

The Navy is proposing to continue using the number of Lookouts currently implemented for this activity. The Navy will have one Lookout on the vessel or aircraft conducting small- or medium-caliber gunnery exercises against a surface target.

5.3.1.2.2.7 Gunnery Exercises – Large-Caliber Using a Surface Target

The Navy is proposing to continue using the number of Lookouts currently implemented for this activity. The Navy will have one Lookout on the ship conducting large-caliber gunnery exercises against a surface target.

5.3.1.2.2.8 Missile Exercises (Including Rockets) up to 250 Pound Net Explosive Weight Using a Surface Target

The Navy is proposing to continue using the number of Lookouts currently implemented for this activity. When aircraft are conducting missile exercises up to 250 lb. net explosive weight against a surface target, the Navy will have one Lookout positioned in an aircraft.

5.3.1.2.2.9 Missile Exercises Using 251–500 Pound Net Explosive Weight Using a Surface Target

Lookout measures do not currently exist for missile exercises using 251–500 lb. net explosive weight. The Navy is proposing to add this measure. When aircraft are conducting missile exercises using 251–500 lb. net explosive weight against a surface target, the Navy will have one Lookout positioned in an aircraft.

5.3.1.2.2.10 Bombing Exercises

The Navy is proposing to continue using the number of Lookouts currently implemented for this activity. The Navy will have one Lookout positioned in an aircraft conducting bombing exercises.

5.3.1.2.2.11 Torpedo (Explosive) Testing

The Navy is proposing to continue using the number of Lookouts currently implemented for this activity. The Navy will have one Lookout positioned in an aircraft during torpedo (explosive) testing.

5.3.1.2.2.12 Sinking Exercises

The Navy is proposing to continue using the number of Lookouts currently implemented for this activity. The Navy will have two Lookouts (one positioned in an aircraft and one on a vessel) during sinking exercises.

5.3.1.2.2.13 At-Sea Explosive Testing

Lookout measures do not currently exist for at-sea explosive testing. The Navy is proposing to add this measure. The Navy will have a minimum of one Lookout on each vessel supporting at-sea explosive testing.

5.3.1.2.2.14 Elevated Causeway System – Pile Driving

The Navy is proposing to continue using the number of Lookouts currently implemented for this activity. The Navy will have one Lookout positioned on the platform (which could include the shore, an elevated causeway, or on a small boat) that will maximize the potential for sightings during pile driving and pile removal.

5.3.1.2.2.15 Weapons Firing Noise During Gunnery Exercises – Large-Caliber

The Navy is proposing to continue using the number of Lookouts currently implemented for this activity. The Navy will have one Lookout on the ship conducting explosive and non-explosive large-caliber gunnery exercises. This may be the same Lookout described in Section 5.3.1.2.2.7 (Gunnery Exercises – Large-Caliber Using a Surface Target) or Section 5.3.1.2.3.3 (Non-Explosive Practice Munitions – Small-, Medium-, and Large-Caliber Gunnery Exercises Using a Surface Target) when the large-caliber gunnery exercise is conducted from a ship against a surface target.

5.3.1.2.3 Physical Disturbance and Strike

5.3.1.2.3.1 Vessels

The Navy is proposing to clarify the mitigation measures currently implemented for this activity (including full power propulsion testing). While underway, vessels will have a minimum of one Lookout.

5.3.1.2.3.2 Towed In-Water Devices

The Navy is proposing to continue using the number of Lookouts currently implemented for activities using towed in-water devices (e.g., towed mine neutralization). The Navy will have one Lookout during activities using towed in-water devices when towed from a manned platform.

5.3.1.2.3.3 Non-Explosive Practice Munitions – Small-, Medium-, and Large-Caliber Gunnery Exercises Using a Surface Target

The Navy is proposing to continue using the number of Lookouts currently implemented for these activities. The Navy will have one Lookout during activities involving non-explosive practice munitions (e.g., small-, medium-, and large-caliber gunnery exercises) against a surface target.

5.3.1.2.3.4 Non-Explosive Practice Munitions – Bombing Exercises

The Navy is proposing to continue using the number of Lookouts currently implemented for these activities. The Navy will have one Lookout positioned in an aircraft during non-explosive bombing exercises.

5.3.1.2.3.5 Non-Explosive Practice Munitions – Missile Exercises (Including Rockets) Using a Surface Target

The Navy is proposing to continue using the number of Lookouts currently implemented for these activities. When aircraft are conducting non-explosive missile exercises (including exercises using rockets) against a surface target, the Navy will have one Lookout positioned in an aircraft.

5.3.1.2.4 Effectiveness Assessment for Lookouts

Personnel standing watch in accordance with Navy standard operating procedures have multiple job responsibilities. While on duty, these standard watch personnel often conduct marine species observation in addition to their primary job duties (e.g., aiding in the navigation of a vessel). By having one or more Lookouts dedicated solely to observing the air and surface of the water during certain training and testing activities, the Navy increases the likelihood that marine species will be detected. It is also important to note that a number of training and testing activities involve multiple vessels and aircraft, thereby increasing the cumulative number of Lookouts or watch personnel that could potentially be present during a given activity.

Although using Lookouts is expected to increase the likelihood that marine species will be detected at the surface of the water, it is unlikely that using Lookouts will be able to help avoid impacts on all species entirely due to the inherent limitations of sighting marine mammals and sea turtles, as discussed

in the sections below. Refer to Section 3.4.3.1.8 (Implementing Mitigation to Reduce Sound Exposures) for a quantitative discussion on the Navy's effectiveness assessment for Lookouts during sound-producing activities.

Pursuant to Phase I (e.g., Hawaii Range Complex EIS/OEIS) and in cooperation with NMFS, the Navy has undertaken monitoring efforts to track compliance with take authorizations, help evaluate the effectiveness of implemented mitigation measures, and gain a better understanding of the impacts of the Navy activities on marine resources. In 2010, the Navy initiated a study designed to evaluate the effectiveness of the Navy Lookout team. The University of St. Andrews, Scotland, under contract to the U.S. Navy, developed an initial data collection protocol for use during the study. Between 2010 and 2012, trained Navy marine mammal observers collected data during nine field trials as part of a "proof of concept" phase. The goal of the proof of concept phase was to develop a statistically valid protocol for quantitatively analyzing the effectiveness of Lookouts during Navy training exercises. Field trials were conducted in the Hawaii Range Complex, Southern California Range Complex, and Jacksonville Range Complex onboard one frigate, one cruiser, and seven destroyers. A preliminary analysis of the proof of concept data is ongoing. The Navy is also working to finalize the data collection process for use during the next phase of the study. While data was collected as part of this proof of concept phase, that data is not fairly comparable as protocols were being changed and assessed, nor is that data statistically significant. Therefore, it is improper to use this data to draw any conclusions on the effectiveness of Navy Lookouts.

5.3.1.2.4.1 Detection Probabilities of Marine Mammals in the Study Area

Until the results of the Navy's Lookout effectiveness study are available, the Navy must rely on the best available science to determine detection probabilities of marine mammals by Navy Lookouts. To do so, the Navy has compiled the results of available literature on line-transect analyses, which are typically used to estimate cetacean abundance. In line-transect analyses, the factors affecting the detection of an animal or group of animals directly on the transect line may be probabilistically quantified as g(0). As a reference, a g(0) value of 1 indicates that animals on the transect line are always detected. Table 5.3-1 provides detection probabilities for cetacean species based largely on g(0) values derived from shipboard and aerial surveys in the Study Area, which vary widely based on g(0) derivation factors (e.g., species, sighting platforms, group size, and sea state conditions). Refer to Section 3.4.3.1.8 (Implementing Mitigation to Reduce Sound Exposures) for additional background on g(0) and a discussion of how the Navy used g(0) to quantitatively assess the effectiveness of Lookouts during sound-producing activities.

Table 5.3-1: Sightability Based on Average g(0) Values for Marine Mammal Species in the Study Area

Species/Stocks	Family	Vessel Sightability	Aircraft Sightability
Baird's Beaked Whale	Ziphiidae	0.96	0.18
Blainville's Beaked Whale [1]	Ziphiidae	0.40	0.074
Blue Whale, Fin Whale; Sei Whale	Balaenopteridae	0.921	0.407
Bottlenose Dolphin, Fraser's Dolphin [2]	Delphinidae	0.808	0.96
Bryde's Whale [3]	Balaenopteridae	0.91	0.407
Cuvier's Beaked Whale	Ziphiidae	0.23	0.074

Table 5.3-1: Sightability Based on Average g(0) Values for Marine Mammal Species in the Study Area (continued)

Species/Stocks	Family	Vessel Sightability	Aircraft Sightability
Dall's Porpoise	Phocoenidae	0.822	0.221
Dwarf Sperm Whale, Pygmy Sperm Whale, *Kogia* spp. [1]	Kogiidae	0.35	0.074
False Killer Whale, Melon-headed Whale [2]	Delphinidae	0.76	0.96
Gray Whale	Eschichtiidae	0.921	0.482
Humpback Whale	Balaenopteridae	0.921	0.495
Killer Whale	Delphinidae	0.91	0.96
Long-Beaked Common Dolphin, Short-Beaked Common Dolphin	Delphinidae	0.97	0.99
Longman's Beaked Whale, Pygmy Killer Whale [1]	Ziphiidae, Delphinidae	0.76	0.074
Mesoplodon spp.	Ziphiidae	0.34	0.11
Minke Whale	Balaenopteridae	0.856	0.386
Northern Right Whale Dolphin	Delphinidae	0.856	0.96
Pacific White-Sided Dolphin	Delphinidae	0.856	0.96
Pantropical Spotted/Risso's/Rough Toothed/Spinner/Striped Dolphin [2]	Delphinidae	0.76	0.96
Short-finned Pilot Whale [2]	Delphinidae	0.76	0.96
Sperm Whale	Physeteridae	0.87	0.495

[1] For species having no data, the g(0) for Cuvier's aircraft value (where g(0) = 0.074) was used[1].
[2] This species aircraft sightability is an estimate for all delphinids.
[3] This species aircraft sightability is an estimate for blue and fin whales.
Notes: Values reported are averaged based on the data cited for the U.S. Atlantic coast, U.S. west coast, and Hawaii. Some g(0) values in the table above are estimates of perception bias only, some are estimates of availability bias only, and some reflect both, depending on the species and data that are currently available. Based on the Navy's analysis of: Barlow 1995; Barlow 2003; Barlow and Forney 2007; Barlow et al. 1997; Barlow and Gerrodette 1996; Barlow and Sexton 1996; Barlow and Taylor 2005; Blaylock et al. 1995; Carretta et al. 2000; Forney 2007; Forney et al. 1995; Hain et al. 1999; Mobley et al. 2001; Palka 1995a; Palka 1995b, 2005a, b, 2006.

Several variables that play into how easily a marine mammal may be detected by a dedicated observer are directly related to the animal, including its external appearance and size; surface, diving and social behavior; and life history. The following is a generalized discussion of the behavior and external appearance of the marine mammals with the potential to occur in the Study Area as these characters relate to the detectability of each species. The species are grouped loosely based on either taxonomic relatedness or commonalities in size and behavior, and include large whales, cryptic species delphinids, beluga whales, and pinnipeds. Not all statements may hold true for all species in a grouping and exceptions are mentioned where applicable. The information presented in this section may be found in Jefferson et al. (2008) and sources within unless otherwise noted.

Large Whales

Species of large whales found in the Study Area include all the baleen whales and the sperm whale. Baleen whales are generally large, with adults ranging in size from 30 to 89 ft. (9 to 27 m), often making them immediately detectable. Many species of baleen whales have a prominent blow ranging from 10 ft. (3 m) to as much as 39 ft. (12 m) above the surface. However, there are at least two species (Bryde's whale and common minke whale) that often have no visible blow. Baleen whales tend to travel singly or in small groups ranging from pairs to groups of five. The exception to this is the fin whale, which is known to travel in pods of seven or more individuals. All species of baleen whales are known to form larger-scale aggregations in areas of high localized productivity or on breeding grounds. Baleen whales may or may not fluke at the surface before they dive; some species fluke regularly (e.g., the

humpback whale), some fluke variably (e.g., the blue whale and fin whale) and some rarely fluke (e.g., the sei whale, common minke whale, and Bryde's whale). Baleen whales may remain at the surface for extended periods of time as they forage or socialize. Humpback whales are known to corral prey at the surface. Dive behavior varies amongst species. Many species will dive and remain at depth for as long as 30 minutes (min.). Some will adjust their diving behavior according to the presence of vessels (e.g., the humpback whale and fin whale). Sei whales are known to sink just below the surface and remain there between breaths.

Sperm whales also belong to the large whales, with adult males reaching as much as 50 ft. (18 m) in total length. Sperm whales at the surface would likely be easy to detect. They have a prominent, 16 ft. (5 m) blow, and may remain at the surface for long periods of time. They are known to raft (i.e., loll at the surface) and to form surface-active groups when socializing. Sperm whales may travel or congregate in large groups of as many as 50 individuals. Although sperm whales engage in conspicuous surface behavior such as fluking, breaching, and tail-slapping, they are long, deep divers and may remain submerged for over 1 hour.

Cryptic Species

Cryptic and deep-diving species are those that do not surface for long periods of time and are often difficult to see when they surface, which ultimately limits the ability of observers to detect them even in good sighting conditions (Barlow et al. 2006). Cryptic species include beaked whales (family Ziphiidae), dwarf and pygmy sperm whales (*Kogia* species), and harbor porpoises. Beaked whales are difficult to detect at sea. In the Study Area, beaked whales may occur in a variety of group sizes, ranging from single individuals to groups of as many as 22 individuals (MacLeod and D'Amico 2006). Beaked whale diving behavior in general consists of long, deep dives that may last for nearly 90 min. followed by a series of shallower dives and intermittent surfacings (Tyack et al. 2006, Baird et al. 2008). Some individuals remain at the surface for an extended period of time (perhaps 1 hour or more) or make shorter dives (MacLeod and D'Amico, 2006). Detection of beaked whales is further complicated because beaked whales often dive and surface in a synchronous pattern and they travel below the surface of the water (MacLeod and D'Amico 2006).

Dwarf and pygmy sperm whales (referred to broadly as *Kogia* species) are small cetaceans (10–13 ft. [3–4 m] adult length) that are not commonly seen. *Kogia* species are some of the most commonly stranded species in some areas, which suggests that sightings are not indicative of their overall abundance. This supports the idea that they are cryptic, perhaps engaging in inconspicuous surface behavior or actively avoiding vessels. When *Kogia* species are sighted, they are typically seen in groups of no more than five to six individuals. They have no visible blow, do not fluke when they dive, and are known to log (i.e., lie motionless) at the surface. When they do dive, they often will sink out of sight with no prominent behavioral display.

Harbor porpoises are difficult to detect in all but the best of conditions (i.e., no swell, no whitecaps). Harbor porpoises travel singly or in small groups of less than six individuals, but may aggregate into groups of several hundred. They are inconspicuous at the surface, rarely lifting their heads above the surface and often lying motionless. They are small and may actively avoid vessels.

Delphinids

Delphinids are some of the most likely species to be detected at sea by observers. Many species of delphinids engage in very conspicuous surface behavior, including leaping, spinning, bow riding, and traveling along the surface in large groups. Delphinid group sizes may range from 10 to 10,000

individuals, depending on the species and the geographic region. Species such as pilot whales, rough-toothed dolphins, white-beaked dolphins, white-sided dolphins, bottlenose dolphins, stenellid dolphins, common dolphins, and Fraser's dolphins are known to either actively approach and investigate vessels, or bow ride along moving vessels. Fraser's dolphins and common dolphins form huge groups that travel quickly along the surface, churning up the water and making them visible from a great distance. Delphinids may dive for as little as 1 min. to more than 30 min., depending on the species.

Pinnipeds

Pinnipeds (seals and sea lions) are more difficult to detect at sea than cetaceans. Pinnipeds are much smaller, often solitary and generally do not engage in conspicuous surface behavior. There is not a lot of information regarding pinniped behavior at sea. Pinnipeds have a low profile, no dorsal appendage and small body size in comparison with most cetaceans, which limits accurate visual detection to sea states of less than 2 on the Beaufort scale (Carretta et al. 2000). Some species, such as harbor seals, are known to approach and observe human activities on land or on stationary vessels. Harbor seals and gray seals are solitary at sea. Harp seals appear to be an exception, traveling in large groups at the surface and churning up whitewater like dolphins. Gray seals are known to rest vertically at the surface with only the head exposed. Gray seals may dive for as long as 30 min. and hooded seals for up to 60 min.

5.3.1.2.4.2 Detection Probabilities of Sea Turtles in the Study Area

Sea turtles spend a majority of their time below the surface and are difficult to sight from a vessel until the animal is at close range (Hazel et al. 2007). Sea turtles often spend over 90 percent of their time underwater and are not visible more than 6.5 ft. (2 m) below the surface (Mansfield 2006). Sea turtles are generally much smaller than cetaceans, so while shipboard surveys designed for sighting marine mammals are adequate for detecting large sea turtles (e.g., adult leatherbacks), they are usually not adequate for detecting the smaller sized turtles (e.g., juveniles and Kemp's ridleys). Juvenile sea turtles may be especially difficult to detect. Aerial detection may be more effective in spotting sea turtles on the surface, particularly in calm seas and clear water, but it is possible that the smallest age classes are not detected even in good conditions (Marsh and Saalfeld 1989). Visual detection of sea turtles, especially small turtles, is further complicated by their startle behavior in the presence of vessels. Turtles on the surface may dive below the surface of the water in the presence of a vessel before it is detected by shipboard or aerial observers (Kenney 2005). The detection probability of sea turtles is generally lower than that of cetaceans. The use of Lookouts for visual detection of sea turtles is likely effective only at close range, and is thought to be less effective for small individuals than large individuals.

5.3.1.2.4.3 Summary of Lookout Effectiveness

Due to the various detection probabilities, levels of Lookout experience, and variability of sighting conditions, Lookouts will not always be effective at avoiding impacts on all species. However, Lookouts are expected to increase the overall likelihood that certain marine mammal species and some sea turtles will be detected at the surface of the water, when compared to the likelihood that these same species would be detected if Lookouts are not used. The Navy believes the continued use of Lookouts contributes to helping reduce potential impacts on these species from training and testing activities.

5.3.1.2.5 Operational Assessment for Lookouts

As written, implementation of the mitigation measures recommended in Section 5.3.1.2 (Lookouts) has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activities, and Navy policy. The number of Lookouts

recommended for each measure often represents the maximum Lookout capacity based on limited resources (e.g., space and manning restrictions).

5.3.2 MITIGATION ZONE PROCEDURAL MEASURES

Safety zones described in Section 5.1 (Standard Operating Procedures) are zones designed for human safety, whereas this section will introduce mitigation zones. A mitigation zone is designed solely for the purpose of reducing potential impacts on marine mammals and sea turtles from training and testing activities. Mitigation zones are measured as the radius from a source. Unique to each activity category, each radius represents a distance that the Navy will visually observe to help reduce injury to marine species. Visual detections of applicable marine species will be communicated immediately to the appropriate watch station for information dissemination and appropriate action. If the presence of marine mammals is detected acoustically, Lookouts posted in aircraft and on vessels will increase the vigilance of their visual surveillance. As a reference, aerial surveys are typically made by flying at 1,500 ft. altitude or lower at the slowest safe speed.

Many of the proposed activities have mitigation measures that are currently being implemented, as required by previous environmental documents or consultations. Most of the current Phase I (e.g., Hawaii Range Complex EIS/OEIS) mitigation zones for activities that involve the use of impulsive and non-impulsive sources were originally designed to reduce the potential for onset of temporary threshold shift (TTS). For the HSTT EIS/OEIS, the Navy updated the acoustic propagation modeling to incorporate updated hearing threshold metrics (i.e., upper and lower frequency limits), updated density data for marine mammals, and factors such as an animal's likely presence at various depths. An explanation of the acoustic propagation modeling process can be found in the *Determination of Acoustic Effects on Marine Mammals and Sea Turtles for the Hawaii-Southern California Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement* technical report (Marine Species Modeling Team 2013).

As a result of the updates to the acoustic propagation modeling, in some cases the ranges to onset of TTS effects are much larger than those output by previous Phase I models. Due to the ineffectiveness and unacceptable operational impacts associated with mitigating these large areas, the Navy is unable to mitigate for onset of TTS for every activity. In this HSTT analysis, the Navy developed each recommended mitigation zone to avoid or reduce the potential for onset of the lowest level of injury, permanent threshold shift (PTS), out to the predicted maximum range. In some cases where the ranges to effects are smaller than previous models estimated, the mitigation zones were adjusted accordingly to provide consistency across the measures. Mitigating to the predicted maximum range to PTS consequently also mitigates to the predicted maximum range to onset mortality (1 percent mortality), onset slight lung injury, and onset slight gastrointestinal tract injury, since the maximum range to effects for these criteria are shorter than for PTS. Furthermore, in most cases, the predicted maximum range to PTS also consequently covers the predicted average range to TTS. Table 5.3-2 summarizes the predicted average range to TTS, average range to PTS, maximum range to PTS, and recommended mitigation zone for each activity category, based on the Navy's acoustic propagation modeling results.

The activity-specific mitigation zones are based on the longest range for all the functional hearing groups (based on the hearing threshold metrics described in Section 3.4, Marine Mammals, and Section 3.5, Sea Turtles). The mitigation zone for a majority of activities is driven by either the high-frequency cetacean or the sea turtle functional hearing groups. Therefore, the mitigation zones are even more protective for the remaining functional hearing groups (i.e., low-frequency cetaceans,

mid-frequency cetaceans, and pinnipeds), and likely cover a larger portion of the potential range to onset of TTS.

In some instances, the Navy recommends mitigation zones that are larger or smaller than the predicted maximum range to PTS based on the effectiveness and operational assessments. The recommended mitigation zones and their associated assessments are provided throughout the remainder of this section. The recommended measures are either currently implemented, modifications of current measures, or new measures.

For some activities specified throughout the remainder of this section, Lookouts may be required to observe for concentrations of detached floating vegetation (*Sargassum* or kelp paddies), which are indicators of potential marine mammal and sea turtle presence, within the mitigation zone. Those specified activities will not commence if the floating vegetation (*Sargassum* or kelp paddies) is observed within the mitigation zone prior to the initial start of the activity. If floating vegetation is observed prior to the initial start of the activity, the activity will be relocated to an area where no floating vegetation is observed. Training and testing will not cease as a result of indicators entering the mitigation zone after activities have commenced. This measure is intended only for floating vegetation detached from the seafloor.

Table 5.3-2: Predicted Range to Effects and Recommended Mitigation Zones

Activity Category	Representative Source (Bin) [1]	Predicted Average (Longest) Range to TTS	Predicted Average (Longest) Range to PTS	Predicted Maximum Range to PTS	Recommended Mitigation Zone
Non-Impulsive Sound					
Low-Frequency and Hull-Mounted Mid-Frequency Active Sonar	SQS-53 ASW hull-mounted sonar (MF1)	3,821 yd. (3.5 km) for one ping	100 yd. (91 m) for one ping	Not Applicable	6 dB power down at 1,000 yd. (914 m); 4 dB power down at 500 yd. (457 m); and shutdown at 200 yd. (183 m)
	Low-frequency sonar (LF4 and LF5) [2]	3,821 yd. (3.5 km) for one ping	100 yd. (91 m) for one ping	Not Applicable	200 yd. (183 m) [2]
High-Frequency and Non-Hull Mounted Mid-Frequency Active Sonar	AQS-22 ASW dipping sonar (MF4)	230 yd. (210 m) for one ping	20 yd. (18 m) for one ping	Not applicable	200 yd. (183 m)
Explosive and Impulsive Sound					
Improved Extended Echo Ranging Sonobuoys	Explosive sonobuoy (E4)	434 yd. (397 m)	156 yd. (143 m)	563 yd. (515 m)	600 yd. (549 m)
Explosive Sonobuoys using 0.6–2.5 lb. NEW	Explosive sonobuoy (E3)	290 yd. (265 m)	113 yd. (103 m)	309 yd. (283 m)	350 yd. (320 m)
Anti-Swimmer Grenades	Up to 0.5 lb. NEW (E2)	190 yd. (174 m)	83 yd. (76 m)	182 yd. (167 m)	200 yd. (183 m)
Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices	NEW dependent (see Table 5.3-3)				
Mine Neutralization Diver-Placed Mines Using Time-Delay Firing Devices	Up to 29 lb. NEW (E7)[3]	846 yd. (774 m)	286 yd. (262 m)	541 yd. (495 m)	1,000 yd. (915 m)
Gunnery Exercises – Small- and Medium-Caliber Using a Surface Target	40 mm projectile (E2)	190 yd. (174 m)	83 yd. (76 m)	182 yd. (167 m)	200 yd. (183 m)
Gunnery Exercises – Large-Caliber Using a Surface Target	5 in. projectiles (E5 at the surface [4])	453 yd. (414 m)	186 yd. (170 m)	526 yd. (481 m)	600 yd. (549 m)

[1] This table does not provide an inclusive list of source bins; bins presented here represent the source bin with the largest range to effects within the given activity category.
[2] The representative source bin and mitigation zone applies to sources that cannot be powered down (e.g., bins LF4 and LF5).
[3] The ranges listed for this activity are based on a 29 lb. NEW, not the maximum E7 NEW of 60 lb.
[4] The representative source bin E5 has different range to effects depending on the depth of activity occurrence (at the surface or at various depths).
Notes: ASW = anti-submarine warfare, in. = inches, lb. = pounds, m = meters, NEW = net explosive weight, PTS = permanent threshold shift, TTS = temporary threshold shift, yd. = yards

Table 5.3-2: Predicted Range to Effects and Recommended Mitigation Zones (continued)

Activity Category	Representative Source (Bin) [1]	Predicted Average (Longest) Range to TTS	Predicted Average (Longest) Range to PTS	Predicted Maximum Range to PTS	Recommended Mitigation Zone
Missile Exercises (Including Rockets) up to 250 lb. NEW Using a Surface Target	Maverick missile (E9)	949 yd. (868 m)	398 yd. (364 m)	699 yd. (639 m)	900 yd. (823 m)
Missile Exercises from 251 lb. to 500 lb. NEW Using a Surface Target	Harpoon missile (E10)	1,832 yd. (1.7 km)	731 yd. (668 m)	1,883 yd. (1.7 km)	2,000 yd. (1.8 km)
Bombing Exercises	MK-84 2,000 lb. bomb (E12)	2,513 yd. (2.3 km)	991 yd. (906 m)	2,474 yd. (2.3 km)	2,500 yd. (2.3 km) [2]
Torpedo (Explosive) Testing	MK-48 torpedo (E11)	1,632 yd. (1.5 km)	697 yd. (637 m)	2,021 yd. (1.8 km)	2,100 yd. (1.9 km)
Sinking Exercises	Various sources up to the MK-84 2,000 lb. bomb (E12)	2,513 yd. (2.3 km)	991 yd. (906 m)	2,474 yd. (2.3 km)	2.5 nm [2]
At-Sea Explosive Testing	Various sources less than 10 lb. NEW (E5 at various depths [3])	525 yd. (480 m)	204 yd. (187 m)	649 yd. (593 m)	1,600 yd. (1.4 km) [2]
Elevated Causeway System – Pile Driving	24 in. steel impact hammer	1,094 yd. (1.0 km)	51 yd. (46 m)	51 yd. (46 m)	60 yd. (55 m)

[1] This table does not provide an inclusive list of source bins; bins presented here represent the source bin with the largest range to effects within the given activity category.
[2] Recommended mitigation zones are larger than the modeled injury zones to account for multiple types of sources or charges being used.
[3] The representative source bin E5 has different range to effects depending on the depth of activity occurrence (at the surface or at various depths).
Notes: ASW = anti-submarine warfare, in. = inches, km = kilometers, lb. = pounds, m = meters, NEW = net explosive weight, PTS = permanent threshold shift, TTS = temporary threshold shift, yd. = yards

Table 5.3-3: Predicted Range to Effects and Mitigation Zone Radius for Mine Countermeasure And Neutralization Activities Using Positive Control Firing Devices

Charge Size Net Explosive Weight (Bins)	General Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices [1]				Mine Countermeasure and Neutralization Activities Using Diver-Placed Charges Under Positive Control [2]			
	Predicted Average Range to TTS	Predicted Average Range to PTS	Predicted Maximum Range to PTS	Recommended Mitigation Zone	Predicted Average Range to TTS	Predicted Average Range to PTS	Predicted Maximum Range to PTS	Recommended Mitigation Zone
2.6–5 lb. (E4)	434 yd. (397 m)	197 yd. (180 m)	563 yd. (515 m)	600 yd. (549 m)	545 yd. (498 m)	169 yd. (155 m)	301 yd. (275 m)	350 yd. (320 m)
6–10 lb. (E5)	525 yd. (480 m)	204 yd. (187 m)	649 yd. (593 m)	800 yd. (732 m)	587 yd. (537 m)	203 yd. (185 m)	464 yd. (424 m)	500 yd. (457 m)
11–20 lb. (E6)	766 yd. (700 m)	288 yd. (263 m)	648 yd. (593 m)	800 yd. (732 m)	647 yd. (592 m)	232 yd. (212 m)	469 yd. (429 m)	500 yd. (457 m)
21–60 lb. (E7) [3]	1,670 yd. (1.5 km)	581 yd. (531 m)	964 yd. (882 m)	1,200 yd. (1.1 km)	1,532 yd. (1.4 km)	473 yd. (432 m)	789 yd. (721 m)	800 yd. (732 m)
61–100 lb. (E8) [4]	878 yd. (802 m)	383 yd. (351 m)	996 yd. (911 m)	1,600 yd. (1.4 km)	969 yd. (886 m)	438 yd. (400 m)	850 yd. (777 m)	850 yd. (777 m)
251–500 lb. (E10)	1,832 yd. (1.7 km)	731 yd. (668 m)	1,883 yd. (1.7 km)	2,000 yd. (1.8 km)				700 yd. (640 m) [5]
501–650 lb. (E11)	1,632 yd. (1.5 km)	697 yd. (637 m)	2,021 yd. (1.8 km)	2,100 yd. (1.9 km)				Not Applicable

[1] These mitigation zones are applicable to all mine countermeasure and neutralization activities conducted in all locations specified in Tables 2.8-1 through 2.8-5.
[2] These mitigation zones are only applicable to mine countermeasure and neutralization activities involving the use of diver-placed charges. These activities are conducted in shallow water and the mitigation zones are based only on the functional hearing groups with species that occur in these areas (mid-frequency cetaceans and sea turtles).
[3] The E7 bin was only modeled in shallow-water locations so there is no difference for the diver-placed charges category.
[4] The E8 bin was only modeled for surface explosions, so some of the ranges are shorter than for sources modeled in the E7 bin which occur at depth.
[5] This mitigation zone for the E10 charge applies only to very shallow water detonations and is based on empirical data as described in Section 5.3.2.1.2.4 (Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices).
Notes: km = kilometers, lb. = pounds, m = meters, PTS = permanent threshold shift, TTS = temporary threshold shift, yd. = yards

5.3.2.1 Acoustic Stressors

5.3.2.1.1 Non-Impulsive Sound

5.3.2.1.1.1 Low-Frequency and Hull-Mounted Mid-Frequency Active Sonar

Recommended Mitigation and Comparison to Current Mitigation

Mitigation measures do not currently exist for low-frequency active sonar sources analyzed in this Final EIS/OEIS, or new platforms or systems. The Navy is proposing to (1) add mitigation measures for low-frequency active sonar, (2) continue implementing the current measures for mid-frequency active sonar, and (3) clarify the conditions needed to recommence an activity after a sighting. The recommended measures are provided below.

Training and testing activities that involve the use of low-frequency and hull-mounted mid-frequency active sonar (including pierside) will use Lookouts for visual observation from a ship immediately before and during the activity. Active sonar transmission will not begin if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. With the exception of certain low-frequency sources that are not able to be powered down during the activity (e.g., low-frequency sources within bins LF4 and LF5), mitigation will involve powering down the sonar by 6 dB when a marine mammal or sea turtle is sighted within 1,000 yd. (914 m), and by an additional 4 dB when sighted within 500 yd. (457 m) from the source, for a total reduction of 10 dB. If the source can be turned off during the activity, active transmission will cease if a marine mammal or sea turtle (low-frequency sources only) is sighted within 200 yd. (183 m). Active transmission will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, (3) the mitigation zone has been clear from any additional sightings for a period of 30 min., (4) the ship has transited more than 2,000 yd. (1.8 kilometers [km]) beyond the location of the last sighting, or (5) the ship concludes that dolphins are deliberately closing in on the ship to ride the ship's bow wave (and there are no other marine mammal sightings within the mitigation zone). Active transmission may resume when dolphins are bow riding because they are out of the main transmission axis of the active sonar while in the shallow-wave area of the bow.

If the source is not able to be powered down during the activity (e.g., low-frequency sources within bins LF4 and LF5), mitigation will involve ceasing active transmission if a marine mammal or sea turtle is sighted within 200 yd. (183 m). Active transmission will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, (3) the mitigation zone has been clear from any additional sightings for a period of 30 min., or (4) the ship has transited more than 400 yd. (366 m) beyond the location of the last sighting.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted average range to onset of PTS for low-frequency and hull- mounted mid-frequency active sonar sources is 100 yd. (91 m) for one ping. This range was determined by the high-frequency cetacean functional hearing group. The distance for all other marine mammal functional hearing groups is less than 80 yd. (73 m) for one ping, so the mitigation zone will provide further protection from injury (PTS) for these species. Therefore, implementation of the 200 yd. (183 m)

shutdown zone will reduce the potential for exposure to higher levels of energy that would result in injury (PTS) and large threshold shifts that are recoverable (i.e., TTS) when individuals are sighted. Implementation of the 500 yd. (457 m) and 1,000 yd. (914 m) sonar power reductions will further reduce the potential for injury (PTS) and larger threshold shifts that would result in recovery (i.e., TTS) to occur when individual marine mammals are sighted within these zones, especially in cases where the ship and animal are approaching each other.

The mitigation zones the Navy has developed are within a range for which Lookouts can reasonably be expected to maintain situational awareness and visually observe during most conditions. Since the predicted average range to onset of TTS is 3,821 yd. (3.5 km), the entire predicted range to TTS is not reasonably observable. By establishing mitigation zones that can be realistically maintained from ships, Lookouts will be more effective at sighting individual animals. By keeping Lookouts focused within the ranges where exposure to higher levels of energy is possible, the effectiveness at reducing potential impacts on marine mammals and sea turtles will increase. As discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), the likelihood of sighting individual animals, particularly sea turtles and some species of small or cryptic marine mammals, decreases at long distances. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles. Observations for sea turtles are required only during low-frequency active sonar activities because hull-mounted mid-frequency active sonar are not within the primary sea turtle hearing range.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30 min. wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.3.2.1 (Impacts from Sonar and Other Active Acoustic Sources) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 min. would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would eliminate opportunities to detect submarines, objects, or other exercise targets as would be required in a real world combat situation, reduce the sonar operator's situational awareness of the environment where the training or testing is occurring, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles, and; (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.1.2 High-Frequency and Non-Hull Mounted Mid-Frequency Active Sonar

Recommended Mitigation and Comparison to Current Mitigation

Mitigation measures do not currently exist for all high-frequency and non-hull mounted mid-frequency active sonar activities (i.e., new sources or sources not previously analyzed). The Navy is proposing to (1) continue implementing the current mitigation measures for activities currently being executed, such as dipping sonar activities, (2) extend the implementation of its current mitigation to all other activities in this category, and (3) clarify the conditions needed to recommence an activity after a sighting. The recommended measures are provided below.

Mitigation will include visual observation from a vessel or aircraft (with the exception of platforms operating at high altitudes) immediately before and during active transmission within a mitigation zone of 200 yd. (183 m) from the active sonar source. For activities involving helicopter-deployed dipping sonar, visual observation will commence 10 min. before the first deployment of active dipping sonar. Helicopter dipping and sonobuoy deployment will not begin if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. If the source can be turned off during the activity, active transmission will cease if a marine mammal or sea turtle (for MF8, MF9, MF10, and MF12 only) is sighted within the mitigation zone. Active transmission will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, (3) the mitigation zone has been clear from any additional sightings for a period of 10 min. for an aircraft-deployed source, (4) the mitigation zone has been clear from any additional sightings for a period of 30 min. for a vessel-deployed source, (5) the vessel or aircraft has repositioned itself more than 400 yd. (366 m) away from the location of the last sighting, or (6) the vessel concludes that dolphins are deliberately closing in to ride the vessel's bow wave (and there are no other marine mammal sightings within the mitigation zone).

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted average range to onset of PTS for high-frequency and non-hull mounted mid-frequency active sonar sources is 20 yd. (18 m) for one ping. This range was determined by the high-frequency cetacean functional hearing group. The predicted average range to onset of TTS across all functional hearing groups is 230 yd. (210 m) for one ping. Implementation of the 200 yd. (183 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury (PTS) and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted. Lookouts often visually observe either close aboard a vessel or from directly above the source by aircraft (i.e., helicopters). Exceptions include when sonobuoys are deployed and when sources are deployed from high altitude aircraft. When sonobuoys are used, the sonobuoy field may be dispersed over a large distance. As discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), the likelihood of sighting individual animals, particularly sea turtles and some species of small or cryptic marine mammals decreases at long distances. This measure should be effective at reducing risks to all marine mammals and sea turtles that are available to be observed within the mitigation zone. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles. Observations for sea turtles are required only during non-hull mounted mid-frequency active sonar activities within bins MF8, MF9, MF10, and MF12 because high-frequency active sonar and other bins of mid-frequency sonar are not within the primary sea turtle hearing range.

The post-sighting wait periods are designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. The 30 min. wait period for vessel-deployed sources more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving species. However, the analysis in Section 3.4.3.2.1 (Impacts from Sonar and Other Active Acoustic Sources) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur, with the exception of *Kogia* species. Requiring additional delay beyond 30 min. for vessel-deployed sources would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would eliminate opportunities to detect submarines, objects, or other

exercise targets and would be required during a real world combat situation and reduce the sonar operator's situational awareness of the environment where the training or testing is occurring, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The 10 min. wait period for aircraft-deployed sources covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10 min. wait period for aircraft-deployed sources is based on fuel restrictions for the types of aircraft involved in this activity (e.g., helicopters). Requiring additional delay beyond 10 min. for these sources would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would eliminate opportunities to detect submarines, objects, or other exercise targets as would be required during a real world combat situation and reduce the sonar operator's situational awareness of the environment where the training or testing is occurring, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2 Explosives and Impulsive Sound

5.3.2.1.2.1 Improved Extended Echo Ranging Sonobuoys

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to (1) modify the mitigation measures currently implemented for this activity by reducing the marine mammal and sea turtle mitigation zone from 1,000 yd. (914 m) to 600 yd. (549 m), (2) clarify the conditions needed to recommence an activity after a sighting, and (3) adopt the marine mammal and sea turtle mitigation zone size for floating vegetation for ease of implementation. The recommended measures are provided below.

Mitigation will include pre-exercise aerial observation and passive acoustic monitoring, which will begin 30 min. before the first source/receiver pair detonation and continue throughout the duration of the exercise within a mitigation zone of 600 yd. (549 m) around an Improved Extended Echo Ranging sonobuoy. The pre-exercise aerial observation will include the time it takes to deploy the sonobuoy pattern (deployment is conducted by aircraft dropping sonobuoys in the water). Improved Extended Echo Ranging sonobuoys will not be deployed if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone around the intended deployment location. Explosive detonations will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Detonations will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 min.

Passive acoustic monitoring would be conducted with Navy assets, such as sonobuoys, already participating in the activity. These assets would only detect vocalizing marine mammals within the frequency bands monitored by Navy personnel. Passive acoustic detections would not provide range or bearing to detected animals, and therefore cannot provide locations of these animals. Passive acoustic detections would be reported to Lookouts posted in aircraft and on vessels in order to increase vigilance of their visual observation.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for Improved Extended Echo Ranging sonobuoys is 563 yd. (515 m). This range was determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had a shorter range to onset of PTS, so the mitigation zone will provide further protection for these species. The predicted average range to onset of TTS across all functional hearing groups is 434 yd. (397 m). Implementation of the 600 yd. (549 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted. The sonobuoy field may be dispersed over a large distance. As discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), the likelihood of sighting individual animals, particularly sea turtles and some species of small or cryptic marine mammals, decreases at long distances. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles.

The decrease in mitigation zone size will result in no mitigation for exposure to lower levels of potential onset of TTS; however, it will allow for a more focused survey effort over a smaller survey distance, and will consequently increase the likelihood of avoidance of injury and larger threshold shifts that would result in recovery (i.e., TTS) to marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30 min. wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.3.2.2 (Impacts from Explosives) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 min. for aircraft-deployed Improved Extended Echo Ranging sonobuoys would modify the activity in a way that it would no longer meet its intended objective. The 30 min. wait period represents the maximum wait period acceptable for the type of aircraft involved in this activity (e.g., maritime patrol aircraft) based on fuel restrictions. Any additional delay would result in an unacceptable increased risk to personnel safety, require aircraft to depart the activity location to refuel, eliminate opportunities to detect submarines as would be required in a real world combat situation, and reduce the aircrew's situational awareness of the environment where the activity is occurring, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.2 Explosive Sonobuoys Using 0.6–2.5 Pound Net Explosive Weight

Recommended Mitigation and Comparison to Current Mitigation

Mitigation measures do not currently exist for this activity. The Navy is proposing to add the recommended measures provided below.

Mitigation will include pre-exercise aerial monitoring during deployment of the field of sonobuoy pairs (typically up to 20 min.) and continue throughout the duration of the exercise within a mitigation zone

of 350 yd. (320 m) around an explosive sonobuoy. Explosive sonobuoys will not be deployed if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone (around the intended deployment location). Explosive detonations will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Detonations will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 min.

Passive acoustic monitoring will also be conducted with Navy assets, such as sonobuoys, already participating in the activity. These assets would only detect vocalizing marine mammals within the frequency bands monitored by Navy personnel. Passive acoustic detections would not provide range or bearing to detected animals, and therefore cannot provide locations of these animals. Passive acoustic detections would be reported to Lookouts posted in aircraft in order to increase vigilance of their visual observation.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for explosive sonobuoys using 0.6–2.5 lb. net explosive weight is 309 yd. (283 m). This range was determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The predicted average range to onset of TTS across all functional hearing groups is 290 yd. (265 m). Implementation of the 350 yd. (320 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and large threshold shifts that are recoverable (i.e., TTS) when individuals are sighted. The sonobuoy field may be dispersed over a large distance. As discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), the likelihood of sighting individual animals, particularly sea turtles and some species of small or cryptic marine mammals, decreases at long distances.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 10 min. wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10 min. wait period for aircraft-deployed sources is based on fuel restrictions for the types of aircraft involved in this activity (e.g., helicopters). Requiring additional delay beyond 10 min. for these sources would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would eliminate opportunities to detect and track submarines or other exercise targets as would be required in a real world combat situation, reduce the sonar operator's situational awareness of the environment where the training or testing is occurring, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.3 Anti-Swimmer Grenades

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to (1) continue implementing the current mitigation measures for this activity and (2) clarify the conditions needed to recommence an activity after a sighting. The recommended measures are provided below.

Mitigation will include visual observation from a small boat immediately before and during the exercise within a mitigation zone of 200 yd. (183 m) around an anti-swimmer grenade. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Explosive detonations will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Detonations will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, (3) the mitigation zone has been clear from any additional sightings for a period of 30 min., or (4) the activity has been repositioned more than 400 yd. (366 m) away from the location of the last sighting.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for anti-swimmer grenades is 182 yd. (167 m). This range was determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The predicted average range to onset of TTS across all functional hearing groups is 190 yd. (174 m). Implementation of the 200 yd. (183 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted. Since the Lookout is visually observing close aboard the boat, this measure should be effective at reducing the risk to all marine mammals and sea turtles that are available to be observed. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30 min. wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.3.2.2 (Impacts from Explosives) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 min. would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would eliminate opportunities for maritime security forces to detect, respond, to, and defend against enemy scuba divers as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.4 Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices

Recommended Mitigation and Comparison to Current Mitigation

As background, mine countermeasure and neutralization activities can be divided into two main categories: (1) general activities that can be conducted from a variety of platforms and locations, and (2) activities involving the use of diver-placed charges that typically occur close to shore. When either of these activities are conducted using a positive control firing device, the detonation is controlled by the personnel conducting the activity and is not authorized until the area is clear at the time of detonation. Refer to Section 5.3.3.2.2 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef, live hardbottom, artificial reef, and shipwreck mitigation areas.

For general mine countermeasure and neutralization activities, the Navy is proposing to (1) modify the currently implemented mitigation measures to account for additional categories of net explosive weights and to align with the modeled explosive bins, (2) clarify the conditions needed to recommence an activity after a sighting, and (3) add a requirement to observe for floating vegetation. For comparison, the currently implemented mitigation zone for general mine countermeasure and neutralization is 700 yd. (640 m) when using up to a 20 lb. net explosive weight charge. The recommended general mine countermeasure and neutralization measures are provided below and summarized in Table 5.3-3.

The Navy is proposing to use the mitigation zones outlined in Table 5.3-3 during general mine countermeasure activities using positive control firing devices. General mine countermeasure and neutralization activity mitigation will include visual observation from small boats or aircraft beginning 10 min. before, during, and 10 min. after (when helicopters are involved in the activity) or 30 min. before, during, and 30 min. after (when helicopters are not involved in the activity) the completion of the exercise within the mitigation zones around the detonation site. For activities involving explosives in bin E11 (501-650 lb. net explosive weight), aerial observation of the mitigation zone will be conducted.

The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Explosive detonations will cease if a marine mammal, sea turtle, flock of seabirds, or individual foraging seabird is sighted within the mitigation zone. Detonations will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 min. when helicopters are involved in the activity, or (4) the mitigation zone has been clear from any additional sightings for a period of 30 min. when helicopters are not involved in the activity.

For activities involving positive control diver-placed charges, the Navy is proposing to (1) modify the currently implemented mitigation measures for activities involving up to a 29 lb. or 251–500 lb. net explosive weight detonation, (2) add mitigation to account for additional categories of net explosive weights and to align with the modeled explosive bins, (3) clarify the conditions needed to recommence an activity after a sighting, and (4) add a requirement to observe for floating vegetation. For comparison, the currently implemented mitigation zone for up to 29 lb. net explosive weight charges is 700 yd. (640 m). Mitigation measures for activities involving diver-placed charges under positive control do not currently exist for 30–249 lb. net explosive weight detonations. The recommended measures for activities involving positive control diver-placed activities are provided below.

The Navy is proposing to use the mitigation zones outlined in Table 5.3-3 during activities involving positive control diver-placed charges. Visual observation will be conducted by either two small boats, or by one small boat in combination with either one helicopter or one appropriate elevated shore-based platform. Boats will position themselves near the mid-point of the mitigation zone radius (but always outside the detonation plume radius and human safety zone) and travel in a circular pattern around the detonation location.

When using two boats, each boat will be positioned on opposite sides of the detonation location, separated by 180 degrees. If used, helicopters will travel in a circular pattern around the detonation location. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Explosive detonations will cease if a marine mammal, sea turtle, flock of seabirds, or an individual foraging seabird is sighted in the water portion of the mitigation zone (i.e., not on shore). Lookouts will be trained to survey the mitigation zone for seabirds prior to and after the detonation event. During activities conducted in shallow water, a shore-based observer will use binoculars to survey the mitigation zone to detect any seabirds prior to and after each detonation. Detonations will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 min. (10 min. for applicable helicopter activities).

Immediately following the detonation, visual monitoring (using binoculars) will be conducted to survey the mitigation zone for at least 30 min. The Navy will report all injured or dead seabirds sighted during the post-detonation observations to the appropriate Navy Region Environmental Director, Navy Pacific Fleet Environmental Office, and local base wildlife biologist.

For training exercises that include the use of multiple detonations, the second (or third, etc.) detonation will occur either immediately after the preceding detonation (i.e., within 10 seconds of the preceding detonation), or after 30 min. have passed. This measure is intended to reduce the potential impacts to any piscivorous (fish-eating) birds, including least terns and pelicans, that forage in ocean waters or are attracted by stunned fish within the sphere of influence of the detonation.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. The predicted range to effects shown in Table 5.3-3 for general mine countermeasure and neutralization activities using positive control firing devices were determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had shorter ranges to onset of PTS, so the mitigation zones will provide further protection for these species. Implementation of the mitigation zones outlined in Table 5.3-3 will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

As described in Section 5.3.1 (Lookout Procedural Measures), Lookouts positioned in aircraft or small boats may be responsible for tasks in addition to observing the air or surface of the water. For example, a Lookout for this activity may also be responsible for navigation or assistance with mine countermeasure and neutralization deployment. The decrease in mitigation zone size for activities using diver-placed charges will result in no mitigation for exposure to lower levels of potential onset of TTS;

however, it will allow for a more focused survey effort over a smaller area, and will consequently increase the likelihood of avoidance of injury and larger threshold shifts that would result in recovery (i.e., TTS) to marine mammals. Having a Lookout observe a mitigation zone that is too large could potentially increase the safety risk due to an increased level of distraction from normal job duties. Observation of an area beyond what the Navy is proposing to implement would not be likely to result in avoidance or reduction of injury to marine mammals or sea turtles because the effort spent observing those more distant areas would inevitably be minimal.

As described in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), the ability of a Lookout to detect an animal can vary greatly based on what observing platform is being used. For large ranges, aerial observation is more effective. In addition, when observing from a small boat, sea turtle and cryptic marine mammal species can be very difficult to detect beyond a few meters. However, this measure should be effective at reducing potential impacts for individuals that are sighted.

Mine neutralization activities involving diver-placed charges occur primarily close to shore and in shallow water (concentrated in the SSTC and San Clemente Island). The range to effects shown in Table 5.3-3 for mine neutralization activities involving diver-placed charges under positive control were determined by the sea turtle functional hearing group. The mid-frequency hearing group had shorter ranges to onset of PTS, so the mitigation zones will provide further protection for these species. However, mitigation would be implemented for any species observed within the mitigation zone.

In particular for activities involving positive control diver-placed charges, the Navy is recommending different mitigation zones depending on the depth of the water in which the detonation takes place. The Navy used the Reflection and Refraction in a Multilayered Ocean/Ocean Bottoms with Shear Wave Effects model to predict the pressure-wave propagation for underwater detonations in deep and shallow water. Due to the complicated nature of propagation in very shallow water (less than 24 ft. [7 m]), as well as substantial differences between very shallow water sites, the Navy determined the most accurate estimates of underwater sound propagation in two specific areas would result from empirical data developed from explosives testing in these two areas. In order to establish accurate mitigation zones for determining physiological effects on marine mammals, measured waveform propagation data was collected at the actual very shallow water locations at San Clemente Island and the Silver Strand Training Complex, and were used to determine the zone of influence and mitigation zone for very shallow water detonations training and testing at these sites.

Implementation of the mitigation zones outlined in Table 5.3-3 will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted. The decrease in mitigation zone size for activities using diver-placed charges (up to 29 lb. net explosive weight) will result in no mitigation for exposure to lower levels of potential onset of TTS; however, it will allow for a more focused survey effort over a smaller area, and will consequently increase the likelihood of avoidance of injury and larger threshold shifts that would result in recovery (i.e., TTS) to marine mammals.

During activities using diver-placed charges, Lookouts are visually observing from small boats, helicopters, or shore-based platforms. As discussed above, aerial observation (and observations from shore-based platforms with high vantage points) is more effective than observation from a small boat. Since small boats do not have a very elevated observing platform, the distance over which animals can be observed is much shorter. Sea turtles and cryptic marine mammal species would be very difficult to detect further than a few meters away from the boat.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30 min. wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.3.2.2 (Impacts from Explosives) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 min. (when helicopters are not involved in the activity) would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would eliminate opportunities to detect, identify, evaluate, and neutralize mines as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The 10 min. wait period (when helicopters are involved in the activity) covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10 min. wait period is based on helicopter fuel restrictions. Requiring additional delay beyond 10 min. for these sources would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would eliminate opportunities to detect, identify, evaluate, and neutralize mines, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of injury to most marine mammal species or seabirds; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.5 Mine Neutralization Using Diver-Placed Time-Delay Firing Devices

Recommended Mitigation and Comparison to Current Mitigation

As background, when mine neutralization activities using diver-placed charges (up to a 29 lb. net explosive weight) are conducted with a time-delay firing device, the detonation is fused with a specified time-delay by the personnel conducting the activity and is not authorized until the area is clear at the time the fuse is initiated. During these activities, the detonation cannot be terminated once the fuse is initiated due to human safety concerns. Refer to Section 5.3.2.1.2.4 (Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices) for a general discussion of mitigation measures applicable to mine neutralization activities using diver-placed mines. This section will specify unique mitigation zones and observation methods for diver-placed mine activities that use time-delay firing devices. Refer to Section 5.3.3.2.2 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef, live hardbottom, artificial reef, and shipwreck mitigation areas.

The Navy is proposing to (1) modify the mitigation zones and observation requirements currently implemented for mine countermeasure and neutralization activities using diver-placed time-delay firing devices, (2) clarify the conditions needed to recommence an activity after a sighting, and (3) add a requirement to observe for floating vegetation. For comparison, the current mitigation zones are based on size of charge and length of time-delay, ranging from a 1,000 yd. (914 m) mitigation zone for a 5 lb. net explosive weight charge using a 5 min. time-delay to a 1,500 yd. (1,372 m) mitigation zone for a 29 lb. net explosive weight charge using a 10 min. time-delay. The current requirement is for six

Lookouts in three boats (two in each boat) for larger than 1,400 yd. (1,280 m) and four Lookouts in two small boats to be used for observation in mitigation zones that are less than 1,400 yd. (1,280 m). The recommended measures for activities involving diver-placed time-delay firing devices are provided below.

The Navy recommends one mitigation zone for all net explosive weights and lengths of time-delay. Mine neutralization activities involving diver-placed charges will not include time-delay longer than 10 min. Mitigation will include visual surveillance from small boats commencing 30 min. before, during, and until 30 min. after the completion of the exercise within a mitigation zone of 1,000 yd. (915 m) around the detonation site. During activities using time-delay firing devices involving up to a 29 lb. net explosive weight charge, visual observation will take place using two small boats. In addition, when aircraft are involved (e.g., during deployment of divers), the pilot or member of the aircrew will serve as an additional Lookout. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. The fuse initiation will cease if a marine mammal, sea turtle, flock of seabirds, or individual foraging seabird is sighted within the water portion of the mitigation zone (i.e., not on shore). Fuse initiation will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 min.

Survey boats will position themselves near the mid-point of the mitigation zone radius (but always outside the detonation plume radius/human safety zone) and travel in a circular pattern around the detonation location. One Lookout from each boat will look inward toward the detonation site and the other Lookout will look outward away from the detonation site. Each boat will be positioned on opposite sides of the detonation location, separated by 180 degrees. If available for use, helicopters will travel in a circular pattern around the detonation location. Lookouts will be trained to survey the mitigation zone for seabirds prior to and after the detonation event. During activities conducted in shallow water, a shore-based observer will use binoculars to survey the mitigation zone to detect any seabirds prior to and after each detonation.

Immediately following the detonation, visual monitoring (using binoculars) will be conducted to survey the mitigation zone for at least 30 min. The Navy will report all injured or dead seabirds sighted during the post-detonation observations to the appropriate Navy Region Environmental Director, Navy Pacific Fleet Environmental Office, and local base wildlife biologist.

For training exercises that include the use of multiple detonations, the second (or third, etc.) detonation will occur either immediately after the preceding detonation (i.e., within 10 seconds of the preceding detonation), or after 30 min. have passed. This measure is intended to reduce the potential impacts to any piscivorous (fish-eating) birds, including least terns and pelicans, that forage in ocean waters or are attracted by stunned fish within the sphere of influence of the detonation.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for mine neutralization diver-placed mines using time-delay firing devices is 469 yd. (429 m). This range was determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had a shorter

predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The predicted average range to onset of TTS across all functional hearing groups is 647 yd. (592 m). The time-delay firing device mitigation zone was determined by including additional distance on top of the predicted maximum range to onset of PTS to account for a portion of the time that a marine mammal or sea turtle could enter the mitigation zone during the time-delay. Implementation of the 1,000 yd. (915 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

A 1,000 yd. (915 m) mitigation zone represents the maximum distance that the Lookouts on small boats can adequately observe given the number of personnel that will be involved. As discussed in Section 5.3.1.2.2.5 (Mine Neutralization Activities Using Diver-Placed Time-Delay Firing Devices), the use of more than two small boats for observation during this activity presents an unacceptable impact on readiness due to limited personnel resources. Since small boats do not have an elevated observing platform, the distance over which animals can be observed is much shorter. Sea turtles and cryptic marine mammal species would be very difficult to detect further that a few meters away from the boat. Sighting a sea turtle is only likely if a helicopter is participating in the activity. In addition, even with the extended mitigation zone to account for as much of the time-delay as possible, there is still a remote chance that animals may swim into the area after the charge is already set. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30 min. wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.3.2.2 (Impacts from Explosives) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. The 30 min. wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. Requiring additional delay beyond 30 min. would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would eliminate opportunities to detect, identify, evaluate, and neutralize mines as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measures described above because (1) they are likely to result in avoidance or reduction of injury to most marine mammal species; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.6 Gunnery Exercises – Small- and Medium-Caliber Using a Surface Target

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to (1) continue implementing the current mitigation measures for this activity, (2) clarify the conditions needed to recommence an activity after a sighting, and (3) add a requirement to visually observe for kelp paddies. Refer to Section 5.3.3.2.2 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef mitigation areas. The recommended measures are provided below.

Mitigation will include visual observation from a vessel or aircraft immediately before and during the exercise within a mitigation zone of 200 yd. (183 m) around the intended impact location. Vessels will observe the mitigation zone from the firing position. When aircraft are firing, the aircrew will maintain visual watch of the mitigation zone during the activity. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, (3) the mitigation zone has been clear from any additional sightings for a period of 10 min. for a firing aircraft, (4) the mitigation zone has been clear from any additional sightings for a period of 30 min. for a firing vessel, and (5) the intended target location has been repositioned more than 400 yd. (366 m) away from the location of the last sighting.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-3, the predicted maximum range to onset of PTS for small- and medium-caliber gunnery is 182 yd. (167 m). This range was determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The average range to onset of TTS across all functional hearing groups is 190 yd. (174 m). Implementation of the 200 yd. (183 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

Small- and medium-caliber gunnery exercises involve the participating vessel or aircraft firing munitions at a target location that may be up to 4,000 yd. (3.7 km) away, although typically much closer than this. Therefore, it is necessary for the Lookout to be able to visually observe the mitigation zone from varying distances. Large vessel or aircraft platforms would provide a more effective observation platform for Lookouts than small boats. However, as discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), it is highly unlikely that anything but a whale blow or large pod of dolphins will be seen at distances closer to 4,000 yd. (3.7 km). However, this measure is likely effective at reducing the risk of injury to marine mammals that may be observed from the typical target distances. This measure may be ineffective at reducing the risk of injury to sea turtles at large target distances; however, it does reduce the risk for those individuals that may be observed at closer distances. In addition, it is more likely that sea turtles will be observed when exercises involve aircraft versus vessels. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. The 30 min. wait period for a firing vessel more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.3.2.2 (Impacts from Explosives) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 min. for a firing vessel would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would reduce the gun crews' abilities to engage surface targets and practice defensive marksmanship as would be required in a real

world combat situation and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The 10 min. wait period for a firing aircraft covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10 min. wait period is based on fuel restrictions for the types of aircraft involved in this activity (e.g., helicopters). Requiring additional delay beyond 10 min. for these sources would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would eliminate opportunities and reduce the gun crews' abilities to engage surface targets and practice defensive marksmanship as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to some marine mammal species; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.7 Gunnery Exercises – Large-Caliber Using a Surface Target

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to (1) continue using the currently implemented mitigation zone for this activity, (2) clarify the conditions needed to recommence an activity after a sighting, (3) add a requirement to visually observe for kelp paddies, and (4) modify the seafloor habitat mitigation area. Refer to Section 5.3.3.2.2 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef mitigation areas. The recommended measures are provided below.

Mitigation will include visual observation from a ship immediately before and during the exercise within a mitigation zone of 600 yd. (549 m) around the intended impact location. Ships will observe the mitigation zone from the firing position. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 min.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential effects they are designed to reduce. As shown in Table 5.3-3, the predicted maximum range to onset of PTS for large-caliber gunnery is 526 yd. (481 m). This range was determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The average predicted range to onset of TTS across all functional hearing groups is 453 yd. (414 m). Implementation of the 600 yd. (549 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted. Per the

Navy's current reporting requirements, any injured or dead marine mammals or sea turtles will be reported as appropriate.

Large-caliber gunnery exercises involve the participating ship firing munitions at a target location from ranges up to 6 nautical miles (nm) away. Therefore it is necessary for the Lookout to be able to visually observe the mitigation zone from this distance. Although the Lookout will observe for all marine mammals or sea turtles in the area, as discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), it is highly unlikely that anything but a whale blow or large pod of dolphins will be seen. Although this measure is likely ineffective at reducing the risk of injury to sea turtles and some species of marine mammals, it does reduce the risk for those individuals that may be observed. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30 min. wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.3.2.2 (Impacts from Explosives) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 min. would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would reduce the gun crews' abilities to engage surface targets and practice defensive marksmanship as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to some marine mammal species; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.8 Missile Exercises (Including Rockets) up to 250 Pound Net Explosive Weight Using a Surface Target

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to (1) modify the mitigation measures currently implemented for this activity by reducing the mitigation zone from 1,800 yd. (1.6 km) to 900 yd. (823 m), (2) clarify the conditions needed to recommence an activity after a sighting, (3) adopt the marine mammal and sea turtle mitigation zone size for floating vegetation for ease of implementation**,** and (4) modify the platform of observation to eliminate the requirement to observe when ships are firing. Refer to Section 5.3.3.2.2 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef mitigation areas. The recommended measures are provided below.

When aircraft are firing, mitigation will include visual observation by the aircrew or supporting aircraft prior to commencement of the activity within a mitigation zone of 900 yd. (823 m) around the deployed target. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the

mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 min. or 30 min. (depending on aircraft type).

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for a missile exercise (including rockets) up to 250 lb. net explosive weight (bin E9) is 699 yd. (639 m). This range was determined by the sea turtle functional hearing group. The marine mammal functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The average predicted range to onset of TTS across all functional hearing groups is 949 yd. (868 m). Implementation of the 900 yd. (823 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted. The decrease in mitigation zone size will result in no mitigation for exposure to lower levels of potential onset of TTS; however, it will allow for a more focused survey effort over a smaller survey distance, and will consequently increase the likelihood of avoidance of injury and larger threshold shifts that would result in recovery (i.e., TTS) to marine mammals and sea turtles.

Missile exercises involve the participating ship or aircraft firing munitions at a target location typically up to 15 nm away and infrequently include ranges up to 75 nm away. When an aircraft is firing, the aircraft can travel close to the intended impact area so that it can be visually observed. Because that type of observation is not possible for a ship, visual observation is not suitable for activities that involve a ship-fired missile. Even with aircraft firing, there is a chance that animals could enter the impact area after the visual observations have been completed and the activity has commenced. Therefore, this measure is not effective at reducing the risk of injury to animals once the firing activity has begun; however, it does reduce the risk for those individuals that may be observed prior to commencement of the activity when aircraft are firing. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. The 30 min. wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. The 30 min. wait period represents the maximum wait period acceptable for certain types of aircraft involved in this activity (e.g., maritime patrol aircraft) based on their specific fuel restrictions. Requiring additional delay beyond 30 min. for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and launch missiles as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The 10 min. wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10 min. wait period is based on the specific fuel restrictions for the other types of aircraft involved in this activity (e.g., helicopters).

Requiring additional delay beyond 10 min. for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and launch missiles as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.9 Missile Exercises 251–500 Pound Net Explosive Weight Using a Surface Target

Recommended Mitigation and Comparison to Current Mitigation

Mitigation measures do not currently exist for this activity. Refer to Section 5.3.3.2.2 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef mitigation areas. The recommended measures are provided below.

When aircraft are firing, mitigation will include visual observation by the aircrew or supporting aircraft prior to commencement of the activity within a mitigation zone of 2,000 yd. (1.8 km) around the intended impact location. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 min. or 30 min. (depending on aircraft type).

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-3, the predicted maximum range to onset of PTS for a missile exercise using 251–500 lb. net explosive weight (bin E10) is 1,883 yd. (1.7 km). This range was determined by the sea turtle functional hearing group. The marine mammal functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The predicted average range to onset of TTS across all functional hearing groups is 1,832 yd. (1.7 km). Implementation of the 2,000 yd. (1.8 km) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

Missile exercises involve the participating ship or aircraft firing munitions at a target location typically up to 15 nm away and infrequently include ranges up to 75 nm away. When an aircraft is firing, the aircraft can travel close to the intended impact area so that it can be visually observed. Because that type of observation is not possible for a ship, visual observation is not suitable for activities that involve a ship-fired missile. Even with aircraft firing, there is a chance that animals could enter the impact area after the visual observations have been completed and the activity has commenced. Therefore, this measure is not effective at reducing the risk of injury to animals once the firing activity has begun; however, it

does reduce the risk for those individuals that may be observed prior to commencement of the activity when aircraft are firing. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. The 30 min. wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. The 30 min. wait period represents the maximum wait period acceptable for certain types of aircraft involved in this activity (e.g., maritime patrol aircraft) based on their specific fuel restrictions. Requiring additional delay beyond 30 min. for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and launch missiles as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The 10 min. wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10 min. wait period is based on the specific fuel restrictions for the other types of aircraft involved in this activity (e.g., helicopters). Requiring additional delay beyond 10 min. for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and launch missiles as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.10 Bombing Exercises

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to (1) modify the mitigation measures currently implemented for this activity by increasing the mitigation zone from 1,000 yd. (914 m) to 2,500 yd. (2.3 km), (2) clarify the conditions needed to recommence an activity after a sighting, (3) add a requirement to visually observe for kelp paddies, and (4) adopt the marine mammal and sea turtle mitigation zone size for floating vegetation for ease of implementation. Refer to Section 5.3.3.2.2 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef mitigation areas. The recommended measures are provided below.

Mitigation will include visual observation from the aircraft immediately before the exercise and during target approach within a mitigation zone of 2,500 yd. (2.3 km) around the intended impact location. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Bombing will cease if a marine mammal or sea turtle is sighted within

the mitigation zone. Bombing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 min.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for bombing exercises is 2,474 yd. (2.3 km). This range was determined by the sea turtle functional hearing group. The marine mammal functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. For example, the predicted maximum range to onset of PTS to mid-frequency of cetaceans is less than 500 yd. (457 m). The predicted average range to onset of TTS across all functional hearing groups is 2,513 yd. (2.3 km). Implementation of the 2,500 yd. (2.3 km) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

The predicted maximum range to onset mortality across all functional hearing groups is less than 250 yd. (229 m). Therefore, this measure will be effective at reducing potential mortality to all marine mammals and sea turtles when individuals are sighted. As discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), it is highly unlikely that anything but a whale blow or large pod of dolphins will be seen at distances closer to 2,500 yd. (2.3 km) near the perimeter of the mitigation zone. However, this measure is likely effective at reducing the risk of injury to marine mammals and sea turtles that may be observed from the smaller distances within the mitigation zone. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles.

As described in Section 5.3.1 (Lookout Procedural Measures), Lookouts positioned in aircraft may be responsible for tasks in addition to observing the air or surface of the water. For example, a Lookout for this activity may also be responsible for navigation of the aircraft. Having a Lookout observe a mitigation zone that is too large could potentially increase the safety risk due to an increased level of distraction from normal job duties. Similarly, Lookouts posted in aircraft during bombing activities will, by necessity, focus their attention on the water surface below and surrounding the location of bomb deployment. Due to the nature of this activity (e.g., aircraft maintaining a relatively steady altitude of approximately 1,500 ft. and approaching the intended impact location), Lookouts will be able to observe a larger area during bombing activities than other proposed activities that involve the use of Lookouts positioned in aircraft (e.g., Improved Extended Echo Ranging sonobuoy activities). However, observation of an area beyond what the Navy is proposing to implement for bombing activities is not practical and would not likely result in avoidance or reduction of injury to marine mammals or sea turtles because the effort spent observing those more distant areas would inevitably be minimal.

While the increase in mitigation zone size will not mitigate for exposures to lower levels of potential onset of TTS; it will allow for a more focused survey effort over a larger survey distance, and will consequently increase the likelihood of avoidance of injury and larger threshold shifts that would result in recovery (i.e., TTS) to marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has

not already been met. The 10 min. wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10 min. wait period is based on fuel restrictions (factoring in the typical activity locations) for the types of aircraft involved in this activity (e.g., F/A-18). Requiring additional delay beyond 10 min. for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and deliver bombs as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.11 Torpedo (Explosive) Testing

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to (1) modify the mitigation measures currently implemented for this activity by reducing the mitigation zone from 5,063 yd. (4.6 km) to 2,100 yd. (1.9 km), (2) clarify the conditions needed to recommence an activity after a sighting, (3) add a requirement to visually observe for kelp paddies, and (4) remove the requirement to review remotely sensed sea surface temperature maps prior to conducting the activity. The recommended measures are provided below.

Mitigation will include visual observation by aircraft (with the exception of platforms operating at high altitudes) immediately before, during, and after the exercise within a mitigation zone of 2,100 yd. (1.9 km) around the intended impact location. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal, sea turtle, or aggregation of jellyfish is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 min. or 30 min. (depending on aircraft type).

In addition to visual observation, passive acoustic monitoring would be conducted with Navy assets, such as passive ships sonar systems or sonobuoys, already participating in the activity. Passive acoustic observation would be accomplished through the use of remote acoustic sensors or expendable sonobuoys, or via passive acoustic sensors on submarines when they participate in the Proposed Action. These assets would only detect vocalizing marine mammals within the frequency bands monitored by Navy personnel. Passive acoustic detections would not provide range or bearing to detected animals, and therefore cannot provide locations of these animals. Passive acoustic detections would be reported to the Lookout posted in the aircraft in order to increase vigilance of the visual observation; and to the person in control of the activity for their consideration in determining when the mitigation zone is determined free of visible marine mammals.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As

shown in Table 5.3-2, the predicted maximum range to onset of PTS for explosive torpedoes is 2,021 yd. (1.8 km). This range was determined by the sea turtle functional hearing group. The marine mammal functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The average predicted range to onset of TTS across all functional hearing groups is 1,632 yd. (1.5 km). Implementation of the 2,100 yd. (1.9 km) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

The predicted maximum range to onset mortality across all functional hearing groups is less than 600 yd. (549 m). Therefore, this measure will be effective at reducing potential mortality to all marine mammals and sea turtles when individuals are sighted. As discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), it is highly unlikely that anything but a whale blow or large pod of dolphins will be seen at distances closer to 2,100 yd. (1.9 km) near the perimeter of the mitigation zone. However, this measure is likely effective at reducing the risk of injury to marine mammals and sea turtles that may be observed from the smaller distances within the mitigation zone.

As described in Section 5.3.1 (Lookout Procedural Measures), Lookouts positioned in aircraft may be responsible for tasks in addition to observing the air or surface of the water. For example, a Lookout for this activity may also be responsible for navigation of the aircraft. Having a Lookout observe a mitigation zone that is too large could potentially increase the safety risk due to an increased level of distraction from normal job duties. Observation of an area beyond what the Navy is proposing to implement for torpedo (explosive) testing activities is not practical and would not likely result in avoidance or reduction of injury to marine mammals or sea turtles because the effort spent observing those more distant areas would inevitably be minimal.

The decrease in mitigation zone size will result in no mitigation for exposure to lower levels of potential onset of TTS; however, it will allow for a more focused survey effort over a smaller survey distance, and will consequently increase the likelihood of avoidance of injury and larger threshold shifts that would result in recovery (i.e., TTS) to marine mammals and sea turtles. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies] and jellyfish aggregations will further help avoid impacts to marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. The 30 min. wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. The 30 min. wait period represents the maximum wait period acceptable for certain types of aircraft involved in this activity (e.g., maritime patrol aircraft) based on their specific fuel restrictions. Requiring additional delay beyond 30 min. for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and launch torpedoes as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The 10 min. wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10 min. wait period is based on the specific fuel restrictions for the other types of aircraft involved in this activity (e.g., helicopters).

Requiring additional delay beyond 10 min. for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and launch torpedoes as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The original intent of the measure requiring the review of remotely sensed sea surface temperature maps was to help predict areas in which protected species could occur. However, while the presence of sea surface temperature fronts may indicate suitable habitat for marine species and may sometimes lead observers to pay more attention to an area of the ocean likely to be associated with a marine species, sea surface temperature fronts alone are insufficient to locate and prevent avoidance of marine species during this type of exercise.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.12 Sinking Exercises

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to (1) modify the mitigation measures currently implemented for this activity by increasing the mitigation zone from 2.0 nm to 2.5 nm, (2) clarify the conditions needed to recommence an activity after a sighting, (3) add a requirement to visually observe for kelp paddies, and (4) adopt the marine mammal and sea turtle mitigation zone size for concentrations of floating vegetation and aggregation of jellyfish for ease of implementation. The recommended measures are provided below.

Mitigation will include visual observation within a mitigation zone of 2.5 nm around the target ship hulk. Sinking exercises will include aerial observation beginning 90 min. before the first firing, visual observations from vessels throughout the duration of the exercise, and both aerial and vessel observation immediately after any planned or unplanned breaks in weapons firing of longer than 2 hours. Prior to conducting the exercise, the Navy will review remotely sensed sea surface temperature and sea surface height maps to aid in deciding where to release the target ship hulk.

The Navy will also monitor using passive acoustics during the exercise. Passive acoustic monitoring would be conducted with Navy assets, such as passive ships sonar systems or sonobuoys, already participating in the activity. These assets would only detect vocalizing marine mammals within the frequency bands monitored by Navy personnel. Passive acoustic detections would not provide range or bearing to detected animals, and therefore cannot provide locations of these animals. Passive acoustic detections would be reported to Lookouts posted in aircraft and on vessels in order to increase vigilance of their visual surveillance. Lookouts will also increase observation vigilance before the use of torpedoes or unguided ordnance with a net explosive weight of 500 lb. or greater, or if the Beaufort sea state is a 4 or above.

The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. The exercise will cease if a marine mammal, sea turtle, or aggregation of jellyfish is sighted within the mitigation zone. The exercise will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is

thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 min. Upon sinking the vessel, the Navy will conduct post-exercise visual surveillance of the mitigation zone for 2 hours (or until sunset, whichever comes first).

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. During a sinking exercise, multiple weapons sources may be used (projectiles, missiles, bombs, torpedoes), the largest of which is the 2,000 lb. bomb. The recommended mitigation zone is approximately double the predicted maximum range to onset of PTS of the largest weapon source and is designed to account for multiple detonations during the activity. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for a bombing exercise is 2,474 yd. (2.3 km). This range was determined by the sea turtle functional hearing group. The marine mammal functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. For example, the predicted maximum range to onset of PTS to mid-frequency of cetaceans is less than 500 yd. (457 m). The average range to onset of TTS across all functional hearing groups is 2,513 yd. (2.3 km). Implementation of the 2.5 nm mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

The predicted maximum range to onset mortality across all functional hearing groups is less than 250 yd. (229 m). Therefore, this measure will be effective at reducing potential mortality to all marine mammals and sea turtles when individuals are sighted. As discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), it is highly unlikely that anything but a whale blow or large pod of dolphins will be seen at distances closer to 2.5 nm near the perimeter of the mitigation zone. However, this measure is likely effective at reducing the risk of injury to marine mammals and sea turtles that may be observed from the smaller distances within the mitigation zone.

As described in Section 5.3.1 (Lookout Procedural Measures), Lookouts positioned in aircraft or vessels may be responsible for tasks in addition to observing the air or surface of the water. For example, a Lookout for this activity may also be responsible for navigation of the aircraft. Having a Lookout observe a mitigation zone that is too large could potentially increase the safety risk due to an increased level of distraction from normal job duties. Observation of an area beyond what the Navy is proposing to implement for sinking exercises is not practical and would not likely result in avoidance or reduction of injury to marine mammals or sea turtles because the effort spent observing those more distant areas would inevitably be minimal. The decrease in mitigation zone size will result in no mitigation for exposure to lower levels of potential onset of TTS; however, it will allow for a more focused survey effort over a smaller survey distance, and will consequently increase the likelihood of avoidance of injury and larger threshold shifts that would result in recovery (i.e., TTS) to marine mammals and sea turtles. The amount of time it takes for an aircraft to conduct line transects around a detonation point within the currently implemented 2 nm mitigation zone could result in animals entering the mitigation zone at one end while the aircraft completes the survey at the other end of the mitigation zone. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies] and jellyfish aggregations will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30 min. wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.3.2.2 (Impacts from Explosives) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 min. would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would reduce the ship and aircrews' abilities to coordinate attack tactics on a seaborne target as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise. Although activities involving certain types of aircraft (e.g., helicopters) typically employ a 10 min. wait period due to fuel restrictions, the Navy is able to make an exception for this particular activity due to the large variation and rotation of assets that could participate in this type of exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.13 At-Sea Explosive Testing

Recommended Mitigation and Comparison to Current Mitigation

Mitigation measures do not currently exist for at-sea explosive testing activities. Refer to Section 5.3.3.2.2 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef mitigation areas. The Navy is proposing to add the recommended measures provided below.

Mitigation during at-sea explosive testing, such as the sinking of a vessel by a sequential firing of multiple small charges (e.g., explosives in bin E5) for use as an artificial reef, will include visual observation from supporting vessels immediately before and during the activity within a mitigation zone of 1,600 yd. (1.4 km) around the intended impact location. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Detonations will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Detonations will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 min.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. During at-sea explosive testing, multiple weapons sources or charges may be used (projectiles and charges), the largest of which is a 10 lb. net explosive weight charge. The recommended mitigation zone is approximately double the predicted maximum range to onset of PTS of the largest source, and is designed to account for multiple detonations during the activity. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for at-sea explosive testing is 649 yd. (593 m). This range was determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further

protection for these species. The average range to onset of TTS across all functional hearing groups is 525 yd. (480 m). Implementation of the 1,600 yd. (1.4 km) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

The predicted maximum range to onset mortality across all functional hearing groups is less than 60 yd. (55 m). Therefore, this measure will be effective at reducing potential mortality to all marine mammals and sea turtles when individuals are sighted. This measure is likely also effective at reducing the risk of injury to marine mammals and sea turtles within the predicted maximum range to onset of PTS (649 yd. [593 m]). As discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), the likelihood of sighting individual animals, particularly sea turtles and some species of small or cryptic marine mammals, from a vessel decreases at long distances; therefore, this measure is likely ineffective at reducing impacts on sea turtles and some species of marine mammals at distances closer to 1,600 yd. (1.5 km) near the perimeter of the mitigation zone. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30 min. wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.3.2.2 (Impacts from Explosives) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 min. would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would reduce the vessel's ability to determine the pressure generated which is used to test the feasibility of using various net explosive weight sizes for different events, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of injury to some species of marine mammals; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.14 Elevated Causeway System – Pile Driving

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to (1) modify the mitigation measures currently implemented for this activity by increasing the mitigation zone from 50 yd. (46 m) to 60 yd. (55 m), (2) clarify the conditions needed to recommence an activity after a sighting, and (3) add a requirement to visually observe for kelp paddies. The recommended measures are provided below.

Mitigation will include visual observation from a small boat, the elevated causeway, or from shore starting 30 min. prior to and during the exercise within a mitigation zone of 60 yd. (55 m) around the pile driver. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Pile driving will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Pile driving will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the

animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 min.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for pile-driving exercises is 51 yd. (46 m). This range was determined by the injury threshold of 180 dB root mean square for cetaceans. The predicted average range to onset of TTS is 1,094 yd. (1 km). Implementation of the 60 yd. (55 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted. Since the mitigation zone is so small, this measure should be effective at reducing the risk to all marine mammals and sea turtles that are available to be observed within the mitigation zone. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30 min. wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.3.2.3 (Impacts from Pile Driving) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 min. would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would reduce the crew's ability to construct the causeway platform in a manner that would be expected during a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of injury to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.15 Weapons Firing Noise During Gunnery Exercises – Large-Caliber

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to implement the following mitigation measure, which only applies to the firing side of the ship as provided below.

For all explosive and non-explosive large-caliber gunnery exercises conducted from a ship, mitigation will include visual observation immediately before and during the exercise within a mitigation zone of 70 yd. (64 m) within 30 degrees on either side of the gun target line on the firing side. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, (3) the mitigation zone has been clear from any additional sightings for a period of 30 min., or (4) the ship has repositioned itself more than 140 yd. (128 m) away from the location of the last sighting.

Effectiveness Assessment

The mitigation zone is designed to reduce the potential for injury from weapons firing noise during large-caliber gunnery exercises conducted from a ship. The majority of the energy that an animal could be exposed to would occur on the firing side of the vessel and would follow in the direction of fire. It is not operationally feasible to have Lookouts stationed on all sides of the vessel to visually observe for marine mammals and sea turtles due to limited resources (e.g., manning restrictions). Since the Lookout is positioned aboard the firing ship and is visually observing nearby the ship (70 yd. [64 m]), this measure should be effective at reducing the risk to all marine mammals and sea turtles that are available to be observed. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30 min. wait period more than covers the average dive times of most marine mammal species but may not be sufficient for sea turtles. However, the analysis in Section 3.4.3.2.5 (Impacts from Weapons Firing, Launch, and Impact Noise) shows that injury to marine mammals is not expected to occur. Requiring additional delay beyond 30 min. would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would reduce the gun crews' abilities to engage surface targets and practice defensive marksmanship as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.2 Physical Disturbance and Strike

5.3.2.2.1 Vessels and In-Water Devices

5.3.2.2.1.1 Vessels

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to continue using the mitigation measures currently implemented. The recommended measures are provided below.

Vessels will avoid approaching marine mammals head on and will maneuver to maintain a mitigation zone of 500 yd. (457 m) around observed whales, and 200 yd. (183 m) around all other marine mammals (except bow riding dolphins), providing it is safe to do so.

Effectiveness and Operational Assessments

Since the Lookout is visually observing within a reasonable distance of the vessel (within 500 yd. [457 m]), this measure should be effective at reducing the risk to marine mammals that are available to be observed. However, as discussed above in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), large whales and pods of dolphins are more likely to be seen than other more cryptic species, such as beaked whales.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of injury to marine mammals; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.2.1.2 Towed In-Water Devices

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to continue using the mitigation measures currently implemented. The recommended measure is provided below.

The Navy will ensure that towed in-water devices being towed from manned platforms avoid coming within a mitigation zone of 250 yd. (229 m) around any observed marine mammal, providing it is safe to do so.

Effectiveness and Operational Assessments

Since the Lookout is visually observing within a reasonable distance of the vessel (250 yd. [229 m]), this measure should be effective at reducing the risk to marine mammals that are observable. However, as discussed above in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), large whales and pods of dolphins are more likely to be seen than other more cryptic species such as beaked whales.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of injury to marine mammals; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.2.2 Non-Explosive Practice Munitions

5.3.2.2.2.1 Gunnery Exercises – Small-, Medium-, and Large-Caliber Using a Surface Target

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to (1) continue using the mitigation measures currently implemented for this activity, and (2) clarify the conditions needed to recommence an activity after a sighting. The recommended measures are provided below.

Mitigation will include visual observation immediately before and during the exercise within a mitigation zone of 200 yd. (183 m) around the intended impact location. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, (3) the mitigation zone has been clear from any additional sightings for a period of 10 min. for a firing aircraft, (4) the mitigation zone has been clear from any additional sightings for a period of 30 min. for a firing vessel, or (5) the intended target location has been repositioned more than 400 yd. (366 m) away from the location of the last sighting.

Effectiveness and Operational Assessments

The mitigation zone is designed to reduce the potential for direct strike from a non-explosive projectile. Large-caliber gunnery exercises involve the participating ship firing munitions at a target location from ranges up to 6 nm away. Small- and medium-caliber gunnery exercises involve the participating vessel or

aircraft firing munitions at a target location from up to 2 nm away, although typically closer. Therefore it is necessary for the Lookout to be able to visually observe the mitigation zone from these distances. Although the Lookout will observe for all marine mammals or sea turtles in the area, as discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), it is highly unlikely that anything but a whale blow or large pod of dolphins will be seen at distances closer to 6 nm (i.e., at the furthest target distance for large-caliber gunnery exercises) or 2 nm (i.e., at the furthest target distance for small- and medium-caliber gunnery exercises). Although this measure is likely ineffective at reducing the risk of injury to sea turtles and some species of marine mammals, it does reduce the risk for those individuals that may be observed. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30 min. wait period when vessels are firing more than covers the average dive times of most marine mammal species but may not be for sea turtles. However, the analysis in Section 3.4.3.4.3 (Impacts from Military Expended Materials) shows that injury to marine mammals and sea turtles is not expected to occur. Requiring additional delay beyond 30 min. for a firing vessel would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would reduce the gun crews' abilities to engage surface targets and practice defensive marksmanship as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The 10 min. wait period for a firing aircraft covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10 min. wait period is based on fuel restrictions for the types of aircraft involved in this activity (e.g., helicopters). Requiring additional delay beyond 10 min. for these sources would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would eliminate opportunities and reduce the gun crews' abilities to engage surface targets and practice defensive marksmanship as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of injury to some species of marine mammals; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.2.2.2 Bombing Exercises

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to (1) continue using the mitigation measures currently implemented for this activity, and (2) clarify the conditions needed to recommence an activity after a sighting. The recommended measures are provided below.

Mitigation will include visual observation from the aircraft immediately before the exercise and during target approach within a mitigation zone of 1,000 yd. (914 m) around the intended impact location. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Bombing will cease if a marine mammal or sea turtle is sighted within

the mitigation zone. Bombing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 min.

Effectiveness and Operational Assessments

The mitigation zone is designed to reduce the potential for direct strike from a non-explosive bomb. The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. The 10 min. wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10 min. wait period is based on fuel restrictions for the types of aircraft involved in this activity (e.g., F/A-18). Requiring additional delay beyond 10 min. for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and deliver bombs as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of injury to marine mammals or sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.2.2.3 Missile Exercises (Including Rockets) Using a Surface Target

The Navy is proposing to (1) modify the mitigation measures currently implemented for this activity by reducing the mitigation zone from 1,800 yd. (1.6 km) to 900 yd. (823 m), (2) clarify the conditions needed to recommence an activity after a sighting, (3) adopt the marine mammal and sea turtle mitigation zone size for floating vegetation for ease of implementation**,** and (4) modify the platform of observation to eliminate the requirement to observe when ships are firing. Refer to Section 5.3.3.2.2 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef mitigation areas. The recommended measures are provided below.

When aircraft are firing, mitigation will include visual observation by the aircrew or supporting aircraft prior to commencement of the activity within a mitigation zone of 900 yd. (823 m) around the deployed target. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 min. or 30 min. (depending on aircraft type).

Effectiveness and Operational Assessments

The mitigation zone is designed to reduce the potential for direct strike from a non-explosive projectile. Activities using non-explosive missiles (including rockets) involve the participating ship or aircraft firing munitions at a target location typically up to 15 nm away and infrequently include ranges up to 75 nm away. When an aircraft is firing, the aircraft can travel close to the intended impact area so that it can be visually observed. Because that type of observation is not possible for a ship, visual observation is not suitable for activities that involve a ship-fired missile. Even with aircraft firing, there is a chance that animals could enter the impact area after the visual observations have been completed and the activity has commenced. Observation for indicators of marine mammal and sea turtle presence (e.g., concentrations of floating vegetation [*Sargassum* or kelp paddies]) will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. The 30 min. wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.3.4.3 (Impacts from Military Expended Materials) shows that injury to marine mammals and sea turtles is not expected to occur. The 30 min. wait period represents the maximum wait period acceptable for certain types of aircraft involved in this activity (e.g., maritime patrol aircraft) based on their specific fuel restrictions. Requiring additional delay beyond 30 min. for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and launch missiles as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The 10 min. wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10 min. wait period is based on the specific fuel restrictions for the other types of aircraft involved in this activity (e.g., helicopters). Requiring additional delay beyond 10 min. for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and launch missiles as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of injury to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.3 MITIGATION AREAS

The Navy is proposing to implement several mitigation measures within pre-defined habitat areas in the Study Area. For the purposes of this document, the Navy will refer to these areas as "mitigation areas." As described throughout this section, these recommended mitigation areas may be based off endangered species critical habitats, endangered species reproductive areas, or bottom features. The size and location of certain habitat areas, such as the critical habitats, is subject to change over time; however, the Navy's effectiveness and operational assessments and resulting mitigation

recommendations are entirely dependent on the mitigation area defined in this document. Therefore, it is important to note that the Navy is recommending implementing mitigation measures only within each area as described in this document. Applying these mitigations to additional or expanded areas could potentially result in an unacceptable impact on readiness.

5.3.3.1 Marine Mammal Habitats

5.3.3.1.1 Humpback Whale

5.3.3.1.1.1 Humpback Whale Cautionary Area

Recommended Mitigation and Comparison to Current Mitigation

To supplement the mitigation measures described in Section 5.3.2 (Mitigation Zone Procedural Measures), the Navy is proposing continuation of mitigation measures within the Hawaiian Islands Humpback Whale National Marine Sanctuary. Hawaiian Islands humpback whale high density areas have been identified by NMFS as important calving areas for humpback whales from December to April. NMFS has reviewed the Navy's data on mid-frequency active sonar training in these dense humpback whale areas (exclusive of the waters adjacent to Pacific Missile Range Facility) since June 2006 and found it to be rare and infrequent. While past data is no guarantee of future activity, it documents a history of low level mid-frequency active sonar activity in dense humpback areas. The Navy will continue to collect and provide NMFS with specific data for activities conducted within these high density areas during the winter calving season.

In order to be successful at operational missions and against the threat of quiet, diesel-electric submarines, the Navy has, for more than 40 years, routinely conducted anti-submarine warfare training in major exercises in the waters off the Hawaiian Islands, including the Hawaiian Islands Humpback Whale National Marine Sanctuary. During this period, no harmful effects to humpback whales attributed to mid-frequency active sonar use have been observed. Coincident with this use of mid-frequency active sonar, abundance estimates reflect an annual increase in the humpback whale stock (Mobley et al. 2001; Mobley 2004).

NMFS and the Navy have explored ways of reducing or avoiding impacts to humpback whales from exposure to mid-frequency active sonar. Factors including how practical the measure is to implement and how the measure could affect training fidelity are considered before implementing the measure. The Navy recognizes the significance of the Hawaiian Islands for humpback whales. The Navy has designated a humpback whale cautionary area (Figure 5.3-1), which consists of a 3.1 mi. (5 km) mitigation zone that has been identified as having one of the highest concentrations of humpback whales during the critical winter months. The Navy has agreed that training exercises in the humpback whale cautionary area will require a much higher level of clearance than is normal practice in planning and conducting mid-frequency active sonar training. Should national security needs require mid-frequency active sonar training and testing in the cautionary area between 15 December and 15 April, it shall be personally authorized by the Commander, U.S. Pacific Fleet. The Commander, U.S. Pacific Fleet shall base such authorization on the unique characteristics of the area from a military readiness perspective, taking into account the importance of the area for humpback whales and the need to reduce adverse impacts on humpback whales from mid-frequency active sonar whenever practicable. Approval at this level for this type of activity is extraordinary. The Commander, U.S. Pacific Fleet is a four-star Admiral and the highest ranking officer in the U.S. Pacific Fleet. This case-by-case authorization cannot be delegated and represents the Navy's commitment to fully consider and balance mission requirements with environmental stewardship. Further, the Commander, U.S. Pacific Fleet will provide specific direction on required mitigation prior to operational units transiting to and training in

the cautionary area. This process will ensure the decisions to train in this area are made at the highest level in the Pacific Fleet, heighten awareness of humpback whale activities in the cautionary area, and serve to reemphasize that mitigation measures are to be scrupulously followed. The Navy will provide NMFS with advance notification of any such activities.

Effectiveness and Operational Assessments

Mid-frequency active sonar training will not regularly occur within the humpback whale cautionary area between 15 December and 15 April. This training can occur in this area during this time period only with approval by the Commander, U.S. Pacific Fleet. This approach will reduce potential interactions between humpback whales and U.S. Navy training activities during the critical winter months of highest concentrations of humpback whales.

The Navy proposes implementing the recommended measures described above because (1) they are likely to result in avoidance or reduction of injury to the humpback whale; and (2) they have acceptable operational impacts on the proposed activity with regard to safety, practicability, impact on readiness, and Navy policy.

5.3.3.2 Seafloor Resources

5.3.3.2.1 Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks

Recommended Mitigation and Comparison to Current Mitigation

The Navy is proposing to (1) modify some of the mitigation measures for seafloor habitats and shipwrecks and (2) discontinue the currently implemented measures for medium- and large-caliber gunnery exercises and missile exercises using airborne targets. The recommended measures are provided below.

To aid in the implementation of these measures, the Navy will include maps of surveyed shallow coral reefs, artificial reefs, and shipwrecks, in the Protective Measures Assessment Protocol. For mitigation, the term "surveyed" refers to habitat features where the available data indicate the natural boundary of the feature at a generally constant accuracy. Data that are generalized within large geometric areas (e.g., grid cells) are not included.

The Navy will not conduct precision anchoring within the anchor swing diameter, or explosive mine countermeasure and neutralization activities (except in near-shore areas of San Clemente Island in the SOCAL Range Complex and in the SSTC) within 350 yd. (320 m) of surveyed shallow coral reefs, live hardbottom, artificial reefs, and shipwrecks.

The Navy will not conduct explosive or non-explosive small-, medium-, and large-caliber gunnery exercises using a surface target, explosive missile exercises using a surface target, explosive and non-explosive bombing exercises, or at-sea explosive testing within 350 yd. (320 m) of surveyed shallow coral reefs.

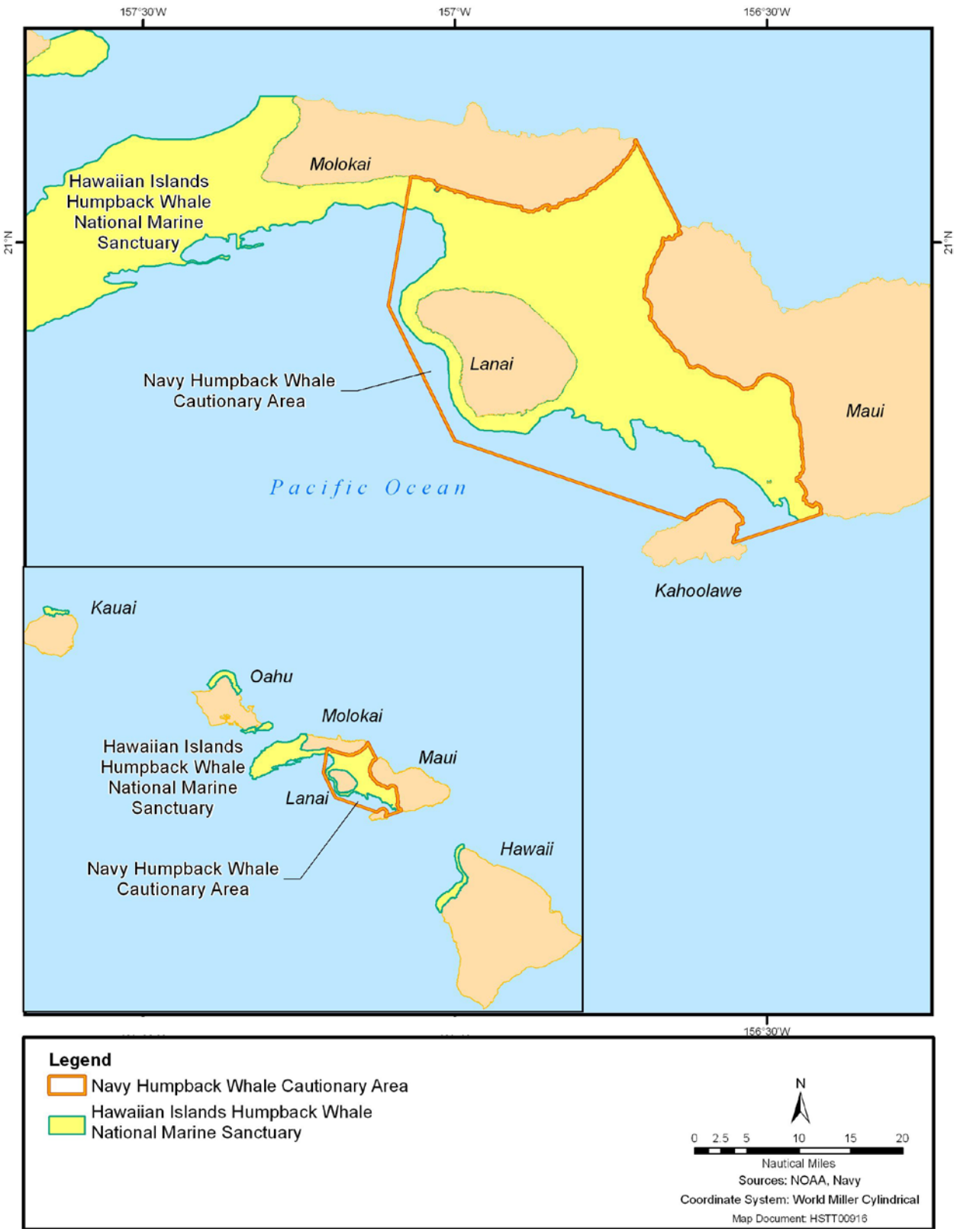

Figure 5.3-1: Navy Humpback Whale Cautionary Area

Effectiveness and Operational Assessments

The Navy's currently implemented seafloor habitats and shipwreck mitigation zones are based off the range to effects for marine mammals or sea turtles, which are driven by hearing thresholds. The Navy's recommended measures are modified to focus on reducing potential physical impacts on seafloor habitats and shipwrecks from explosives and physical strike from military expended materials. The recommended 350 yd. (320 m) mitigation zone is based off the estimated maximum seafloor impact zone for explosions discussed in Section 3.3 (Marine Habitats). The use of non-explosive military expended materials would result in a smaller footprint of potential impact; however, the Navy recommends applying the explosive mitigation zone to all explosive and non-explosive activities as listed above for ease of implementation. This standard mitigation zone will consequently result in an additional protection buffer during the non-explosive activities listed above.

It is not possible to definitively predict or to effectively monitor where the military expended materials from airborne gunnery and missile exercises using aerials targets would be likely to strike seafloor habitats and shipwrecks. The potential debris fall zone can only be predicted within tens of miles for long range events, which can be in excess of 80 nm from the firing location during some missile exercises, and thousands of yards for shorter events, which can occur within several thousand yards of the firing location.

Live hardbottom, shallow water coral reefs, artificial reefs, and shipwrecks fulfill important ecosystem functions. Avoiding or minimizing physical disturbance and strike of these resources will likely reduce the impact on these resources. This measure is only effective with regard to surveyed resources since the Navy needs specific locations to restrict the specified activities. It is not possible for the Navy to avoid these seafloor features when their exact locations are unknown.

The Navy proposes implementing the recommended measures described above because (1) they are likely to result in avoidance or reduction of physical disturbance and strike to seafloor habitats and shipwrecks; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.3.2.2 Cultural Resources

Although effects on underwater cultural resources are not anticipated, the potential for unanticipated discovery of underwater resources always exists. To ensure that previously unidentified submerged cultural resources are adequately protected, the Commander, Naval Region, the Advisory Council on Historic Preservation (Council), and the Hawaii State Historic Preservation Office entered into a Programmatic Agreement in 2003 regarding Navy undertakings in Hawaii. Among the stipulations of the Programmatic Agreement is one focused on unanticipated discoveries: Stipulation XI(A). The Programmatic Agreement stipulates; "If during the performance of an undertaking, historic properties, including submerged archaeological sites and traditional cultural places, are discovered or unanticipated effects are found, or a previously unidentified property which may be eligible for listing on the National Register of Historic Places is discovered, Commander, Naval Region Hawaii will take all reasonable measures to avoid or minimize harm to the property until it concludes consultation with the State Historic Preservation Office and any Native Hawaiian organization, including the Oahu Council of Hawaiian Civic Clubs, which has made known to Commander, Naval Region Hawaii that it attaches religious and cultural significance to the historic property."

Under the existing Programmatic Agreement with the California State Historic Preservation Office, once a currently unidentified site is determined to be eligible for the National Registry of Historic Places, the State Historic Preservation Officer will be consulted to resolve potential adverse effects and identify appropriate treatments stipulated to address identified, unavoidable adverse effects.

5.3.4 MITIGATION MEASURES CONSIDERED BUT ELIMINATED

A number of mitigation measures were suggested during the public comment periods of previous Navy environmental documents and throughout the development of this Final EIS/OEIS. As a result of the assessment process identified in Section 5.2 (Introduction to Mitigation), the Navy determined that some of the suggested measures would likely be ineffective at reducing environmental impacts, have an unacceptable operational impact based on the operational assessment, or be incompatible with Section 5.2.2 (Overview of Mitigation Approach). The measures that the Navy does not recommended for implementation are discussed in Section 5.3.4.1 (Previously Considered but Eliminated) and Section 5.3.4.2 (Previously Accepted but Now Eliminated). There is a distinction between effective and feasible observation procedures for data collection and measures employed to prevent impacts or otherwise serve as mitigation. The discussion below is in reference to those procedures meant to serve as mitigation measures.

5.3.4.1 Previously Considered but Eliminated

5.3.4.1.1 Reducing Amount of Training and Testing Activities

Reducing training and testing for the purpose of mitigation would result in an unacceptable impact on readiness for the following reasons:

The requirements to train are designed to provide the experience needed to ensure Sailors are properly prepared for operational success. Training requirements have been developed through many years of iteration and are designed to ensure Sailors achieve the levels of readiness needed to properly respond to the many contingencies that may occur during an actual mission. The Proposed Action does not include training beyond levels required for maintaining satisfactory levels of readiness due to the need to efficiently use limited resources (e.g., fuel, personnel, and time). Therefore, any reduction of training would not allow Sailors to achieve satisfactory levels of readiness needed to accomplish their mission.

The requirements to test systems prior to their implementation in military activities are identified in Department of Defense (DoD) Directive 5000.1. This directive states that test and evaluation support is to be integrated throughout the defense acquisition process. The Navy rigorously collected data during the developmental stages of this EIS/OEIS to accurately quantify test activities necessary to meet requirements of DoD Directive 5000.1. These testing requirements are designed to determine whether systems perform as expected and are operationally effective, suitable, survivable, and safe for their intended use. Any reduction of testing activities would not allow the Navy to meet its purpose and need to achieve requirements set forth in DoD Directive 5000.1.

5.3.4.1.2 Replacing Training and Testing with Simulated Activities

Replacing training and testing activities with simulated activities for the purpose of mitigation would result in an unacceptable impact on readiness for the following reasons:

As described in Section 2.5.1.3 (Simulated Training and Testing), the Navy currently uses computer simulation for training and testing whenever possible. Computer simulation can provide familiarity and

complement live training; however, it cannot provide the fidelity and level of training necessary to prepare naval forces for deployment.

The Navy is required by law to operationally test major platforms, systems, and components of these platforms and systems in realistic combat conditions before full-scale production can occur. Substituting simulation for live training and testing fails to meet the purpose of and need for the Proposed Action and therefore was eliminated from consideration as a mitigation measure.

5.3.4.1.3 Reducing Sonar Source Levels and Total Number of Hours

Active sonar is only used when required by the mission since it has the potential to alert opposing forces to the sonar platform's presence. Passive sonar and all other sensors are used in concert with active sonar to the maximum extent practicable when available and when required by the mission. Reducing active sonar source levels and the total number of active sonar hours used during training and testing activities for the purpose of mitigation would adversely impact the effectiveness of military readiness activities and increase safety risks to personnel for the following reasons:

Sonar operators need to train as they would operate during real combat situations. Operators of sonar equipment are always cognizant of the environmental variables affecting sound propagation. In this regard, sonar equipment power levels are always set consistent with mission requirements. Reducing sonar source levels for the purpose of mitigation precludes sonar operators from learning to operate the sonar systems with their entire range of capabilities throughout the extremely diverse range of environmental conditions they may encounter. Failure to train with the entire range of capabilities will reduce the effectiveness of the sonar operators should their skills be required during real world events. Not only would they not develop the skills necessary to identify and track submarines at the maximum distances of their systems capabilities, they would not learn how to use their systems' capabilities during the entire range of environmental conditions they may encounter. Likewise, they would not develop the knowledge of how to fully integrate multiple anti-submarine warfare capabilities, including other ships and aircraft into an integrated anti-submarine warfare team.

Failure to train with the entire range of capabilities also compromises training by reducing the ability for a sonar operator to detect, track, and hold an enemy target, mine, or other object, and by reducing the realism of other training scenarios (e.g., navigation training). Particularly during a strike group exercise, sonar operators need to learn to handle real world combat situations (e.g., the ability to manage sonar operations during periods of mutual interference, which can occur when more than one sonar system is operating simultaneously). Training with reduced sonar source levels would ultimately condition Sailors to expect conditions that they would not experience in a real world combat situation, thereby resulting in an unacceptable increased risk to personnel safety and the strike group's ability to achieve mission success. The Navy must test its systems in the same way they would be used for military readiness activities. Reducing sonar source levels during testing would impact the ability to determine whether systems are operationally effective, suitable, survivable, and safe. Ultimately, reducing sonar source levels would reduce training and testing realism. Reducing the total number of sonar hours used during training and testing would prevent the Navy from meeting its military readiness qualification standards.

5.3.4.1.4 Implementing Active Sonar Ramp-Up Procedures during Training

Implementing active sonar ramp-up procedures (slowly increasing the sound in the water to necessary levels) in an attempt to clear the range prior to conducting activities for the purpose of mitigation during training activities would result in an unacceptable impact on readiness and would not necessarily be effective at reducing potential impacts on marine species for the following reason:

Ramp-up procedures would alert opponents to the participants' presence. This would consequently negatively affect the realism of training because the target submarine could detect the searching unit before the searching unit could detect the target submarine, enabling the target submarine to take evasive measures. This is not representative of a real world situation and thereby would impact training realism and effectiveness. Training with reduced realism would alter Sailors' abilities to effectively operate in a real world combat situation, thereby resulting in an unacceptable increased risk to personnel safety and the sonar operator's ability to achieve mission success.

Although ramp-up procedures have been used for some testing activities, effectiveness at avoiding or reducing impacts on marine mammals has not been demonstrated. Until evidence suggests that ramp-up procedures are effective means of avoiding or reducing potential impacts on marine mammals, the Navy is proposing to eliminate the implementation of this measure for testing activities as part of the Proposed Action.

5.3.4.1.5 Reducing Vessel Speed

As described in Section 5.1.1 (Vessel Safety), as a standard operating procedure, Navy personnel are required to use extreme caution and operate at a slow, safe speed consistent with mission and safety. These standard operating procedures are designed to allow a vessel to take proper and effective action to avoid a collision with any sighted object or disturbance (which may include a marine mammal), and to stop within a distance appropriate to the prevailing circumstances and conditions. Implementing widespread reductions in vessel speed throughout the Study Area for the purpose of mitigation would be impractical with regard to military readiness activities, and result in an unacceptable impact on readiness for the following reasons:

Vessel operators need to be able to react to changing tactical situations and evaluate system capabilities in training and testing as they would in actual combat. Widespread speed restrictions would not allow the Navy to properly test vessel capabilities, for example, during full power propulsion testing during sea trials. Training with reduced realism would alter Sailors' abilities to effectively operate in a real world combat situation, thereby resulting in an unacceptable increased risk to personnel safety and the vessel operator's ability to achieve mission success.

5.3.4.1.6 Limiting Access to Training and Testing Locations

Limiting training and testing activities to specific locations for the purpose of mitigation would be impractical with regard to implementation, would adversely impact the effectiveness of military readiness activities, and would increase safety risks to personnel for the following reasons:

As described in Section 2.5.1.1 (Alternative Training and Testing Locations), the ability to use the diverse and multidimensional capabilities of each range complex and testing range results in the Navy's ability to develop and maintain high levels of readiness. Major exercises using integrated warfare components require large areas of the littorals, open ocean, and certain nearshore areas for realistic and safe training. Limiting training and testing (including the use of sonar and other active acoustic sources or explosives) to specific locations (e.g., abyssal waters and surveyed offshore waters) and avoiding areas (e.g., embayments or large areas of the littorals and open ocean) would be impractical to implement with regard to the need to conduct activities in proximity to certain facilities and range complexes. These restrictions would also adversely impact the safety of the training and testing activities by requiring activities to take place in more remote areas where safety support may be limited.

Training and testing activities require continuous access to large areas consisting potentially of thousands of square miles of ocean and air space to provide naval personnel the ability to train with and develop competence and confidence in their capabilities and their entire suite of weapons and sensors. Exercises may change mid-stream based on evaluators' assessments of performance and other conditions including weather or mechanical issues. These may preclude use of a permission scheme for access to water space. Threats to national security are constantly evolving and the Navy requires the ability to adapt training to meet these emerging threats as well as develop and test systems to effectively operate in these environments. Restricting access to limited locations would impact the ability of Navy training and testing to evolve as the threat evolves. Operational units already incorporate requirements for safety of personnel including air space and shipping routes. Safety restrictions may include limits on distance from military air fields during carrier flight operations and air traffic corridors for safety of military and civilian aviation. These types of limitations shape how exercise planners develop and implement training scenarios including those involving defense of aircraft carriers from submarines.

Therefore, limiting access to training and testing locations would reduce realism of training by restricting access to important real world combat situations, such as bathymetric features and varying oceanographic features. As described in Section 5.3.4.1.7 (Avoiding Locations Based on Bathymetry and Environmental Conditions), Sailors must be trained to handle bottom bounce, sound passing through changing currents, eddies, or across changes in ocean temperature, pressure, or salinity. Training in a few specific locations would alter Sailors' abilities to effectively operate in varying real world combat situations, thereby resulting in an unacceptable increased risk to personnel safety and the ability to achieve mission success.

5.3.4.1.7 Avoiding Locations Based on Bathymetry and Environmental Conditions

Avoiding locations for training and testing activities based on bathymetry and environmental conditions for the purpose of mitigation would increase safety risks to personnel and result in an unacceptable impact on readiness for the following reasons:

Areas where training and testing activities are scheduled to occur are carefully chosen to provide safety and allow realism of events. As described in Section 2.5.1.1 (Alternative Training and Testing Locations), the varying environmental conditions of the Study Area (e.g., bathymetry and topography) maximize the training realism and testing effectiveness. Limiting training and testing, including the use of sonar and other active acoustic sources or explosives, to avoid steep or complex bathymetric features (e.g., submarine canyons and large seamounts) and oceanographic features (e.g., surface fronts and variations in sea surface temperatures) would reduce the realism of the military readiness activity. Systems must be tested in a variety of bathymetric and environmental conditions to ensure functionality and accuracy in a variety of environments. Sonar operators need to train as they would operate during real world combat situations. Because real world combat situations include diverse bathymetric and environmental conditions, Sailors must be trained to handle bottom bounce, sound passing through changing currents, eddies, or across changes in ocean temperature, pressure, or salinity. Training with reduced realism would alter Sailors' abilities to effectively operate in a real world combat situation, thereby resulting in an unacceptable increased risk to personnel safety and the sonar operator's ability to achieve mission success.

5.3.4.1.8 Avoiding or Reducing Active Sonar at Night and During Periods of Low Visibility

Avoiding or reducing active sonar at night and during periods of low visibility for the purpose of mitigation would result in an unacceptable impact on readiness for the following reasons:

The Navy must train in the same manner as it will fight. Anti-submarine warfare can require a significant amount of time to develop the "tactical picture," or an understanding of the battle space (e.g., area searched or unsearched, identifying false contacts, and understanding the water conditions). Reducing or securing power in low-visibility conditions would affect a commander's ability to develop this tactical picture and would not provide the needed training realism. Training differently from what would be needed in an actual combat scenario would decrease training effectiveness, reduce the crew's abilities, and introduce an increased safety risk to personnel.

Mid-frequency active sonar training is required year-round in all environments, including night and low-visibility conditions. Training occurs over many hours or days, which requires large teams of personnel working together in shifts around the clock to work through a scenario. Training at night is vital because environmental differences between day and night affect the detection capabilities of sonar. Temperature layers that move up and down in the water column and ambient noise levels can vary significantly between night and day, which affects sound propagation and could affect how sonar systems are operated. Consequently, personnel must train during all hours of the day to ensure they identify and respond to changing environmental conditions, and not doing so would unacceptably decrease training effectiveness and reduce the crews' abilities. Therefore, the Navy cannot operate only in daylight hours or wait for the weather to clear before training.

The Navy must test its systems in the same way they would be used for military readiness activities. Reducing or securing power in adverse weather conditions or at night would impact the ability to determine whether systems are operationally effective, suitable, survivable, and safe. Additionally, some systems have a nighttime testing requirement. Therefore, Navy personnel cannot operate only in daylight hours or wait for the weather to clear before or during all test events.

5.3.4.1.9 Avoiding or Reducing Active Sonar during Strong Surface Ducts

Avoiding or reducing active sonar during strong surface ducts for the purpose of mitigation would increase safety risks to personnel, be impractical with regard to implementation of military readiness activities, and result in an unacceptable impact on readiness for the following reasons:

The Navy must train in the same manner as it will fight. Anti-submarine warfare can require a significant amount of time to develop the "tactical picture," or an understanding of the battle space such as area searched or unsearched, identifying false contacts, understanding the water conditions, etc. Surface ducting is a condition when water conditions (e.g., temperature layers, lack of wave action) result in little sound energy penetrating beyond a narrow layer near the surface of the water. Submarines have long been known to exploit the phenomena associated with surface ducting. Therefore, training in surface ducting conditions is a critical component to military readiness because sonar operators need to learn how sonar transmissions are altered due to surface ducting, how submarines may take advantage of them, and how to operate sonar effectively in this environment. Avoiding or reducing active sonar during surface ducting conditions would affect a commander's ability to develop this tactical picture and would not provide the needed training realism. Diminished realism would reduce a sonar operator's ability to effectively operate in a real world combat situation, thereby resulting in an unacceptable increased risk to personnel safety and the ability to achieve mission success.

Furthermore, avoiding surface ducting would be impractical to implement because ocean conditions contributing to surface ducting change frequently, and surface ducts can be of varying duration. Surface ducting can also lack uniformity and may or may not extend over a large geographic area, making it difficult to determine where to reduce power and for what periods.

5.3.4.1.10 Avoiding Locations Based on Distances from Isobaths or Shorelines

Avoiding locations for training and testing activities within the Study Area based on wide-scale distances from isobaths or the shoreline for the purpose of mitigation would be impractical with regard to implementation of military readiness activities, result in unacceptable impact on readiness, and would not be an effective means of mitigation, and would increase safety risks to personnel for the following reasons:

A measure requiring avoidance of mid-frequency active sonar within 13 nm of the 656 ft. (200 m) isobaths was part of the Rim of the Pacific exercise 2006 authorization by NMFS. This measure, as well as similar measures of like distances, lacks any scientific basis when applied to the context of the Study Area (e.g., bathymetry, sound propagation, and width of channels). There is no scientific analysis indicating this measure is protective and no known basis for these specific metrics. The Rim of the Pacific 2006 exercise mitigation measure precluded active anti-submarine training in the littoral region, which significantly impacted realism and training effectiveness (e.g., protecting ships from submarine threats during amphibious landings). This mitigation procedure had no observable effect on the protection of marine mammals during Rim of the Pacific 2006 exercises, and its value is unclear; however, its adverse effect on realistic training, as with all arbitrary distance from land restrictions, is significant.

Training in shallower water is an essential component to maintaining military readiness. Sound propagates differently in shallower water and operators must learn to train in this environment. Additionally, submarines have become quieter through the use of improved technology and have learned to hide in the higher ambient noise levels of the shallow waters of coastal environments. In real world events, it is highly likely Sailors would be working in, and therefore must train in, these types of areas.

Areas where training and testing activities are scheduled to occur are carefully chosen to provide safety and allow realism of events. The proximity to facilities, range complexes, and testing ranges is essential to the training and testing realism and effectiveness required to train and certify naval forces ready for combat operations. Limiting access to nearshore areas would restrict access to certain training and testing locations and would increase transit time for these activities, which would result in an increased risk to personnel safety, particularly for platforms with fuel restrictions (e.g., aircraft) or for certain activities such as mine countermeasures and neutralization activities using diver-placed mines.

The ability to use the diverse and multi-dimensional capabilities of each range complex and testing range results in the Navy's ability to develop and maintain high levels of readiness. Otherwise limiting training and testing (including the use of sonar and other active acoustic sources or explosives) to avoid arbitrary distances from isobaths or the shoreline would adversely impact the effectiveness of the training and testing. This includes avoiding conducting activities within 12 nm from shore, 25 nm from shore, between shore and the 20 m isobath, and 13 nm out from the 656 ft. (200 m) isobath. Operating in shallow water is essential in order to provide realistic training on real world combat conditions with regard to shallow water sound propagation.

5.3.4.1.11 Avoiding Marine Species Habitats

Navy has recommended measures within several mitigation areas (Section 5.3.3, Mitigation Areas) that have been well-documented as important habitats for particular species and in which implementation of mitigation would not result in unacceptable impacts on readiness. These mitigation areas have been carefully selected on a case-by-case basis through consultation with NMFS and the U.S. Fish and Wildlife

Service. Otherwise avoiding all marine species habitats (e.g., foraging locations, reproductive locations, migration corridors, and locations of modeled takes) for the purpose of mitigation would be impractical with regard to implementation of military readiness activities, would result in unacceptable impact on readiness, and would increase safety risks to personnel for the following reasons:

As described in Section 5.3.4.1.6 (Limiting Access to Training and Testing Locations) and Section 5.3.4.1.7 (Avoiding Locations Based on Bathymetry and Environmental Conditions), areas where training and testing activities are scheduled to occur are carefully chosen to provide safety and allow realism of events, and the varying environmental conditions of these areas maximize the training realism and testing effectiveness. Activity locations inevitably overlap a wide array of marine species habitats, including foraging habitats, reproductive areas, and migration corridors. Otherwise limiting activities to avoid these habitats would adversely impact the effectiveness of the training or testing activity, and would therefore result in an unacceptable increased risk to personnel safety and the ability to achieve mission success.

As described in the *Determination of Acoustic Effects on Marine Mammals and Sea Turtles for the Hawaii-Southern California Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement* technical report (Marine Species Modeling Team 2013), modeling locations were developed based on historical data and anticipated future needs. The model does not provide information detailed enough to analyze or compare locations based on potential take levels for each activity; therefore, applying the modeling results to inform development of mitigation areas would not be appropriate.

5.3.4.1.12 Avoiding Marine Protected Areas

The Navy recommends conducting special mitigation within areas (Section 5.3.3, Mitigation Areas) that have been well-documented as important habitats for particular species. Otherwise avoiding marine protected areas for the purpose of mitigation would increase safety risks to personnel, be impractical with regard to implementation, and would not be warranted based on the discussions presented in the Chapter 3 (Affected Environment and Environmental Consequences) environmental analyses for biological resources and Section 6.1.2 (Marine Protected Areas).

Areas where training and testing activities are scheduled to occur are carefully chosen to provide safety and allow realism of events. The proximity to facilities, range complexes, and testing ranges is essential to the training and testing realism and effectiveness required to train and certify naval forces ready for combat operations. Limiting access to marine protected areas would restrict access to training and testing locations and would increase transit time, which would result in an increased risk to personnel safety, particularly for platforms with fuel restrictions (e.g., aircraft).

As described in Section 6.1.2 (Marine Protected Areas), due to the nature of most training and testing activities (e.g., requiring deep water), proposed activities are unlikely to occur in the extremely shallow nearshore waters typical of most marine protected areas. Within most marine protected areas, the only activity likely to occur is an aircraft overflight during transit from an airfield to an offshore training or testing location. Exposure of marine protected area resources to aircraft overflights would be brief and is expected to cause only a minor and temporary behavioral reaction due to noise for marine mammals, sea turtles, birds, or fish that may be present in the area. There is potential for birds to be struck by aircraft; however, the Navy implements standard operating procedures that require pilots of Navy aircraft to make every attempt to avoid large flocks of birds in order to reduce the safety risk involved with a potential bird strike. Additional mitigation or avoidance of these marine protection areas would

be unnecessary, and limiting passage through the areas would restrict direct access to training and testing locations. Such avoidance would ultimately increase transit time and for platforms with fuel restrictions (e.g., aircraft) would therefore result in an unacceptable increased risk to personnel safety.

For marine protected areas (e.g., gear restricted areas) located further offshore, activities in addition to aircraft overflights may occur. Refer to Section 6.1.2 (Marine Protected Areas) for a more detailed discussion on the activities that are expected to occur within marine protected areas in the Study Area. Ultimately, limiting access to training and testing locations that overlap, are contained within, or are adjacent to marine protected areas would reduce realism of training by restricting access to important real world combat situations, such as bathymetric features and varying oceanographic features. As described in Section 2.5.1.1 (Alternative Training and Testing Locations), the ability to use the diverse and multidimensional capabilities of each range complex and testing range results in the Navy's ability to develop and maintain high levels of readiness. Major exercises using integrated warfare components require large areas of the littorals, open ocean, and certain nearshore areas for realistic and safe training. Limiting training and testing to specific locations and avoiding all marine protected areas would be impractical to implement with regard to the need to conduct activities in proximity to certain facilities, range complexes, and testing ranges. The Navy typically conducts activities in proximity to certain facilities, range complexes, and testing ranges in order to reduce travel time and funding required to conduct training away from a unit's home base. Activities involving the use of helicopters typically occur in proximity to shore or refueling stations due to fuel restrictions and personnel safety. Training and testing location limitations would also adversely impact the safety of the training and testing activities by requiring activities to take place in more remote areas where safety support may be limited. Refer to Section 5.3.4.1.6 (Limiting Access to Training and Testing Locations) for further discussion on the impacts of limiting access to training and testing locations on the Navy's ability to maintain military readiness.

5.3.4.1.13 Increasing Visual and Passive Acoustic Observations

Increasing visual and passive acoustic observations for the purpose of mitigation would be impractical with regard to implementation of military readiness activities and result in unacceptable impact on readiness for the following reasons:

The Navy recommended mitigation measures already represent the maximum level of effort (e.g., numbers of Lookouts and passive sonobuoys) that the Navy can commit to observing mitigation zones given the number of personnel that will be involved and the number and type of assets and resources available. The number of Lookouts that the Navy recommends for each measure often represents the maximum capacity based on limited resources (e.g., space and manning restrictions). For example, platforms such as the Littoral Combat Ship are minimally manned and are therefore physically unable to accommodate more than one Lookout. Furthermore, training and testing activities are carefully planned with regard to personnel duties. Requiring additional Lookouts would either require adding personnel, for which there would be no additional space, or reassigning duties, which would divert Navy personnel from essential tasks required to meet mission objectives.

The Navy will conduct passive acoustic monitoring during several activities with Navy assets, such as sonobuoys, already participating in the activity (e.g., sinking exercises, torpedo [explosive] testing, and improved extended echo ranging sonobuoys). Refer to Section 5.3.2 (Mitigation Zone Procedural Measures) for additional information on the use of passive acoustics during training and testing activities. The Navy does not have the resources to construct and maintain additional passive acoustic monitoring systems for each training and testing activity.

5.3.4.1.14 Increasing the Size of Observed Mitigation Zones

Increasing the size of observed mitigation zones for the purpose of mitigation would be impractical with regard to implementation of military readiness activities and result in unacceptable impact on readiness for the following reasons:

The Navy developed activity-specific mitigation zones based on the Navy's acoustic propagation model. In this HSTT analysis, the Navy developed each recommended mitigation zone to avoid or reduce the potential for onset of the lowest level of injury, PTS, out to the predicted maximum range. Mitigating to the predicted maximum range to PTS consequently also mitigates to the predicted maximum range to onset mortality (1 percent mortality), onset slight lung injury, and onset slight gastrointestinal tract injury, since the maximum range to effects for these criteria are shorter than for PTS. Furthermore, in most cases, the predicted maximum range to PTS also covers the predicted average range to TTS. In some instances, the Navy recommends mitigation zones that are larger or smaller than the predicted maximum range to PTS based on the associated effectiveness and operational assessments presented in Section 5.3.2 (Mitigation Zone Procedural Measures).

The Navy recommended mitigation zones represent the maximum area the Navy can effectively observe based on the platform of observation, number of personnel that will be involved, and the number and type of assets and resources available. As mitigation zone sizes increase, the potential for reducing impacts decreases. For instance, if a mitigation zone increases from 1,000 to 4,000 yd. (914 to 3,658 m), the area that must be observed increases sixteen-fold. The Navy recommended mitigation measures balance the need to reduce potential impacts with the ability to provide effective observations throughout a given mitigation zone. Implementation of mitigation zones is most effective when the zone is appropriately sized to be realistically observed. The Navy does not have the resources to maintain additional Lookouts or observer platforms that would be needed to effectively observe mitigation zones of increased size. Further, as explained above, the number of Lookouts that the Navy recommends for each measure often represents the maximum capacity based on limited resources (e.g., space and manning restrictions). For example, platforms such as the Littoral Combat Ship are minimally manned and are therefore physically unable to accommodate more than one Lookout. Training and testing activities are carefully planned with regard to personnel duties. Requiring observation of mitigation zones of increased size would either require adding personnel, for which there would be no additional space or resources, or reassigning duties, which would divert Navy personnel from essential tasks required to meet mission objectives. For most activities, Lookouts are required to observe for concentrations of detached floating vegetation (*Sargassum* or kelp paddies), which are indicators of potential marine mammal and sea turtle presence, within the mitigation zone to further help reduce the potential for injury to occur.

5.3.4.1.15 Conducting Visual Observations Using Third-Party Observers

With limited exceptions, use of third-party observers (e.g., trained marine species observers) in air or on surface platforms in addition to existing Navy Lookouts for the purposes of mitigation would be impractical with regard to implementation of military readiness activities and result in unacceptable impact on readiness for the following reasons:

Navy personnel are extensively trained in spotting items on or near the water surface. Use of Navy Lookouts ensures immediate implementation of mitigation if marine species are sighted. A critical skill set of effective Navy training is communication. Navy Lookouts are trained to act swiftly and decisively to ensure that appropriate actions are taken. Additionally, multiple training and testing events can occur simultaneously and in various regions throughout the Study Area, and can last for days or weeks at a

time. The Navy does not have the resources to maintain third-party observers to accomplish the task for every event.

The use of third-party observers would compromise security for some activities involving active sonar due to the requirement to provide advance notification of specific times and locations of Navy platforms. Reliance on the availability of third-party personnel would impact training and testing flexibility. The presence of other aircraft in the vicinity of naval activities would raise safety concerns for both the commercial observers and naval aircraft. Furthermore, vessels have limited passenger capacity. Training and testing event planning includes careful consideration of this limited capacity in the placement of personnel on ships involved in the event. Inclusion of non-Navy observers onboard these vessels would require that in some cases there would be no additional space for essential Navy personnel required to meet the exercise objectives.

The areas where training events will most likely occur in the Study Area cover approximately 1 million square nautical miles. Contiguous anti-submarine warfare events may cover many hundreds or even thousands of square miles. The number of civilian vessels or aircraft required to monitor the area of these events would be considerable. It is, thus, not feasible to survey or monitor the large exercise areas in the time required. In addition, marine mammals may move into or out of an area, if surveyed before an event, or an animal could move into an area after an event took place. Given that there are no adequate controls to account for these or other possibilities, there is little utility to performing extensive before or after event surveys of large exercise areas as a mitigation measure.

Surveying during an event raises safety issues with multiple, slow civilian aircraft operating in the same airspace as military aircraft engaged in combat training activities. In addition, many of the training and testing events take place far from land, limiting both the time available for civilian aircraft to be in the event area and presenting a concern should aircraft mechanical problems arise. Scheduling civilian vessels or aircraft to coincide with training events would impact training effectiveness, since exercise event timetables cannot be precisely fixed and are instead based on the free-flow development of tactical situations. Waiting for civilian aircraft or vessels to complete surveys, refuel, or be on station would slow the progress of the exercise and impact the effectiveness of the military readiness activity.

5.3.4.1.16 Adopting Mitigation Measures of Foreign Navies

Adopting mitigation measures of foreign navies generally for the purpose of mitigation, such as expanding the mitigation zones to match those used by a particular foreign navy, would be impractical with regard to implementation of military readiness activities and result in unacceptable impact on readiness for the following reasons:

Mitigation measures are carefully customized for and agreed upon by each individual navy based on potential impacts of the activities on marine species and the impacts of the mitigation measures on military readiness. The mitigation measures developed for one navy would not necessarily be effective at reducing potential impacts on marine species by all navies. Similarly, mitigation measures that do not cause an unacceptable impact on one navy may cause an unacceptable impact on another. For example, most other navies do not possess an integrated strike group and do not have integrated training requirements. The Navy's training is built around the integrated warfare concept and is based on the Navy's capabilities, the threats faced, the operating environment, and the overall mission. Implementing other navies' mitigation would be incompatible with U.S. Navy requirements. The U.S. Navy's recommended mitigation measures have been carefully designed to reduce potential impacts on marine species while not causing an unacceptable impact on readiness.

5.3.4.1.17 Increasing Reporting Requirements

The Navy has extensive reporting requirements, including exercise, testing, and monitoring reporting designed to verify implementation of mitigation, comply with current permits, and improve future environmental assessments (Section 5.5.2, Reporting). Increasing the requirement to report marine species sightings to augment scientific data collection and to further verify the implementation of mitigation measures is unnecessary and would increase safety risks to personnel, be impractical with regard to implementation of military readiness activities, and result in unacceptable impact on readiness for the following reasons:

Vessels, aircraft, and personnel engaged in training and testing events are intensively employed throughout the duration of training and testing activities. Any additional workload assigned that is unrelated to their primary duty would adversely impact personnel safety and the effectiveness of the military readiness activity they are undertaking. Lookouts are not trained to make accurate species-specific identification and would not be able to provide the detailed information that the scientific community would use. Alternatively, the Navy has an integrated comprehensive monitoring program (Section 5.4, Mitigation Summary) that does provide information that is available and useful to the scientific community in annual monitoring reports.

5.3.4.2 Previously Accepted but Now Eliminated

5.3.4.2.1 Implementing Active Sonar Ramp-Up Procedures During Testing

Some testing activities have implemented active sonar ramp-up procedures (slowly increasing the sound in the water to necessary levels) in an attempt to clear the range prior to conduct of activities for the purpose of mitigation. Although ramp-up procedures have been used for some testing activities, the effectiveness at avoiding or reducing impacts on marine mammals has not been demonstrated. Until evidence suggests that ramp-up procedures are an effective means of avoiding or reducing potential impacts on marine mammals, and for reasons discussed in section 5.3.4.1.4 (Implementing Active Sonar Ramp-Up Procedures During Training), the Navy is proposing to eliminate the implementation of this measure for testing activities as part of the Proposed Action.

5.3.4.2.2 Implementing a Mitigation Zone for Missile Exercises with Airborne Targets

Per current mitigation, a mitigation zone of 1,000 yd. (915 m) is observed around the expected expended material field. The Navy is proposing to eliminate the need for a Lookout to maintain a mitigation zone for missile exercises involving airborne targets. Most airborne targets are recoverable aerial drones, and missile impact with the target does not typically occur. Most anti-air missiles used in training are telemetry configured (i.e., they do not have an actual warhead). Impact of a target is unlikely because missiles are designed to detonate (simulated detonation for telemetry missiles) in the vicinity of the target and not as a result of a direct strike on the target. Given the speed of the missile and the target, the high altitudes involved, and the long ranges of missile travel possible, it is not possible to definitively predict or to effectively observe where the missile fragments will fall. The potential expended material fall zone can only be predicted within tens of miles for long range events, which can be in excess of 80 nm from the firing location, and thousands of yards for shorter events, which can occur within several thousand yards from the firing location. Establishment of a mitigation zone for activities involving airborne targets would be ineffective at reducing potential impacts.

Furthermore, the potential risk to any marine mammal or sea turtle from a missile exercise with an airborne target is a direct strike from falling expended material. Based on the extremely low potential

for a target strike and associated expended material field to co-occur in space and time with a marine species at or near the surface of the water, the potential for a direct strike is negligible.

5.3.4.2.3 Implementing a Mitigation Zone for Medium and Large-Caliber Gunnery Exercises with Airborne Targets

Per current mitigation, a mitigation zone is observed in the vicinity of the expected military expended materials field. The Navy is proposing to eliminate the need for a Lookout to observe the vicinity of the expected military expended materials for medium- and large-caliber gunnery exercises involving airborne targets. The potential military expended materials fall zone can only be predicted within thousands of yards, which can be up to 7 nm from the firing location. Establishment of a mitigation zone for activities involving airborne targets would be ineffective at reducing potential impacts.

Furthermore, the potential risk to any marine mammal or sea turtle from a gunnery exercise with an airborne target is a direct strike from falling military expended materials. Based on the extremely low potential for military expended materials to co-occur in space and time with a marine species at or near the surface of the water, the potential for a direct strike is negligible.

5.3.4.2.4 Implementing Measures for Laser Test Operations

Visual surveys would be conducted for all testing activities involving laser line scan, light imaging detection, and ranging lasers. Per current standard operating procedures, only trained personnel operate lasers and visual observation of the area is conducted to ensure human safety. The Navy is proposing to discontinue this procedure as a mitigation measure because: (1) it is currently a standard operating procedure conducted for human safety, and (2) the environmental consequences analysis suggests that impacts on resources from laser activities are not expected.

5.4 MITIGATION SUMMARY

Table 5.4-1 provides a summary of the Navy's recommended mitigation measures. For reference, currently implemented mitigation measures for each activity category are also summarized in the table. The process for developing each of these measures is detailed in Section 5.2.3 (Assessment Method) and involved: (1) an effectiveness assessment to determine if implementation of the measure will likely result in avoidance or reduction of an impact on a resource, and (2) an operational assessment to determine if implementation of the measures will have acceptable operational impacts on the Proposed Action with regard to personnel safety, practicality of implementation, readiness, and Navy policy. Measures are intended to meet applicable regulatory compliance requirements for NEPA, Executive Order 12114, and Council on Environmental Quality guidance. The Navy recommended mitigation measures were also developed consistent with resource-specific environmental requirements, as follows:

- Measures specifying marine mammals and indicators of marine mammal presence (e.g. floating vegetation [*Sargassum* or kelp paddies], large schools of fish, or flocks of seabirds) as the protection focus are intended to meet MMPA requirements.
- Measures specifying marine mammals, sea turtles, flocks of seabirds, floating vegetation (*Sargassum* or kelp paddies), large schools of fish, jellyfish aggregations, or shallow coral reefs as the protection focus are intended to meet ESA requirements.
- Measures specifying shallow coral reefs, live hardbottom, artificial reefs, or shipwrecks as the protection focus are intended to meet Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act.

- Measures specifying shipwrecks is an additional protection focus intended to meet Abandoned Shipwreck Act and National Historic Preservation Act requirements.

The measures presented in Table 5.4-1 are discussed in greater detail in Section 5.3.1 (Lookout Procedural Measures), Section 5.3.2 (Mitigation Zone Procedural Measures), and Section 5.3.3 (Mitigation Areas). As discussed in Section 5.2.2.2 (Protective Measures Assessment Protocol), the final suite of mitigations resulting from the ongoing planning for this Final EIS/OEIS, as well as the regulatory consultation and permitting processes will be integrated into the Protective Measures Assessment Protocol for implementation purposes. Section 5.5 (Monitoring and Reporting) describes the monitoring and reporting efforts the Navy will undertake to investigate the effectiveness of implemented mitigation measures and to better understand the impacts of the Proposed Action on marine resources..

Table 5.4-1: Summary of Recommended Mitigation Measures

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Specialized Training	Lookouts will complete the Introduction to the U.S. Navy Afloat Environmental Compliance Training Series and the U.S. Navy Marine Species Awareness Training (or civilian equivalent).	The mitigation zones observed by Lookouts are specified for each Mitigation Zone Procedural Measure below.	Applicable personnel will complete the U.S. Navy Marine Species Awareness Training prior to standing watch or serving as a Lookout.
Low-Frequency and Hull-Mounted Mid-Frequency Active Sonar during Anti-Submarine Warfare and Mine Warfare	2 Lookouts (general) 1 Lookout (minimally manned, moored, or anchored)	Sources that can be powered down: 1,000 yd. (914 m) and 500 yd. (457 m) power downs and 200 yd. (183 m) shutdown for marine mammals (hull-mounted mid-frequency and low-frequency) and sea turtles (low-frequency only). Sources that cannot be powered down: 200 yd. (183 m) shutdown for marine mammals and sea turtles. Both: observation for concentrations of floating vegetation (*Sargassum* or kelp paddies).	Hull-mounted mid-frequency: 1,000 yd. (914 m) and 500 yd. (457 m) power downs and 200 yd. (183 m) shutdown for marine mammals and sea turtles; avoidance of *Sargassum* rafts. Low-frequency: None
High-Frequency and Non-Hull Mounted Mid-Frequency Active Sonar	1 Lookout	200 yd. (183 m) for marine mammals (high-frequency and mid-frequency), sea turtles (bins MF8, MF9, MF10, and MF12 only), and concentrations of floating vegetation (*Sargassum* or kelp paddies).	Non-hull mounted mid-frequency: 200 yd. (183 m) for marine mammals, floating vegetation, and kelp paddies. High-frequency: None
Improved Extended Echo Ranging Sonobuoys	1 Lookout	600 yd. (549 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Passive acoustic monitoring conducted with Navy assets participating in the activity.	1,000 yd. (914 m) for marine mammals and sea turtles; 400 yd. (366 m) for floating vegetation and kelp paddies. Passive acoustic monitoring conducted with Navy assets participating in the activity.

Table 5.4-1: Summary of Recommended Mitigation Measures (continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Explosive Sonobuoys using 0.6–2.5 lb. NEW	1 Lookout	350 yd. (320 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Passive acoustic monitoring conducted with Navy assets participating in the activity.	None
Anti-Swimmer Grenades	1 Lookout	200 yd. (183 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies).	None.
Mine Countermeasures and Mine Neutralization using Positive Control	General: 1 or 2 Lookouts (NEW dependent) Diver-placed: 2 Lookouts Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs, and artificial reefs, shipwrecks. Lookouts will survey the mitigation zone for seabirds prior to and after the detonation event.	NEW dependent for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). SOCAL and HRC (except near-shore areas of San Clemente Island and in the SSTC): 350 yd. (320 m) from surveyed shallow coral reefs, live hardbottom, artificial reefs, and shipwrecks.	General: NEW dependent for marine mammals and sea turtles. Diver-placed: 700 yd. (640 m) for up to 29 lb. or 250–500 lb. charge for marine mammals and turtles. 1,000 ft. (305 m) from surveyed live hardbottom, artificial reefs, and shipwrecks.
Mine Neutralization Activities Using Diver-Placed Time-Delay Firing Devices	4 Lookouts Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs, and artificial reefs, shipwrecks. Lookouts will survey the mitigation zone for seabirds prior to and after the detonation event.	Up to 10 min. time-delay using up to 29 lb. NEW: 1,000 yd. (915 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies).	10 min. time-day on 29 lb. NEW: 1,450 yd. (1,326 m) for marine mammals and sea turtles.

Table 5.4-1: Summary of Recommended Mitigation Measures (continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Explosive and Non-Explosive Gunnery Exercises – Small- and Medium-Caliber Using a Surface Target	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	200 yd. (183 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). 350 yd. (320 m) for surveyed shallow coral reefs.	200 yd. (183 m) for marine mammals, sea turtles, floating vegetation and surveyed shallow coral reefs.
Explosive and Non-Explosive Gunnery Exercises – Large-Caliber Using a Surface Target	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	Explosive: 600 yd. (549 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Non-Explosive: 200 yd. (183 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Both: 70 yd. (64 m) within 30 degrees on either side of the gun target line on the firing side for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Both: 350 yd. (320 m) for surveyed shallow coral reefs.	Explosive: 600 yd. (549 m) for marine mammals, sea turtles, floating vegetation, and surveyed shallow coral reefs. Non-Explosive: 200 yd. (183 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Both: 70 yd. (64 m) around entire ship for marine mammals and sea turtles.
Non-Explosive Missile Exercises and Explosive Missile Exercises (Including Rockets) up to 250 lb. NEW Using a Surface Target	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	900 yd. (823 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). 350 yd. (320 m) for surveyed shallow coral reefs.	1,800 yd. (1.6 km) for marine mammals, sea turtles, floating vegetation and kelp paddies.

Table 5.4-1: Summary of Recommended Mitigation Measures (continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Explosive Missile Exercises Using 251–500 lb. NEW Using a Surface Target	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	2,000 yd. (1.8 km) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). 350 yd. (320 m) for surveyed shallow coral reefs.	None.
Explosive and Non-Explosive Bombing Exercises	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	Explosive: 2,500 yd. (2.3 km) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Non-Explosive: 1,000 yd. (914 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Both: 350 yd. (320 m) for surveyed shallow coral reefs.	Explosive: 1,000 yd. (914 m) for marine mammals, sea turtles, and floating vegetation. Non-Explosive: 1,000 yd. (914 m) for marine mammals, sea turtles, floating vegetation and kelp paddies.
Torpedo (Explosive) Testing	1 Lookout	2,100 yd. (1.9 km) for marine mammals, sea turtles, concentrations of floating vegetation (*Sargassum* or kelp paddies), and jellyfish aggregations. Passive acoustic monitoring conducted with Navy assets participating in the activity.	5,063 yd. (4.6 km) for marine mammals, sea turtles, floating vegetation and jellyfish aggregations
Sinking Exercises	2 Lookouts	2.5 nm for marine mammals, sea turtles, concentrations of floating vegetation (*Sargassum* or kelp paddies), and jellyfish aggregations. Passive acoustic monitoring conducted with Navy assets participating in the activity.	2.0 nm for marine mammals, sea turtles, floating vegetation and jellyfish aggregations.

Table 5.4-1: Summary of Recommended Mitigation Measures (continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
At-Sea Explosive Testing	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	1,600 yd. (1.4 km) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). 350 yd. (320 m) for surveyed shallow coral reefs.	None.
Elevated Causeway System – Pile Driving	1 Lookout	60 yd. (55 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies).	50 yd. for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies).
Vessel Movements	1 Lookout	500 yd. (457 m) for whales. 200 yd. (183 m) for all other marine mammals (except bow riding dolphins).	500 yd. (457 m) for whales. 200 yd. (183 m) for all other marine mammals (except bow riding dolphins).
Towed In-Water Device Use	1 Lookout	250 yd. (229 m) for marine mammals	250 yd. (229 m) for marine mammals.
Humpback Whale Cautionary Area	Activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	Mid-frequency active sonar training will not occur within the humpback whale cautionary area between 15 December and 15 April without prior approval by the Commander, U.S. Pacific Fleet.	Mid-frequency active sonar training will not occur within the humpback whale cautionary area between 15 December and 15 April without prior approval by the Commander, U.S. Pacific Fleet.

Table 5.4-1: Summary of Recommended Mitigation Measures (continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks	No Lookouts in addition to standard personnel standing watch Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs, and artificial reefs, shipwrecks.	No precision anchoring within the anchor swing diameter and no explosive mine countermeasure and neutralization activities (except in near-shore areas of San Clemente Island in the SOCAL Range Complex and in the SSTC) within 350 yd. (320 m) of surveyed shallow coral reefs, live hardbottom, artificial reefs, and shipwrecks. No explosive or non-explosive small-, medium-, and large-caliber gunnery exercises using a surface target, explosive or non-explosive missile exercises using a surface target, explosive and non-explosive bombing exercises, or at-sea explosive testing within 350 yd. (320 m) of surveyed shallow coral reefs.	Varying mitigation zone distances based on marine mammal ranges to effects.

Notes: ft. = feet, km = kilometers, lb. = pounds, m = meters, mi. = miles, min. = minutes, NEW = net explosive weight, nm = nautical miles, yd. = yards

5.5 MONITORING AND REPORTING

5.5.1 APPROACH TO MONITORING

The Navy is committed to demonstrating environmental stewardship while executing its National Defense Mission and complying with the suite of federal environmental laws and regulations. As a complement to the Navy's commitment to avoiding and reducing impacts of the Proposed Action through mitigation, the Navy will undertake monitoring efforts to track compliance with take authorizations, help evaluate the effectiveness of implemented mitigation measures, and gain a better understanding of the effects of the Proposed Action on marine resources. Taken together, mitigation and monitoring comprise the Navy's integrated approach for reducing environmental impacts from the Proposed Action. The Navy's overall monitoring approach will seek to leverage and build on existing research efforts whenever possible.

Consistent with the cooperating agency agreement with NMFS, mitigation and monitoring measures presented in this Final EIS/OEIS focus on the requirements for protection and management of marine resources. A well-designed monitoring program can provide important feedback for validating assumptions made in analyses and allow for adaptive management of marine resources. Since monitoring will be required for compliance with the Letters of Authorization issued for the Proposed Action under the MMPA, details of the monitoring program will be developed in coordination with NMFS through the regulatory process. Discussions with resource agencies during the consultation and permitting processes may result in changes to the mitigation as described in this document. Such changes will be reflected in the Records of Decision and consultation documents such as the ESA Biological Opinion.

5.5.1.1 Integrated Comprehensive Monitoring Program

The Integrated Comprehensive Monitoring Program is intended to coordinate monitoring efforts across all regions where the Navy trains and tests and to allocate the most appropriate level and type of effort for each range complex (U.S. Department of the Navy 2010). The current Navy monitoring program is composed of a collection of range-specific monitoring plans, each of which was developed individually as part of MMPA and ESA compliance processes as environmental documentation was completed. These individual plans establish range- or activity-specific monitoring requirements for each range complex, testing range, or activity and are collectively intended to address the Integrated Comprehensive Monitoring Plan top-level goals.

A 2010 Navy-sponsored monitoring meeting in Arlington, Virginia, initiated a process to critically evaluate the current Navy monitoring plans and begin development of revisions and updates to both existing region-specific plans as well as the Integrated Comprehensive Monitoring Plan. Discussions at that meeting as well as the following Navy and NMFS annual adaptive management meeting established a way ahead for continued refinement of the Navy's monitoring program. This process included establishing a Scientific Advisory Group of leading marine mammal scientists with the initial task of developing recommendations that would serve as the basis for a Strategic Plan for Navy monitoring. The Strategic Plan is intended to be a primary component of the Integrated Comprehensive Monitoring Program, provide a "vision" for Navy monitoring across geographic regions, and serve as guidance for determining how to most efficiently and effectively invest the marine species monitoring resources to address Integrated Comprehensive Monitoring Plan top-level goals and satisfy MMPA Letter of Authorization regulatory requirements.

The objective of the Strategic Plan is to continue the evolution of Navy marine species monitoring towards a single integrated program, incorporating Scientific Advisory Group recommendations, and establishing a more transparent framework for soliciting, evaluating, and implementing monitoring work across the range complexes and testing ranges. The Strategic Plan must consider a range of factors in addition to the scientific recommendations including logistic, operational, and funding considerations and will be revised regularly as part of the annual adaptive management process.

The Integrated Comprehensive Monitoring Plan establishes top-level goals that have been developed in coordination with NMFS (U.S. Department of the Navy 2010). The following top-level goals will become more specific with regard to identifying potential projects and monitoring field work through the Strategic Plan process as projects are evaluated and initiated in the Study Area.

- An increase in the understanding of the likely occurrence of marine mammals or ESA-listed marine species in the vicinity of the action (i.e., presence, abundance, distribution, and density of species).
- An increase in the understanding of the nature, scope, or context of the likely exposure of marine mammals and ESA-listed species to any of the potential stressor(s) associated with the action (e.g., tonal and impulsive sound), through better understanding of one or more of the following: (1) the action and the environment in which it occurs (e.g., sound source characterization, propagation, and ambient noise levels); (2) the affected species (e.g., life history or dive patterns); (3) the likely co-occurrence of marine mammals and ESA-listed marine species with the action (in whole or part) associated with specific adverse impacts; or (4) the likely biological or behavioral context of exposure to the stressor for the marine mammal and ESA-listed marine species (e.g., age class of exposed animals or known pupping, calving or feeding areas).
- An increase in the understanding of how individual marine mammals or ESA-listed marine species respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible, e.g., at what distance or received level).
- An increase in the understanding of how anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either: (1) the long-term fitness and survival of an individual; or (2) the population, species, or stock (e.g., through impacts on annual rates of recruitment or survival).
- An increase in the understanding of the effectiveness of mitigation and monitoring measures;
- A better understanding and record of the manner in which the authorized entity complies with the Incidental Take Authorization and Incidental Take Statement.
- An increase in the probability of detecting marine mammals (through improved technology or methods), both specifically within the mitigation zone (thus allowing for more effective implementation of the mitigation) and in general, to better achieve the above goals.
- A reduction in the adverse impact of activities to the least practicable level, as defined in the MMPA.

5.5.1.2 Scientific Advisory Group Recommendations

Navy established the Scientific Advisory Group in 2011 with the initial task of evaluating current Navy monitoring approaches under the Integrated Comprehensive Monitoring Plan and existing MMPA Letters of Authorization and developing objective scientific recommendations that would form the basis for the Strategic Plan. While recommendations were fairly broad and not prescriptive from a range complex perspective, the Scientific Advisory Group did provide specific programmatic recommendations

that serve as guiding principles for the continued evolution of the Navy Marine Species Monitoring Program and provide a direction for the Strategic Plan to move this development. Key recommendations include:

- Working within a conceptual framework of knowledge, from basic information on the occurrence of species within each range complex, to more specific matters of exposure, response, and consequences.
- Facilitating collaboration among researchers in each region, with the intent to develop a coherent and synergistic regional monitoring and research effort.
- Striving to move away from a "box-checking" mentality. Monitoring studies should be designed and conducted according to scientific objectives, rather than on merely cataloging effort expended.
- Approach the monitoring program holistically and select projects that offer the best opportunity to advance understanding of the issues, as opposed to establishing range-specific requirements.

5.5.2 REPORTING

The Navy is committed to documenting and reporting relevant aspects of training and testing activities to verify implementation of mitigation, comply with current permits, and improve future environmental assessments. Navy reporting initiatives are described below.

5.5.2.1 Exercise, Testing, and Monitoring Reporting

The Navy will submit annual exercise, testing, and monitoring reports to the Office of Protected Resources at NMFS. The exercise reports will describe the level of training and testing conducted during the reporting period, and the monitoring reports will describe both the nature of the monitoring that has been conducted and the actual results of the monitoring. All of the details regarding the content of the annual reports will be coordinated with NMFS through the permitting process. All reports submitted to date can be found on the NMFS Office of Protected Resources webpage.

5.5.2.2 Stranding Response Plan

In coordination with NMFS, the Navy will have a stranding response plan. All of the details regarding the content of the stranding response plan will be coordinated with NMFS through the permitting process.

5.5.2.3 Bird Strike Reporting

The Navy will report all damaging and non-damaging bird strikes to the Naval Safety Center.

5.5.2.4 Marine Mammal Incident Reporting

If any injury or death of a marine mammal is observed during training or testing activities, the Navy will immediately halt the activity and report the incident, including dead for injured animals, to NMFS or the United States Fish and Wildlife Service, as appropriate.

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REFERENCES

Baird, A.H., V.R. Cumbo, W. Leggat, and M. Rodriguez-Lanetty. (2007). Fidelity and flexibility in coral symbioses. Marine Ecology Progress Series. Vol. 347:307-309.

Baird, R., D.L. Webster, G.S. Schorr, D.J. McSweeney. (2008). Diel Variation in Beaked Whale Diving Behavior. Monterey, California; Naval Post Graduate School.

Barlow, J. (2010). Cetacean abundance in the California Current estimated from a 2008 ship-based line-transect survey. NOAA Technical Memorandum NMFS-SWFSC-456. National Oceanic and Atmospheric Administration.

Barlow, J. and K. A. Forney. (2007). "Abundance and population density of cetaceans in the California Current ecosystem." Fishery Bulletin 105: 509-526.

Barlow, J., Ferguson, M. C., Perrin, W. F., Ballance, L., Gerrodette, T., Joyce, G. (2006). Abundance and densities of beaked and bottlenose whales (family Ziphiidae). *Journal of Cetacean Research and Management, 7*(3), 263-270.

Carretta, J. V., Lowry, M. S., Stinchcomb, C. E., Lynne, M. S. & Cosgrove, R. E. (2000). Distribution and abundance of marine mammals at San Clemente Island and surrounding offshore waters: Results from aerial and ground surveys in 1998 and 1999 [Administrative Report]. (LJ-00-02, pp. 43). La Jolla, CA: NOAA: Southwest Fisheries Science Center.

Hazel, J., Lawler, I. R., Marsh, H. & Robson, S. (2007). Vessel speed increases collision risk for the green turtle Chelonia mydas. *Endangered Species Research, 3*, 105-113.

Jefferson, T. A., Webber, M. A. & Pitman, R. L. (2008). *Marine Mammals of the World: A Comprehensive Guide to their Identification* (pp. 573). London, UK: Elsevier.

Kenney, R. D. (2005). Personal communication via email between Dr. Robert Kenney, University of Rhode Island, and Mr. William Barnhill, Geo-Marine, Inc. W. Barnhill and GeoMarine Inc., Plano, Texas.

Laake, J.L., Calambokidis, J., Osmek, S.D., and Rugh, D.J. (1997). Probability of detecting harbor porpoise from aerial surveys: estimating g(0). J. Wildl. Manage. 61:63-75.

MacLeod, C. D. & D'Amico, A. (2006). A review of beaked whale behaviour and ecology in relation to assessing and mitigating impacts of anthropogenic noise. *Journal of Cetacean Research and Management, 7*(3), 211-222.

Mansfield, K. L. (2006). *Sources of Mortality, Movements and Behavior of Sea Turtles in Virginia.* The College of William and Mary.

Marine Species Modeling Team. (2013). Determination of Acoustic Effects on Marine Mammals and Sea Turtles for the Hawaii-Southern California Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement. Naval Undersea Warfare Command Division, Newport.

Marsh, H. and Saalfeld, W. K. (1989). Aerial Surveys of Sea Turtles in the Northern Great Barrier Reef Marine Park. Australia Wildlife Research 16, 239-249.

Mobley, J. Jr., Spitz, S. and Grotefendt, R. (2001). Abundance of Humpback Whales in Hawaiian Waters: Results of 1993-2000 Aerial Surveys. Hawaiina Islands Humpback Whale National Marine Sanctuary

Office of National Marine Sanctuaries National Oceanic and Atmospheric Administration U.S. Department of Commerce and the Department of Land and Natural Resources State of Hawaii, 1-17.

Mobley, J. R. (2004). Results of Marine Mammal Surveys on U.S. Navy Underwater Ranges in Hawaii and Bahamas: 27.

Tyack, P. L. Johnson, M. Aguilar Soto, N. Sturlese, A. Madsen, P. T. (2006). Extreme Diving of Beaked Whales. The Journal of Experimental Biology 209, 4238-4253. USFWS (2001a). Green sea turtle (Chelonia mydas) fact sheet.

U.S. Department of the Navy. (2010). Navy Integrated Comprehensive Monitoring Plan. [Final Report 2010]. 73.

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6 ADDITIONAL REGULATORY CONSIDERATIONS

In accordance with the Council on Environmental Quality regulations for implementing the National Environmental Policy Act (NEPA), federal agencies shall, to the fullest extent possible, integrate the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice so that all such procedures run concurrently rather than consecutively. This chapter summarizes environmental compliance for the Proposed Action, consistency with other federal, state, and local plans, policies, and regulations not considered in Chapter 3 (Affected Environment and Environmental Consequences); the relationship between short-term impacts; and the maintenance and enhancement of long-term productivity in the affected environment; irreversible and irretrievable commitments of resources, and energy conservation.

6.1 CONSISTENCY WITH OTHER APPLICABLE FEDERAL, STATE, AND LOCAL PLANS, POLICIES, AND REGULATIONS

Implementation of the Proposed Action for the Hawaii-Southern California Training and Testing (HSTT) Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS), would comply with applicable federal, state, and local laws, regulations, and executive orders. The Navy is consulting with and will continue to consult with regulatory agencies, as appropriate, during the NEPA process and prior to implementation of the Proposed Action to ensure that requirements are met. Table 6.1-1 summarizes environmental compliance requirements that that were considered in preparing this EIS/OEIS (including those that may be secondary considerations in the resource evaluations) not considered in Chapter 3 (Affected Environment and Environmental Consequences). Section 3.0.1 (Regulatory Framework) provides brief excerpts of the primary federal statutes, executive orders, international standards, and guidance that form the regulatory framework for the resource evaluations. Documentation of consultation and coordination with regulatory agencies is provided in Appendix C. Formal Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA) consultation began following the Draft EIS/OEIS release and has been completed. Because consultation is currently ongoing, not all consultation documentation is included in Appendix C or the website at this time, but all compliance will be completed prior to the signing of the Record of Decision for the Proposed Action.

Table 6.1-1: Summary of Environmental Compliance for the Proposed Action

Laws, Executive Orders, International Standards, and Guidance	Status of Compliance
Laws	
Abandoned Shipwreck Act (43 United States Code [U.S.C.] §§ 2101-2106)	The 1987 Abandoned Shipwreck Act establishes requirements for educational and recreational access to abandoned shipwrecks; the protection of such resources through the establishment of underwater parks and protected areas; the development of specific guidelines for management and protection in consultation with various stakeholders; defines the jurisdiction and responsibility of federal and state agencies; and explicitly states that the law of salvage and the law of finds do not apply. Under the Act, the Department of the Interior and National Park Service issued guidelines in 2007 to help states manage shipwrecks in their waters. The Act defines the federal government's title to any abandoned shipwreck that meets criteria for inclusion in the National Register of Historic Places within state submerged lands, with the stipulation that the federal government transfer the title of the shipwreck to the state whose submerged lands contain the shipwreck. For abandoned shipwrecks in United States (U.S.) Territorial Waters, the federal government asserts title to the resource. See Section 3.10 (Cultural Resources) for assessment and conclusion that the Proposed Action is consistent with the Act.
Act to Prevent Pollution from Ships (33 U.S.C. §1901 et seq.)	Requirements associated with the Act to Prevent Pollution from Ships are implemented by the Navy Environmental Readiness Program Manual and related Navy guidance documents governing waste management, pollution prevention, and recycling. At sea, the Navy complies with these regulations and operates in a manner that minimizes or eliminates any adverse affects to the marine environment.
Antiquities Act (16 U.S.C. § 431)	The Proposed Action is consistent with the Act's objectives for protection of archaeological and historical sites and objects, preservation of cultural resources, and the public's access to them. See Section 3.10 (Cultural Resources) for the assessment.
Coastal Zone Management Act (16 U.S.C. §1451 et seq.)	The Navy is completing the Coastal Zone Management Act (CZMA) federal consistency determination process with the California and Hawaii CZMA offices. See Section 6.1.1 (Coastal Zone Management Act Compliance).
Historic Sites Act (16 U.S.C. §§ 461-467)	The Proposed Action is consistent with the national policy for the preservation of historic sites, buildings, and objects of national significance. See Chapter 3.10 (Cultural Resources) for assessment.
National Fishery Enhancement Act (33 U.S.C. § 2101 et seq.)	The Proposed Action is consistent with regulations administered by National Marine and Fisheries Service (NMFS) and U.S. Army Corps of Engineers concerning artificial reefs in the navigable waters of the United States. See Section 3.9 (Fish) for the assessment.
National Marine Sanctuaries Act (16 U.S.C. § 1431 et seq.)	Two National Marine Sanctuaries administered by National Oceanic and Atmospheric Administration Office of National Marine Sanctuaries lie within the Study Area. These are discussed further in Section 6.1.2 (Marine Protected Areas).
Rivers and Harbors Act (33 U.S.C. § 401 et seq.)	Under the Rivers and Harbors Act, a permit is required when construction is proposed in navigable waterways. The Navy will acquire Army Corps of Engineer permits where applicable.
Submerged Lands Act of 1953 (43 U.S.C. §§ 1301-1315)	The Proposed Action is consistent with regulations concerning the Submerged Lands Act.

Table 6.1-1: Summary of Environmental Compliance for the Proposed Action (continued)

Laws, Executive Orders, International Standards, and Guidance	Status of Compliance
Laws	
Sunken Military Craft Act (Public Law 108-375, 10 U.S.C. § 113 Note and 118 Stat. 2094-2098)	The Proposed Action would have no adverse effects on sunken U.S. military ships and aircraft within the Study Area. If a site is determined to be eligible for the National Register of Historic Places, the State Historic Preservation Officer would be consulted to address potential effects. See Section 3.10 (Cultural Resources) for the assessment.
California Coastal National Monument Designation (Presidential Proclamation, January 11, 2000)	The proclamation designates all non-major U.S.-owned lands (rocks, islands, etc.) along the coast of California from mean high tide out to a distance of 12 nm as national monuments. The Southern California Range Complex includes resources designated as part of the California Coastal National Monument area. The Navy and the Bureau of Land Management have agreed on the terms of a Memorandum of Understanding dated 5 November 2007 regarding Navy activities in the vicinity of monument resources. Implementation of the Proposed Action would be consistent with the Memorandum of Understanding and would not affect monument resources.
California Marine Life Protection Act and Marine Managed Areas Improvement Act (California Fish and Game Code §§ 2850-2863)	California Marine Life Protection Act requires California Department of Fish and Game to confer with the Navy regarding issues related to Navy activities that may affect Marine Managed Areas.
Military Munitions Rule	The Military Munitions Rule identifies when conventional and chemical military munitions are considered solid waste under the Resource Conservation and Recovery Act (42 U.S.C. § 6901 et seq.). Military munitions are not considered solid waste based on two conditions stated at 40 Code of Federal Regulations (C.F.R.) § 266.202(a)(1)(i-iii). These two conditions are when munitions are used for their intended purpose and when unused munitions or a component of are subject to materials recovery activities. These two conditions cover the uses of munitions included in the Proposed Action; therefore, the Resource Conservation and Recovery Act does not apply.
Executive Orders	
Executive Order 11990*, Protection of Wetlands*	Implementation of the Proposed Action would not affect wetlands as defined in Executive Order 11990.
Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*	Because all of the proposed activities occur in the ocean where there are no minority or low-income populations present, there are no disproportionately high and adverse human health or environmental impacts from the Proposed Action on minority populations or low-income populations. See Section 3.0.5.2 (Resources and Issues Eliminated from Further Consideration) for the assessment.
Executive Order 12962*, Recreational Fisheries*	The Proposed Action would not affect federal agencies' ability to fulfill certain duties with regard to promoting the health and access of the public to recreational fishing areas. See Section 3.11 (Socioeconomics) for the assessment.
Executive Order 13045*, Protection of Children from Environmental Health Risks and Safety Risks*	Because all of the proposed activities occur in the ocean where there are no child populations present, the Proposed Action would not lead to disproportionate risks to children that result from environmental health risks or safety risks. See Section 3.0.5.2 (Resources and Issues Eliminated from Further Consideration) for the assessment.

Table 6.1-1: Summary of Environmental Compliance for the Proposed Action (continued)

Laws, Executive Orders, International Standards, and Guidance	Status of Compliance
Executive Orders	
Executive Order 13089*, Coral Reef Protection*	The Navy has prepared this EIS/OEIS in accordance with requirements that federal agencies whose actions affect U.S. coral reef ecosystems shall provide for implementation of measures needed to research, monitor, manage, and restore them, including reducing impacts from pollution and sedimentation. See Section 3.8 (Marine Invertebrates) for assessment.
Executive Order 13112*, Invasive Species*	The Proposed Action would not increase the number of or introduce new invasive species nor require the Navy to take measures to avoid introduction and spread of those species. Naval vessels are exempt from 33 C.F.R. 151 Subpart D, Ballast Water Management for Control of Nonindigenous Species in Waters of the United States.
Executive Order 13158, *Marine Protected Areas*	The Navy has prepared this EIS/OEIS in accordance with requirements for the protection of existing national system marine protected areas. See Section 6.1.2 (Marine Protected Areas) for more information.
Executive Order 13514*, Federal Leadership in Environmental, Energy, and Economic Performance*	The Proposed Action is consistent with the integrated strategy toward sustainability in the federal government and to making reduction of greenhouse gas emissions a priority for federal agencies.
Executive Order 13547*, Stewardship of the Ocean, Our Coasts, and the Great Lakes*	The Proposed Action is consistent with the comprehensive national policy for the Stewardship of the Ocean, Our Coasts, and the Great Lakes.
International Standards	
International Convention for the Prevention of Pollution from Ships	This standard prohibits certain discharges of oil, garbage, and other substances from vessels. The convention and its annexes are implemented by national legislation, including the Act to Prevent Pollution from Ships (33 U.S.C. §§ 1901 to 1915) and the Federal Water Pollution Control Act (33 U.S.C. §§ 1321 to 1322). The Proposed Action does not include vessel operation and discharge from ships; however, the Navy vessels operating in the Study Area would comply with the discharge requirements established in this program, minimizing or eliminating potential impacts from discharges from ships.

Note: nm = nautical mile(s)

6.1.1 COASTAL ZONE MANAGEMENT ACT COMPLIANCE

The Coastal Zone Management Act of 1972 (16 United States Code [U.S.C.] § 1451, et seq.) encourages coastal states to be proactive in managing coastal zone uses and resources. The Act established a voluntary coastal planning program under which participating states submit a Coastal Management Plan to the National Oceanographic and Atmospheric Administration for approval. Under the Act, federal actions that have an effect on a coastal use or resource are required to be consistent, to the maximum extent practicable, with the enforceable policies of federally approved Coastal Management Plans.

The Coastal Zone Management Act defines the coastal zone as extending “to the outer limit of State title and ownership under the Submerged Lands Act” (i.e., 3 nautical miles [nm] or 9 nm from the shoreline, depending on the location). The extent of the coastal zone inland varies from state to state, but the shoreward extent is not relevant to this Proposed Action.

A Consistency Determination, or a Negative Determination, may be submitted for review of federal agency activities. A federal agency submits a consistency determination when it determines that its activity may have either a direct or an indirect effect on a state coastal use or resource. In accordance with 15 Code of Federal Regulations (C.F.R.) § 930.39, the consistency determination will include a brief statement indicating whether the proposed activity will be undertaken in a manner consistent to the maximum extent practicable with the enforceable policies of the management program. The consistency determination should be based on evaluation of the relevant enforceable policies of the management program. In accordance with 15 C.F.R. §930.35, "if a Federal agency determines that there will not be coastal effects, then the Federal agency shall provide the State agencies with a negative determination for a Federal agency activity: (1) Identified by a State agency on its list, as described in §930.34(b), or through case-by-case monitoring of unlisted activities; or (2) Which is the same as or is similar to activities for which consistency determinations have been prepared in the past; or (3) For which the Federal agency undertook a thorough consistency assessment and developed initial findings on the coastal effects of the activity." Thus, a negative determination must be submitted to a state if the agency determines no coastal effects and one or more of the triggers above is met.

6.1.1.1 California Coastal Management Program

The state of California has an approved Coastal Management Plan, administered by the California Coastal Commission. The California Coastal Act of 1976 (California Public Resources Code, § 30000 et seq.) implements California's Coastal Management Program. The California Coastal Act includes policies to protect and expand public access to shorelines, and to protect, enhance, and restore environmentally sensitive habitats, including intertidal and nearshore waters, wetlands, bays and estuaries, riparian habitat, certain woods and grasslands, streams, lakes, and habitat for rare and endangered plants and animals.

Under the Coastal Zone Management Act, the California Coastal Commission must provide an opportunity for public comment and involvement in the federal coastal consistency determination process.

In January 2013, the Navy (Commander, U.S. Pacific Fleet) submitted a Consistency Determination for activities within the California portion of the Study Area to the California Coastal Commission. In March 2013, the California Coastal Commission notified the Commander, U.S. Pacific Fleet that it objected to the Navy's Consistency Determination based on a lack of sufficient information. In March 2013, Commander, U.S. Pacific Fleet replied to the California Coastal Commission, responding to each specific objection raised in the Commission's March 2013 letter. The Navy used the remainder of the federal consistency review period to attempt to resolve the differences with the California Coastal Commission. Under 15 C.F.R. §930.43, if the Navy concludes that its proposed action is fully consistent with the enforceable policies of the management program, it may proceed with the activity, but must notify the State agency of its decision to proceed before the project commences. HSTT activities are fully consistent with the enforceable polices of the California Coastal Management Program. In the event that Navy is not able to reach an agreement on the consistency of its activities with the California Coastal Commission, the Navy will comply with 15 C.F.R. §930.43(e) and notify the California Coastal Commission if the Navy decides to proceed over California Coastal Commission's objection. The correspondence between the Navy and the California Coastal Commission can be found in Appendix C (Agency Correspondence).

6.1.1.2 Hawaii Coastal Zone Management Program

Hawaii has an approved Coastal Zone Management Program (Chapter 205A, Hawaii Revised Statutes), administered by the Hawaii Office of Planning. The program meets the federal coastal zone management requirements in managing coastal areas and resources, including beaches, fishponds, scenic areas, marinas, wetlands, harbors, recreational areas, historic sites, and marine resources.

Hawaii's Coastal Zone Management Program employs a wide variety of regulatory and non-regulatory techniques to address coastal issues and uphold environmental law. Among them are stewardship, planning, permitting, education, and outreach.

In January 2013, the Navy (Commander, U.S. Pacific Fleet) submitted a Consistency Determination for activities within the Hawaii portion of the Study Area to the State of Hawaii Office of Planning. In March 2013, the Office of Planning conditionally concurred with the Navy's Consistency Determination. The condition placed on the concurrence was that during training and testing activities, the Navy "within the State of Hawaii Coastal Zone Management area shall not harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect endangered or threatened species of aquatic life or wildlife, or cut, collect, uproot, destroy, injure, or possess endangered or threatened species of aquatic life or land plants, or attempt to engage in any such conduct." The Navy responded to the Office of Planning's letter to clarify that the Navy's activities are consistent with the enforceable policies under Hawaii Revised Statutes Chapter 195 (e) and (g) because any take would be incidental to, and not the purpose of, an otherwise lawful activity and confirmed the Navy has consulted with the National Marine and Fisheries Service (NMFS) for take authorizations under the MMPA and ESA. In response to Navy's letter to the Hawaii Office of Planning, the State has concurred that the Navy's activities are fully consistent with the enforceable policies of the Hawaii Coastal Zone Management Program. The correspondence between the Navy and the Hawaii Office of Planning can be found in Appendix C (Agency Correspondence).

6.1.2 Marine Protected Areas

Many areas of the marine environment have some level of federal, state, or local management or protection. Marine protected areas have conservation or management purposes, defined boundaries, and some legal authority to protect resources. Marine protected areas vary widely in purpose, managing agency, management approaches, level of protection, and restrictions on human uses. They have been designated to achieve objectives ranging from conservation of biodiversity, to preservation of sunken historic vessels, to protection of spawning habitats important to commercial and recreational fisheries. Executive Order (EO) 13158*, Marine Protected Areas,* was created to "strengthen the management, protection, and conservation of existing marine protected areas and establish new or expanded marine protected areas; develop a scientifically based, comprehensive national system of marine protected areas representing diverse U.S. marine ecosystems, and the nation's natural and cultural resources; and avoid causing harm to marine protected areas through federally conducted, approved, or funded activities."

Executive Order 13158 requires each Federal agency whose actions affect the natural or cultural resources that are protected by a national system of marine protected areas to identify such actions, and in taking such actions, avoid harm to those natural and cultural resources. Pursuant to Section 5 of EO 13158, agency requirements apply only to the natural or cultural resources specifically afforded protection by the site as described by the List of National System Marine Protected Areas. For sites that have both a terrestrial and marine area, only the marine portion and its associated protected resources are included on the List of National System Marine Protected Areas and subject to Section 5 of EO

13158. A full list and map of areas accepted in the National System of Marine Protected Areas is available from the National Marine Protected Areas Center.

The National Marine Protected Areas Center, which is federally managed through the National Oceanic and Atmospheric Administration, is tasked with implementing EO 13158. In order to meet the qualifications for the various terms within EO 13158, the National Marine Protected Areas Center developed a Marine Protected Areas Classification system. This system uses six criteria to describe the key features of most marine protected areas, as follows:

1. Primary conservation focus, such as natural heritage, cultural heritage, or sustainable production
2. Level of protection (e.g., no access, no impact, no take, zoned with no-take areas, zoned multiple use, or uniform multiple use)
3. Permanence of protection
4. Constancy of protection
5. Ecological scale of protection
6. Restrictions on extraction

The National Marine Protected Areas Center utilizes these criteria to evaluate marine protected areas for inclusion in the National System of Marine Protected Areas. Implementation of the National System of Marine Protected Areas is managed by the Department of Commerce and the Department of the Interior. Executive Order 13158 requires the Department of Commerce and the Department of the Interior to consult with other federal agencies about the inclusion of sites into the National System of Marine Protected Areas, including the Department of Defense. The National System of Marine Protected Areas includes marine protected areas managed under the following six systems:

National Marine Sanctuary System. Under the National Marine Sanctuaries Act, the National Oceanic and Atmospheric Administration established national marine sanctuaries for marine areas with special conservation, recreational, ecological, historical, cultural, archaeological, scientific, educational, or aesthetic qualities. Within the Study Area there are three National Marine Sanctuary System sites (two national marine sanctuaries [Hawaiian Islands Humpback Whale National Marine Sanctuary, Channel Islands National Marine Sanctuary] and one marine national monument [Papahanaumokuakea Marine National Monument]) all of which are included in the National System of Marine Protected Areas.

Marine National Monuments. Marine national monuments are designated through Presidential Proclamation under the authority of the Antiquities Act of 1906 (16 U.S.C. § 431). Marine national monuments are often co-managed by state, federal, and local governments, in order to preserve diverse habitats and ecosystem functions. Within the Study Area there is one marine national monument, Papahanaumokuakea Marine National Monument, which is also included in the National Marine Sanctuary System and the National System of Marine Protected Areas. In the proclamation designating the Monument, specific language was included that stated: “The prohibitions required by this proclamation shall not apply to activities and exercises of the Armed Forces (including those carried out by the United States Coast Guard) that are consistent with applicable laws.”

National Wildlife Refuge System. The U.S. Fish and Wildlife Service manages ocean and Great Lakes refuges for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats. There are two national wildlife refuge areas within

the Study Area, Johnston Island National Wildlife Refuge and Midway Atoll National Wildlife Refuge, both of which are included in the National System of Marine Protected Areas.

State and Local Marine Protected Areas. State and local governments have established marine protected areas for the management of fisheries, nursery grounds, shellfish beds, recreation, tourism, and other uses; these areas have a diverse array of conservation focuses, from protecting ecological functions, to preserving shipwrecks, to maintaining traditional or cultural interaction with the marine environment. There are 18 state or local marine protected areas within the Study Area that are included in the National System of Marine Protected Areas (see Table 6.1-2). Within the Study Area, there are California Marine Protected Areas not yet included in the National Marine Protected Areas Center inventory: Begg Rock State Marine Reserve, Santa Barbara Island State Marine Reserve, nine separate areas on Catalina Island, Dana Point State Marine Conservation Area, Swami's State Marine Conservation Area, San Diego-Scripps Coastal State Marine Conservation Area, Matlahuayl State Marine Conservation Area, South La Jolla State Marine Conservation Area, South La Jolla State Marine Reserve, and Cabrillo State Marine Reserve.

The Navy has had direct participation in the California Marine Protected Areas process and the establishment of the Marine Protected Areas in the Study Area. The development process includes the recognition of the Navy's ongoing activities within those areas, with a finding that those activities are compatible with the Marine Protected Areas. For the California Marine Protected Areas, California Title 14, Section 632 states: "Nothing in this section expressly or implicitly precludes, restricts or requires modification of current or future uses of the waters identified as marine protected areas, special closures, or the lands or waters adjacent to these designated areas by the Department of Defense, its allies or agents."

National Parks System. The National Park System contains ocean and Great Lakes parks, including some national monuments, administered by the U.S. Department of the Interior National Park Service to conserve the scenery and the natural and historic objects and wildlife contained within. There is one National Parks System site, Channel Islands National Park, within the Study Area that is included in the National System of Marine Protected Areas.

National Estuarine Research Reserve System. National Estuarine Research Reserve System sites protect estuarine land and water and provide essential habitat for wildlife; educational opportunities for student, teachers, and the public; and living laboratories for scientists. There are no National Estuarine Research Reserve System sites within the Study Area.

This EIS/OEIS has been prepared in accordance with requirements for natural or cultural resources protected under the National System of Marine Protected Areas. While several marine protected areas are located within the Study Area and are included in the National System of Marine Protected Areas, it is important to note that the Navy rarely trains or tests in many of these areas. The Navy, when conducting activities within these marine protected areas, abides by the regulations of the individual marine protected area. Table 6.1-2 provides information on the individual marine protected area regulations and the Navy activities that occur in these areas. Additionally, there are two National Marine Sanctuaries within the Study Area that are included in the National System of Marine Protected Areas the (Channel Islands National Marine Sanctuary and the Hawaiian Islands Humpback Whale National Marine Sanctuary) and one marine national monument, the Papahanaumokuakea Marine National Monument. These areas receive protection under EO 13158, the National Marine Sanctuaries Act, or both, and are described in more detail below.

Table 6.1-2: Marine Protected Areas within the Hawaii-Southern California Training and Testing Study Area

Marine Protected Area	Location Within the Study Area	Protection Focus	Regulations Applicable to Navy Activities	Navy Proposed Activities and Potential Impacts
Channel Islands National Marine Sanctuary (CINMS)	California	Ecosystem	Prohibitions "…do not apply to military activities carried out by DoD [Department of Defense] as of the effective date (22 September 1980) of these regulations. (15 C.F.R. § 922.73)" However, if any activities "modified in such a way that requires the preparation of an environmental assessment or environmental impact statement…relevant to a Sanctuary resource or quality" said activity is not considered a pre-existing activity under these regulations. The regulations also state that "all DoD activities must be carried out in a manner that avoids to the maximum extent practicable any adverse impacts on sanctuary resources and qualities." If a DoD activity causes any destruction, loss, or injury to a Sanctuary resource then the "DoD, in coordination with the Director, must promptly prevent and mitigate further damage and must restore or replace the Sanctuary resource or quality in a manner approved by the Director."	For the Hawaii-Southern California Training and Testing (HSTT) Environmental Impact Statement (EIS),[1] the Navy will continue to conduct anti-submarine warfare training in the vicinity of the Santa Barbara Island portion of the sanctuary. Navy activities within the CINMS are specifically identified in Section 3.5.9 of the Channel Islands National Marine Sanctuary Final Management Plan/Final EIS Volume II (National Oceanic and Atmospheric Administration 2008). These Navy activities are exempt from the prohibitions in the Sanctuary. The sanctuary regulations require that all DoD military activities shall be carried out in a manner that avoids to the maximum extent practicable any adverse impacts on sanctuary resources and qualities. The Navy does not propose new, modified, or increased frequency of activities in the CINMS, or activities that are different from those currently conducted in this area. Therefore, proposed activities are consistent with those activities currently conducted in this area, and those described in the Sanctuary's Final Management Plan/Final EIS. These HSTT activities would continue to be exempt from the prohibitions identified in the Sanctuary's regulations. HSTT activities within the Sanctuary would be conducted with an extensive set of mitigations measures (see Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) and will avoid to the maximum extent practicable any adverse impacts on the Sanctuary resources and qualities.

[1] As described in Section 2.1.2.2, the area around Santa Barbara Island is a part of the Point Mugu Sea Range (PMSR) which is the subject of a separate EIS. For HSTT this area is addressed because it is used as a part of the HSTT activities, specifically anti-submarine warfare. The PMSR overlaps a larger portion of the Channel Islands National Marine Sanctuary—see the PMSR EIS for additional details.

Table 6.1-2: Marine Protected Areas within the Hawaii-Southern California Training and Testing Study Area (continued)

Marine Protected Area	Location Within the Study Area	Protection Focus	Regulations Applicable to Navy Activities	Navy Proposed Activities and Potential Impacts
Channel Islands National Park (CNIP)	California	Ecosystem	This CINP extends one mile around the islands within the Channel Islands National Marine Sanctuary. Within the Study Area, this is a small portion around Santa Barbara Island.	The Navy continues to conduct sonar-related activities in the vicinity of the Santa Barbara Island No other activities are conducted in the vicinity of this area. The Navy complies with all applicable National Park Service regulations within the CINP.
Farnsworth Bank ASBS[2] State Water Quality Protection Area	California	Ecosystem	Waste discharges are prohibited.	The Navy conducts training and testing in all warfare areas, including sonar-related activities outside of, but in the vicinity of, this area. The Navy does not discharge waste in or near this area.
Heisler Park ASBS[2] State Water Quality Protection Area	California	Ecosystem	Waste discharges are prohibited.	The Navy conducts training and testing in all warfare areas, including amphibious activities south of this area in the Camp Pendleton Amphibious Assault Area. The Navy does not discharge waste in or near this area.
La Jolla ASBS[2] State Water Quality Protection Area	California	Ecosystem	Waste discharges are prohibited.	The Navy conducts training and testing in all warfare areas, including mine warfare training activities and underwater communications testing activities just offshore (within 3 nm) of this water quality protection area. The Navy does not discharge any waste in or near this area.
Northwestern Santa Catalina Island ASBS[2] State Water Quality Protection Area	California	Ecosystem	Waste discharges are prohibited.	The Navy conducts training and testing in all warfare areas, including sonar-related activities outside of this, but in the vicinity of this area. The Navy does not discharge waste in or near this area.

[2] ASBS is an Area of Special Biological Significance.

Table 6.1-2: Marine Protected Areas within the Hawaii-Southern California Training and Testing Study Area (continued)

Marine Protected Area	Location Within the Study Area	Protection Focus	Regulations Applicable to Navy Activities	Navy Proposed Activities and Potential Impacts
Robert E. Badham ASBS[2] State Water Quality Protection Area	California	Ecosystem	Waste discharges are prohibited. However, discharges incidental to military training and research, development, test, and evaluation operations are allowed. Discharges incidental to underwater demolition and other in-water explosions are not allowed in the two military closure areas in the vicinity of Wilson Cove and Castle Rock. Discharges must not result in a violation of the water quality objectives, including the protection of the marine aquatic life beneficial use, anywhere in the ASBS.	The Navy conducts training and testing in all warfare areas, including amphibious activities in this area. The Navy does not discharge waste in or near this area. in violation of the site specific regulations.
San Clemente Island ASBS[2] State Water Quality Protection Area	California	Ecosystem	Waste discharges are prohibited. However, discharges incidental to military training and research, development, test, and evaluation operations are allowed. Discharges incidental to underwater demolition and other in-water explosions are not allowed in the two military closure areas in the vicinity of Wilson Cove and Castle Rock. Discharges must not result in a violation of the water quality objectives, including the protection of the marine aquatic life beneficial use, anywhere in the ASBS.	The Navy conducts training and testing in all warfare areas, including amphibious, anti-surface warfare, anti-submarine warfare, electronic warfare, mine warfare, and naval special warfare training and testing activities in this area. The Navy does not discharge waste in or near this area in violation of the site specific regulations.
San Diego-Scripps ASBS[2] State Water Quality Protection Area	California	Ecosystem	Waste discharges are prohibited.	The Navy conducts training and testing in all warfare areas, including mine warfare training activities and underwater communications testing activities just offshore (within 3 nm) of this water quality protection area. The Navy does not discharge any waste in or near this area.
Santa Barbara and Anacapa Islands ASBS[2] State Water Quality Protection Area	California (Santa Barbara Island only)	Ecosystem	Waste discharges are prohibited.	The Navy conducts training and testing in all warfare areas, including sonar-related activities in and near this area. The Navy does not discharge waste in or near this area.

Table 6.1-2: Marine Protected Areas within the Hawaii-Southern California Training and Testing Study Area (continued)

Marine Protected Area	Location Within the Study Area	Protection Focus	Regulations Applicable to Navy Activities	Navy Proposed Activities and Potential Impacts
San Nicolas Island and Begg Rock ASBS[2] State Water Quality Protection Area	California	Ecosystem	Waste discharges are prohibited. However, discharges incidental to military research, development, testing, and evaluation of, and training with, guided missile and other weapons systems, fleet training exercises, small-scale amphibious warfare training, and special warfare training are allowed. Discharges incidental to underwater demolition and other in-water explosions are not allowed. Discharges must not result in a violation of the water quality objectives, including the protection of the marine aquatic life beneficial use, anywhere in the ASBS.	The Navy conducts training and testing in all warfare areas, including sonar-related activities outside of, but in the vicinity of this area, primarily to the southeast. The Navy does not discharge waste in or near this area in violation of the site specific regulations.
Southeast Santa Catalina Island ASBS[2] State Water Quality Protection Area	California	Ecosystem	Waste discharges are prohibited.	The Navy conducts training and testing in all warfare areas, including sonar-related activities outside of this, but in the vicinity of this area. The Navy does not discharge waste in or near this area.
Western Santa Catalina Island ASBS[2] State Water Quality Protection Area	California	Ecosystem	Waste discharges are prohibited.	The Navy conducts training and testing in all warfare areas, including sonar-related activities outside of this, but in the vicinity of this area. The Navy does not discharge waste in or near this area.
Ahihi-Kinau Natural Area Reserve	Hawaii	Ecosystem	Prohibited: anchoring in any manner, injuring or removing any marine organism, damaging or disturbing any geological features, moving or damaging historic or prehistoric remains.	The Navy conducts no activities in this area.
Kalaupapa National Historical Park	Hawaii	Ecosystem	Prohibited: restrictions on commercial and recreational fishing.	The Navy conducts no activities near Kalaupapa National Historical Park.
Hanauma Bay Marine Life Conservation District	Hawaii	Ecosystem	Prohibited: operating any watercraft, injuring or removing any marine organism, damaging or disturbing any geological features.	The Navy conducts no activities in or near Hanauma Bay.

Table 6.1-2: Marine Protected Areas within the Hawaii-Southern California Training and Testing Study Area (continued)

Marine Protected Area	Location Within the Study Area	Protection Focus	Regulations Applicable to Navy Activities	Navy Proposed Activities and Potential Impacts
Kahoolawe Island Reserve	Hawaii	Ecosystem	Prohibited: all entrance into and activities within the reserve (such as boating, fishing and diving) unless specifically authorized by the Island Reserve Commission.	The Navy conducts no activities on or near Kahoolawe Island. Submarines may conduct underwater mine detection activities several nautical miles west of Kahoolawe.
Kaloko-Honokohau National Historical Park	Hawaii	Ecosystem	Prohibited: unpermitted uses of lay nets and aquarium collections.	The Navy conducts no activities near Kaloko-Honokohau National Historical Park.
Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS)	Hawaii	Focal Resource	Prohibitions on activities within the sanctuary, as outlined in the National Marine Sanctuary Program Regulations for the Hawaiian Islands Humpback Whale National Marine Sanctuary (15 C.F.R. § 922.183), do not apply to "…all classes of military activities, internal or external to the Sanctuary, that are being or have been conducted before the effective date of these regulations." (2 June 1997) and as identified in the Final EIS and Management Plan. Additionally, any activity that is "modified in such a way that it is likely to destroy, cause the loss of, or injure a Sanctuary resource in manner significantly greater than was considered in a previous consultation under section 304(d) of the National Marine Sanctuary Act and § 922.187 of this subpart, the modified activity will be treated as a new military activity under paragraph (c) of this section."	For the HSTT EIS activities, the Navy will continue to conduct anti-submarine warfare training and testing, consisting of mid- and high-frequency active sonar use. This type of activity occurs throughout the range complex and overlaps with the boundaries of the sanctuary primarily around the islands of Maui, Lanai, and Molokai. Navy activities within the HIHWNMS are specifically identified in Appendix F of the Final Management Plan/Final EIS Volume II (National Oceanic and Atmospheric Administration 1997). These Navy activities are exempt from the prohibitions in the Sanctuary. The Navy does not propose new, modified, or an increased frequency of activities in the HIHWNMS or activities that are different from those currently conducted in this area. Therefore, proposed activities are consistent with those activities currently conducted in this area and those described in the sanctuary's Final Management Plan/Final EIS. These HSTT activities would continue to be exempt from the prohibitions identified in the Sanctuary's regulations. HSTT activities within the HIHWNMS would be conducted with an extensive set of mitigations measures (see Chapter 5) and will avoid to the maximum extent practicable any adverse impacts on the Sanctuary resources and qualities.

Table 6.1-2: Marine Protected Areas within the Hawaii-Southern California Training and Testing Study Area (continued)

Marine Protected Area	Location Within the Study Area	Protection Focus	Regulations Applicable to Navy Activities	Navy Proposed Activities and Potential Impacts
Johnston Island National Wildlife Refuge	U.S. Territory	Ecosystem	Prohibitions do not apply to activities and exercises of the Armed Forces. Any activities carried forward within the area will be conducted in a manner consistent "so far as is reasonable and practical" with the prohibitions. If an activity causes any destruction, loss, or injury to a resource within the refuge then the DoD will coordinate with the Secretary of the Interior or Commerce, to take appropriate actions respond, mitigate, restore or replace the affected areas.	The Navy conducts no activities in or near the Johnston Island National Wildlife Refuge. Ships may transit in the vicinity of the refuge.
Molokini Shoal Marine Life Conservation District	Hawaii	Ecosystem	Prohibited: injuring or removing any marine organism (except in Subzone B), damaging or disturbing any geological features, moor and anchoring of boats.	The Navy conducts no activities on or near Molokini.
Midway Atoll National Wildlife Refuge	Hawaii	Ecosystem	Same prohibitions as listed under the Papahanaumokuakea Marine National Monument.	The Navy's proposed action includes activities conducted east of Nihoa Island and inside the eastern edge of the monument boundaries. These activities may include: - Anti-air warfare - Anti-surface warfare - Anti-submarine warfare - Electronic warfare
Pupukea Marine Life Conservation District	Hawaii	Ecosystem	Prohibited: injuring or removing any marine organism (outside of species and gear specific regulations), damaging or disturbing any geological features.	The Navy conducts no activities in this area.

Table 6.1-2: Marine Protected Areas within the Hawaii-Southern California Training and Testing Study Area (continued)

Marine Protected Area	Location Within the Study Area	Protection Focus	Regulations Applicable to Navy Activities	Navy Proposed Activities and Potential Impacts
Papahanaumokuakea Marine National Monument and World Heritage Site	Hawaii	Ecosystem	Prohibitions on activities within the Papahanaumokuakea Marine National Monument and World Heritage Site (50 C.F.R. § 404), state that "all activities and exercises of the Armed Forces shall be carried out in a manner that avoids, to the extent practicable and consistent with operational requirements, adverse impacts on Monument resources and qualities." Additionally, these regulations require that "in the event of threatened or actual destruction of, loss of, or injury to a Monument resource or quality resulting from an incident, including but not limited to spill and groundings, caused by a component of the [DoD] or the United States Coast Guard, the cognizant component shall promptly coordinate with the Secretaries for the purpose of taking appropriate actions to respond to and mitigate the harm and, if possible, restore or replace the Monument resource or quality."	The Navy's proposed action includes activities conducted east of Nihoa Island and inside the eastern edge of the monument boundaries. These activities may include: - Anti-air warfare - Anti-surface warfare - Anti-submarine warfare - Electronic warfare
Kealakekua Bay Marine Life Conservation District	Hawaii	Ecosystem	Prohibited: injuring or removing any marine organism (except within Subzone B), damaging or disturbing any geological features, anchoring of boats in Subzone A (may be anchored in Subzone B only in sand).	The Navy conducts no activities in this area.
West Hawaii Regional Fishery Management Area	Hawaii	Focal Resource	Prohibited: unpermitted uses of lay nets and aquarium collections.	The Navy conducts no activities in this area.

6.1.2.1.1 Channel Islands National Marine Sanctuary

The Channel Islands National Marine Sanctuary consists of an area of 1,109 square nautical miles (nm^2) around Anacapa Island, Santa Cruz Island, Santa Rosa Island, San Miguel Island and, Santa Barbara Island to the south (Figure 6.1-1). Only 92 nm^2 of Santa Barbara Island, or about eight percent of the sanctuary, occurs within the Southern California portion of the Study Area.

Key habitats within the sanctuary include kelp forest, surfgrass and eelgrass, intertidal zone, nearshore subtidal, deepwater benthic, and water column habitat. The diversity of habitats onshore and offshore contributes to the high species diversity in the Channel Islands National Marine Sanctuary, with more than 195 species of birds using open water, shore, or island habitats in the area (National Marine Sanctuaries 2009a). At least 33 species of cetaceans have been reported in the Channel Islands National Marine Sanctuary (National Marine Sanctuaries 2009a). Four species of sea turtles have been reported in the region—green, loggerhead, olive ridley, and leatherback—and all four species may be found within the sanctuary at any time of year. At least 492 species of algae and four species of sea grasses make up the marine plants of the sanctuary (National Marine Sanctuaries 2009a). Due to its transitional location between cold and warm water currents and the diversity of bottom habitats, the Channel Islands National Marine Sanctuary supports a variety of invertebrates, including two endangered species (black abalone and the white abalone). Of the 481 species of fish commonly found in the region, many occur in the sanctuary. See Section 3.4 (Marine Mammals), Section 3.5 (Sea Turtles), Section 3.6 (Sea Birds), Section 3.7 (Marine Vegetation), Section 3.8 (Marine Invertebrates), and Section 3.9 (Fish) for additional information on these species.

General regulations for the Channel Islands National Marine Sanctuary prohibit the following (15 C.F.R. § 922.72(a)):

> (1) Exploring for, developing, or producing hydrocarbons within the Sanctuary, except pursuant to leases executed prior to March 30, 1981, and except the laying of pipeline pursuant to exploring for, developing, or producing hydrocarbons.
>
> (2) Exploring for, developing, or producing minerals within the Sanctuary, except producing byproducts incidental to hydrocarbon production allowed by paragraph (a)(1) of this section.
>
> (3)(i) Discharging or depositing from within or into the Sanctuary any material or other matter except:
>
>> (A) Fish, fish parts, or chumming materials (bait) used in or resulting from lawful fishing activity within the Sanctuary, provided that such discharge or deposit is during the conduct of lawful fishing activity within the Sanctuary;
>>
>> (B) For a vessel less than 300 gross registered tons (GRT), or an oceangoing ship without sufficient holding tank capacity to hold sewage while within the Sanctuary, biodegradable effluent generated incidental to vessel use by an operable Type I or II marine sanitation device (U.S. Coast Guard classification) approved in accordance with section 312 of the Federal Water Pollution Control Act, as amended, (FWPCA), 33 U.S.C. 1321 et seq. Vessel operators must lock all marine sanitation devices in a manner that prevents discharge or deposit of untreated sewage;

(C) Biodegradable matter from:

(1) Vessel deck wash down;
(2) Vessel engine cooling water;
(3) Graywater from a vessel less than 300 gross registered tons;
(4) Graywater from an oceangoing ship without sufficient holding tank capacity to hold graywater while within the Sanctuary;

(D) Vessel engine or generator exhaust;

(E) Effluent routinely and necessarily discharged or deposited incidental to hydrocarbon exploration, development, or production allowed by paragraph (a)(1) of this section; or

(F) Discharge allowed under section 312(n) of the FWPCA.

(3)(ii) Discharging or depositing from beyond the boundary of the Sanctuary any material or other matter that subsequently enters the Sanctuary and injures a Sanctuary resource or quality, except those listed in paragraphs (a)(3)(i)(B) through (F) of this section and fish, fish parts, or chumming materials (bait) used in or resulting from lawful fishing activity beyond the boundary of the Sanctuary, provided that such discharge or deposit is during the conduct of lawful fishing activity there.

(4) Drilling into, dredging, or otherwise altering the submerged lands of the Sanctuary; or constructing or placing any structure, material, or other matter on or in the submerged lands of the Sanctuary, except as incidental to and necessary to:

(i) Anchor a vessel;
(ii) Install an authorized navigational aid;
(iii) Conduct lawful fishing activity;
(iv) Lay pipeline pursuant to exploring for, developing, or producing hydrocarbons; or
(v) Explore for, develop, or produce hydrocarbons as allowed by paragraph (a)(1) of this section.

(5) Abandoning any structure, material, or other matter on or in the submerged lands of the Sanctuary.

(6) Except to transport persons or supplies to or from any Island, operating within one nmi of any Island any vessel engaged in the trade of carrying cargo, including, but not limited to, tankers and other bulk carriers and barges, any vessel engaged in the trade of servicing offshore installations, or any vessel of three hundred gross registered tons or more, except fishing or kelp harvesting vessels.

(7) Disturbing a seabird or marine mammal by flying a motorized aircraft at less than 1,000 feet over the waters within one nautical mile of any Island, except to engage in kelp bed surveys or to transport persons or supplies to or from an Island. Failure to maintain a minimum altitude of 1,000 feet above ground level over such waters is presumed to disturb marine mammals or seabirds.

(8) Moving, removing, injuring, or possessing, or attempting to move, remove, injure, or possess a Sanctuary historical resource.

(9) Taking any marine mammal, sea turtle, or seabird within or above the Sanctuary, except as authorized by the Marine Mammal Protection Act, as amended, (MMPA), 16 U.S.C. 1361 et seq., Endangered Species Act, as amended, (ESA), 16 U.S.C. 1531 et seq., Migratory Bird Treaty Act, as amended, (MBTA), 16 U.S.C. 703 et seq., or any regulation, as amended, promulgated under the MMPA, ESA, or MBTA.

(10) Possessing within the Sanctuary (regardless of where taken from, moved, or removed from) any marine mammal, sea turtle, or seabird, except as authorized by the MMPA, ESA, MBTA, or any regulation, as amended, promulgated under the MMPA, ESA, or MBTA.

(11) Marking, defacing, damaging, moving, removing, or tampering with any sign, notice, or placard, whether temporary or permanent, or any monument, stake, post, or other boundary marker related to the Sanctuary.

(12) Introducing or otherwise releasing from within or into the Sanctuary an introduced species, except striped bass (*Morone saxatilis*) released during catch and release fishing activity.

(13) Operating a motorized personal watercraft within waters of the Sanctuary that are coextensive with the Channel Islands National Park, established by 16 U.S.C. 410(ff).

According to the National Marine Sanctuary Program Regulations for the Channel Islands National Marine Sanctuary (15 C.F.R., § 922.73), the prohibitions "…do not apply to military activities carried out by DoD [Department of Defense] as of the effective date of these regulations." However, any activity that is "modified in such a way that requires the preparation of an environmental assessment or environmental impact statement…relevant to a Sanctuary resource or quality" is not considered a pre-existing activity. The National Marine Sanctuary Program Regulations also states "all DoD activities must be carried out in a manner that avoids to the maximum extent practicable any adverse impacts on sanctuary resources and qualities." If a DoD activity causes any destruction, loss or injury to a Sanctuary resource then the "DoD, in coordination with the Director, must promptly prevent and mitigate further damage and must restore or replace the Sanctuary resource or quality in a manner approve by the Director."

The Navy does not propose new or an increase in activities in the Channel Islands National Marine Sanctuary, or activities that are different from those currently conducted in this area. Increases to military activities described in the Proposed Action would not occur in the sanctuary. Therefore, proposed activities are consistent with those activities currently conducted in this area, are consistent with those described in the sanctuary's designation document and in Section 3.5.9 (Department of Defense Activities, pre-existing activities) of the *Final Channel Islands National Marine Sanctuary Management Plan/Final Environmental Impact Statement (FMP/FEIS), Volume II: Environmental Impact Statement* (2008), authored and published by the National Oceanic and Atmospheric Administration, and would continue to be exempt from the prohibitions identified in the Sanctuary's regulations. HSTT activities within the Sanctuary would be conducted with an extensive set of mitigations measures (see Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) and will avoid to the maximum extent practicable any adverse impacts on the Sanctuary resources and qualities.

To ensure compliance with the National Marine Sanctuary Program Regulations, the Navy considered all proposed training and testing activities to determine which activities may destroy, cause the loss of, or injure sanctuary resources, or result in adverse impacts on sanctuary resources or qualities. The Navy concluded that the proposed activities could fall into the following three categories:

1. The following platforms, sources, or items that are part of Navy activities may be used within the Channel Islands National Marine Sanctuary because they were specifically exempted:

    - Aircraft and Aerial Targets

    Aircraft and aerial targets are expected to cause only a minor and temporary behavioral reaction due to noise for marine mammals, sea turtles, birds, or fish that may be present in the area. However, in addition to behavioral reactions due to noise, seabirds could potentially be struck by aircraft or aerial targets. The Navy implements standard operating procedures that require pilots of Navy aircraft to make every attempt to avoid large flocks of birds in order to reduce the safety risk involved with a potential bird strike. For a more detailed discussion of potential impacts to these resources from the use of aircraft and aerial targets, see the following sections:

    - Section 3.4.3.2.7 (Impacts from Aircraft Noise) for marine mammals
    - Section 3.5.3.1.12 (Impacts from Vessel and Aircraft Noise) for sea turtles
    - Section 3.6.3.1.5 (Impacts from Aircraft and Vessel Noise) and Section 3.6.3.3.1 (Impacts from Aircraft and Aerial Target Strikes) for birds
    - Section 3.9.3.1.2 (Impacts from Sonar and Other Active Sources) for fish

    - Vessels and in-water devices (that do not make contact with seafloor)

    Noise (other than sonar or radiated and induced noise) from vessels and in-water devices is expected to cause only a minor and temporary behavioral reaction for marine mammals, sea turtles, seabirds, or fish that may be present in the area. Marine mammals, sea turtles, seabirds, floating vegetation, and invertebrates could potentially be struck by or collide with vessels. However, the Navy implements mitigation measures to reduce the potential for vessel strikes of marine mammals (Section 5.3.2.2, Physical Disturbance and Strike, and Section 5.3.3.1, Marine Mammal Habitats). In addition, all vessels use extreme caution and proceed at a “safe speed” so they can take proper and effective action to avoid a collision with any sighted object or disturbance and can be stopped within a distance appropriate to the prevailing circumstances and conditions. For a more detailed discussion of potential impacts to these resources from the use of vessels and in-water devices, see the following sections:

    - Section 3.4.3.4.1 (Impacts from Vessel Strike) and Section 3.4.3.4.2 (Impacts from In-Water Devices) for marine mammals
    - Section 3.5.3.3.1 (Impacts from Vessels) and Section 3.5.3.3.2 (Impacts from In-Water Devices) for sea turtles
    - Section 3.6.3.3.2 (Impacts from Vessels and In-Water Devices) for birds
    - Section 3.7.3.2.1 (Impacts from Vessels and In-Water Devices) for vegetation
    - Section 3.8.3.3.1 (Impacts from Vessels and In-Water Devices) for invertebrates
    - Section 3.9.3.3.1 (Impacts from Vessels and In-Water Devices) for fish

    - Explosives detonated in-air, at the surface, or in the water (includes gunnery, bombing, torpedoes, missiles, and mine countermeasures)

Explosives detonated in-air, at the surface, or in the water could impact marine mammals, sea turtles, birds, invertebrates, floating vegetation, or fish that may be present in the area. Impacts are expected to range from temporary behavioral reactions to injury, damage, or death. However, the Navy implements mitigation measures to reduce the potential for impacts from the use of explosives (Section 5.3.1.2.2, Acoustic Stressors—Explosives and Impulsive Sound, and Section 5.3.2.1.2, Explosives and Impulsive Sound). For a more detailed discussion of potential impacts to these resources from the use of explosives detonated in-air, at the surface, or in the water, see the following sections:

- Section 3.4.3.2.2 (Impacts from Explosives) for marine mammals
- Section 3.5.3.1.8 (Impacts from Explosives) for sea turtles
- Section 3.6.3.1.2 (Impacts from Explosives and Swimmer Defense Airguns) for birds
- Section 3.7.3.1.1 (Impacts from Explosives) for vegetation
- Section 3.8.3.1.2 (Impacts from Explosives and Other Impulsive Sources) for invertebrates
- Section 3.9.3.1.3 (Impacts from Explosives and Other Impulsive Acoustic Sources) for fish

- Military expended materials resulting from exempted activities

Military expended materials resulting from exempted activities include fragments from high-explosive munitions, non-explosive practice munitions, and targets. These items could directly strike marine mammals, sea turtles, birds, invertebrates, floating vegetation, or fish that may be present in the area. However, the probability of military expended materials directly striking a marine resource is extremely low. In addition, the Navy implements mitigation measures to reduce the potential for direct strike from non-explosive practice munitions (Section 5.3.1.2.3, Physical Disturbance and Strike, and Section 5.3.2.2.2, Non-Explosive Practice Munitions). In addition to biological resources, military expended materials can land on marine substrates. The Navy implements mitigation measures to reduce the potential for direct strike to shallow coral reefs from non-explosive practice munitions (Section 5.3.3.2, Seafloor Resources). For a more detailed discussion of potential impacts to these resources from the use of non-explosive practice munitions fired in-air or at the surface, see the following sections:

- Section 3.3.3.2.4 (Impacts from Military Expended Materials) for marine habitats
- Section 3.4.3.4.3 (Impacts from Military Expended Materials) for marine mammals
- Section 3.5.3.3.3 (Impacts from Military Expended Materials) for sea turtles
- Section 3.6.3.3.3 (Impacts from Military Expended Materials) for birds
- Section 3.7.3.2.2 (Impacts from Military Expended Materials) for vegetation
- Section 3.8.3.3.2 (Impacts from Military Expended Materials) for invertebrates
- Section 3.9.3.3.2 (Impacts from Military Expended Materials) for fish

2. The following platforms, sources, or items that are part of Navy activities may be used within the Channel Islands National Marine Sanctuary because they (1) are not likely to destroy, cause the loss of, or injure sanctuary resources or qualities; and (2) would not cause <u>significant impacts</u> on sanctuary resources:

- Sonar and other active acoustic sources

Sonar and other active acoustic sources are expected to cause only a minor and temporary behavioral reaction for invertebrates (cephalopods and crustaceans), diving birds, or fish that may be present in the area. No effect is anticipated to corals. Marine mammals and sea

turtles could potentially be injured (permanent threshold shifts in hearing) from sonar and other active acoustic sources. However, although marine mammals and sea turtles may occur within the Channel Islands National Marine Sanctuary, there is no evidence to suggest that they would be concentrated in this area; therefore, the likelihood of injury is low. Furthermore, the Navy implements mitigation measures to reduce the potential for marine mammals and sea turtles to be exposed to sonar and other active acoustic sources throughout the entire Study Area (Section 5.3.1.2.1, Acoustic Stressors – Non-Impulsive Sound, and Section 5.3.2.1.1, Non-Impulsive Sound). For a more detailed discussion of potential impacts to these resources from the use of sonar and other active acoustic sources, see the following sections:

- Section 3.4.3.2.1 (Impacts from Sonar and Other Active Acoustic Sources) for marine mammals
- Section 3.5.3.1.7 (Impacts from Sonar and Other Active Acoustic Sources) for sea turtles
- Section 3.6.3.1.1 (Impacts from Sonar and Other Active Acoustic Sources) for birds
- Section 3.8.3.1.1 (Impacts from Sonar and Other Active Acoustic Sources) for invertebrates
- Section 3.9.3.1.2 (Impacts from Sonar and Other Active Sources) for fish

- Electromagnetic devices

Electromagnetic devices are expected to cause only a minor and temporary behavioral reaction for marine mammals, sea turtles, birds, invertebrates (arthropods, such as lobsters), or fish that may be present in the area. For a more detailed discussion of potential impacts to these resources from the use of electromagnetic devices, see the following sections:

- Section 3.4.3.3.1 (Impacts from Electromagnetic Devices) for marine mammals
- Section 3.5.3.2.1 (Impacts from Electromagnetic Devices) for sea turtles
- Section 3.6.3.2.1 (Impacts from Electromagnetic Devices) for birds
- Section 3.8.3.2.1 (Impacts from Electromagnetic Devices) for invertebrates
- Section 3.9.3.2.1 (Impacts from Electromagnetic Devices) for fish

3. The following platforms, sources, or items that are part of Navy activities, but are not planned to be used within the Channel Islands National Marine Sanctuary (including a 2.7 nm buffer) as part of the Proposed Action:

   - Military expended materials resulting from non-exempted activities
   - Seafloor devices

The Office of National Marine Sanctuaries has determined that no consultation is required for HSTT activities in the Channel Islands National Marine Sanctuary (Appendix C, Agency Correspondence).

Figure 6.1-1: Channel Islands National Marine Sanctuary

6.1.2.1.2 Hawaiian Islands Humpback Whale National Marine Sanctuary

Scientists estimate that more than 50 percent of the entire North Pacific humpback whale population migrates to Hawaiian waters each winter to mate, calve, and nurse their young. The continued protection of humpback whales and their habitat is crucial to the long-term recovery of this endangered species. In addition to protection under the MMPA and the ESA, the humpback whale is protected in Hawaiian waters by the Hawaiian Islands National Marine Sanctuary Act.

The Hawaiian Islands National Marine Sanctuary Act established the Hawaiian Islands Humpback Whale National Marine Sanctuary. The sanctuary is composed of 1,035 nm^2 of the waters around Maui, Lanai, and Molokai; and smaller areas off the north shore of Kauai, off Hawaii's west coast, and off the north and southeast coasts of Oahu (Figure 6.1-2). The Sanctuary is entirely within the Hawaii portion of the Study Area, constitutes one of the world's most important North Pacific humpback whale (*Megaptera novaeangliae*) habitats, and is a primary region for humpback reproduction in the U.S. (National Marine Sanctuary Program 2002).

The sanctuary boundaries extend from the shoreline to 600 feet (ft.) (183 meters [m]) deep in many areas, encompassing a variety of marine ecosystems, including sea grass beds and coral reefs. Corals and coralline algae are the dominant reef-building organisms in Hawaii's reef ecosystems. Endangered Hawaiian monk seals and sea turtles are found in the sanctuary (Office of National Marine Sanctuaries 2010). Important reef biota include finger coral, cauliflower coral, lobe coral, algae, and marine invertebrates, such as shrimp, lobsters, crabs, and sea urchins. Fish populations on the sanctuary reefs include parrotfish, wrasses, damselfish, surgeon fish, goatfish, jacks, and sharks. See Section 3.4 (Marine Mammals), Section 3.5 (Sea Turtles), Section 3.7 (Marine Vegetation), Section 3.8 (Marine Invertebrates), and Section 3.9 (Fish) for additional information on these species.

A management review process for the Hawaiian Islands Humpback Whale National Marine Sanctuary is underway. A proposal to expand the scope of the sanctuary to conserve other living marine resources was made available to the public for comment between July and October 2010, and public scoping meetings were held in August 2010 (National Oceanic and Atmospheric Administration 2010). According to the National Marine Sanctuary Program Regulations for the Hawaiian Islands Humpback Whale National Marine Sanctuary (15 C.F.R., § 922.184), there are no prohibitions specifically related to military activities.

General regulations for the Hawaiian Islands Humpback Whale National Marine Sanctuary prohibit the following (15 C.F.R. § 922.184(a)):

> (1) Approaching, or causing a vessel or other object to approach, within the Sanctuary, by any means, within 100 yards of any humpback whale except as authorized under the Marine Mammal Protection Act, as amended (MMPA), 16 U.S.C. 1361 et seq., and the Endangered Species Act, as amended (ESA), 16 U.S.C. 1531 et seq.;
>
> (2) Operating any aircraft above the Sanctuary within 1,000 feet of any humpback whale except as necessary for takeoff or landing from an airport or runway, or as authorized under the MMPA and the ESA;
>
> (3) Taking any humpback whale in the Sanctuary except as authorized under the MMPA and the ESA;

(4) Possessing within the Sanctuary (regardless of where taken) any living or dead humpback whale or part thereof taken in violation of the MMPA or the ESA;

(5) Discharging or depositing any material or other matter in the Sanctuary; altering the seabed of the Sanctuary; or discharging or depositing any material or other matter outside the Sanctuary if the discharge or deposit subsequently enters and injures a humpback whale or humpback whale habitat, provided that such activity:

(i) requires a Federal or State permit, license, lease, or other authorization; and

(ii) is conducted:

(A) without such permit, license, lease, or other authorization, or

(B) not in compliance with the terms or conditions of such permit, license, lease, or other authorization.

(6) Interfering with, obstructing, delaying or preventing an investigation, search, seizure or disposition of seized property in connection with enforcement of either of the Acts or any regulations issued under either of the Acts.

According to the National Marine Sanctuary Program Regulations for the Hawaiian Islands Humpback Whale National Marine Sanctuary (15 C.F.R., § 922.183), "…all classes of military activities, internal or external to the Sanctuary, that are being or have been conducted before the effective date of these regulations …[the prohibitions] do not apply to these classes of activities." Additionally, any activity that is "modified in such a way that it is likely to destroy, cause the loss of, or injure a Sanctuary resource in manner significantly greater than was considered in a previous consultation under section 304(d) of the National Marine Sanctuary Act and § 922.187 of this subpart, the modified activity will be treated as a new military activity under paragraph (c) of this section." Navy activities within the Hawaiian Islands Humpback Whale National Marine Sanctuary are specifically identified in Appendix F of the Final Management Plan/Final EIS Volume II (National Oceanic and Atmospheric Administration 1997). These Navy activities are exempt from the prohibitions in the Sanctuary. Within the sanctuary, the Navy conducts primarily anti-submarine warfare training and testing, consisting of mid- and high-frequency active sonar use. This type of training occurs throughout the range complex, but overlaps with the boundaries of the sanctuary only in that portion around the islands of Maui, Lanai, and Molokai. The Navy does not propose new or modified activities in the Hawaiian Islands Humpback Whale National Marine Sanctuary, or activities that are different from those currently conducted in this area. Increases to military activities described in the Proposed Action would not occur in the sanctuary. Therefore, proposed activities are consistent with those activities currently conducted in this area and those described in the sanctuary's Final Management Plan/Final EIS. These HSTT activities would continue to be exempt from the prohibitions identified in the Sanctuary's regulations. HSTT activities within the Hawaiian Islands Humpback Whale National Marine Sanctuary would be conducted with an extensive set of mitigation measures (see Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) and will avoid to the maximum extent practicable any adverse impacts on the Sanctuary resources and qualities.

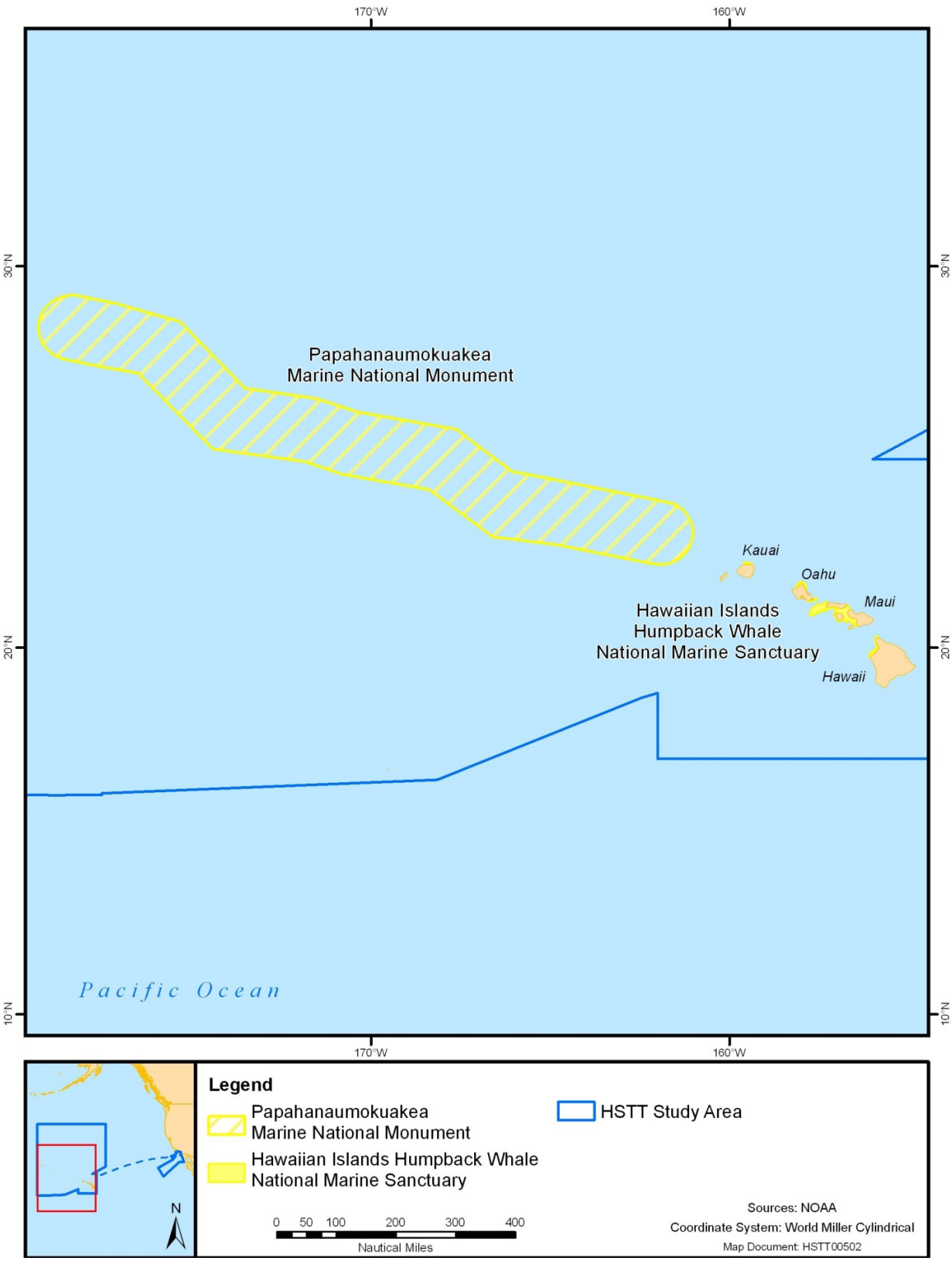

Figure 6.1-2: Papahanaumokuakea Marine National Monument and the Hawaiian Islands Humpback Whale National Marine Sanctuary

The Navy does not propose new or an increase in activities in the Hawaiian Islands Humpback Whale National Marine Sanctuary, or activities that are different from those currently conducted in this area. Therefore, proposed activities are consistent with those activities currently conducted in this area, are consistent with those described in the sanctuary's designation document, and are not being changed or modified in a way that would require consultation. Additionally, the Navy has designated a humpback whale cautionary area within the sanctuary, around an area that has been identified as having one of the highest concentrations of humpback whales during the critical winter months. Should national security needs require MFA sonar training and testing in the cautionary area between 15 December and 15 April, it shall be personally authorized by the Commander, U.S. Pacific Fleet. Further, the Navy will provide specific direction on required mitigation prior to operational units transiting to and training in the cautionary area. The Navy will provide the National Marine Fisheries Service with advance notification of any such activities.

To ensure compliance with the National Marine Sanctuary Program Regulations, the Navy considered all proposed training and testing activities to determine which activities may destroy, cause the loss of, or injure sanctuary resources, or result in adverse impacts on sanctuary resources or qualities. The Navy concluded that the proposed activities could fall into the following three categories:

1. The following platforms, sources, or items that are part of Navy activities may be used within the Hawaiian Islands Humpback Whale National Marine Sanctuary because they were specifically exempted:

    - Aircraft and Aerial Targets

    Aircraft and aerial targets are expected to cause only a minor and temporary behavioral reaction due to noise for marine mammals, sea turtles, birds, or fish that may be present in the area. However, in addition to behavioral reactions due to noise, seabirds could potentially be struck by aircraft or aerial targets. The Navy implements standard operating procedures that require pilots of Navy aircraft to make every attempt to avoid large flocks of birds in order to reduce the safety risk involved with a potential bird strike. For a more detailed discussion of potential impacts to these resources from the use of aircraft and aerial targets, see the following sections:

    - Section 3.4.3.2.7 (Impacts from Aircraft Noise) for marine mammals
    - Section 3.5.3.1.12 (Impacts from Vessel and Aircraft Noise) for sea turtles
    - Section 3.6.3.1.5 (Impacts from Aircraft and Vessel Noise) and Section 3.6.3.3.1 (Impacts from Aircraft and Aerial Target Strikes) for birds
    - Section 3.9.3.1.2 (Impacts from Sonar and Other Active Sources) for fish

    - Vessels and in-water devices (that do not make contact with seafloor)

    Noise (other than sonar or radiated and induced noise) from vessels and in-water devices is expected to cause only a minor and temporary behavioral reaction for marine mammals, sea turtles, seabirds, or fish that may be present in the area. Marine mammals, sea turtles, seabirds, floating vegetation, and invertebrates could potentially be struck by or collide with vessels. However, the Navy implements mitigation measures to reduce the potential for vessel strikes of marine mammals (Section 5.3.2.2, Physical Disturbance and Strike, and Section 5.3.3.1, Marine Mammal Habitats). In addition, all vessels use extreme caution and proceed at a "safe speed" so they can take proper and effective action to avoid a collision with any sighted object or disturbance and can be stopped within a distance appropriate to the prevailing circumstances and conditions. For a more detailed discussion of potential

impacts to these resources from the use of vessels and in-water devices, see the following sections:

- Section 3.4.3.4.1 (Impacts from Vessels) and Section 3.4.3.4.2 (Impacts from In-Water Devices) for marine mammals
- Section 3.5.3.3.1 (Impacts from Vessels) and Section 3.5.3.3.2 (Impacts from In-Water Devices) for sea turtles
- Section 3.6.3.3.2 (Impacts from Vessels and In-Water Devices) for birds
- Section 3.7.3.2.1 (Impacts from Vessels and In-Water Devices) for vegetation
- Section 3.8.3.3.1 (Impacts from Vessels and In-Water Devices) for invertebrates
- Section 3.9.3.3.1 (Impacts from Vessels and In-Water Devices) for fish

- Explosives detonated in-air, at the surface, or in the water (includes gunnery, bombing, torpedoes, missiles, and mine countermeasures)

Explosives detonated in-air, at the surface, or in the water could impact marine mammals, sea turtles, birds, invertebrates, floating vegetation, or fish that may be present in the area. Impacts are expected to range from temporary behavioral reactions to injury, damage, or death. However, the Navy implements mitigation measures to reduce the potential for impacts from the use of explosives (Section 5.3.1.2.2, Acoustic Stressors—Explosives and Impulsive Sound, and Section 5.3.2.1.2, Explosives and Impulsive Sound). For a more detailed discussion of potential impacts to these resources from the use of explosives detonated in-air, at the surface, or in the water, see the following sections:

- Section 3.4.3.2.2 (Impacts from Explosives) for marine mammals
- Section 3.5.3.1.8 (Impacts from Explosives) for sea turtles
- Section 3.6.3.1.2 (Impacts from Explosives and Swimmer Defense Airguns) for birds
- Section 3.7.3.1.1 (Impacts from Explosives) for vegetation
- Section 3.8.3.1.2 (Impacts from Explosives and Other Impulsive Sources) for invertebrates
- Section 3.9.3.1.3 (Impacts from Explosives and Other Impulsive Acoustic Sources) for fish

- Military expended materials resulting from exempted activities

Military expended materials resulting from exempted activities include fragments from high-explosive munitions, non-explosive practice munitions, and targets. These items could directly strike marine mammals, sea turtles, birds, invertebrates, floating vegetation, or fish that may be present in the area. However, the probability of military expended materials directly striking a marine resource is extremely low. In addition, the Navy implements mitigation measures to reduce the potential for direct strike from non-explosive practice munitions (Section 5.3.1.2.3, Physical Disturbance and Strike, and Section 5.3.2.2.2, Non-Explosive Practice Munitions). In addition to biological resources, military expended materials can land on marine substrates. The Navy implements mitigation measures to reduce the potential for direct strike to shallow coral reefs from non-explosive practice munitions (Section 5.3.3.2, Seafloor Resources). For a more detailed discussion of potential impacts to these resources from the use of non-explosive practice munitions fired in-air or at the surface, see the following sections:

- Section 3.3.3.2.4 (Impacts from Military Expended Materials) for marine habitats
- Section 3.4.3.4.3 (Impacts from Military Expended Materials) for marine mammals
- Section 3.5.3.3.3 (Impacts from Military Expended Materials) for sea turtles
- Section 3.6.3.3.3 (Impacts from Military Expended Materials) for birds

- Section 3.7.3.2.2 (Impacts from Military Expended Materials) for vegetation
- Section 3.8.3.3.2 (Impacts from Military Expended Materials) for invertebrates
- Section 3.9.3.3.2 (Impacts from Military Expended Materials) for fish

2. The following platforms, sources, or items that are part of Navy activities may be used within the Hawaiian Islands Humpback Whale National Marine Sanctuary because they (1) are not likely to destroy, cause the loss of, or injure sanctuary resources or qualities; and (2) would not cause significant impacts on sanctuary resources:

   - Sonar and other active acoustic sources

   Sonar and other active acoustic sources are expected to cause only a minor and temporary behavioral reaction for invertebrates (cephalopods and crustaceans), diving birds, or fish that may be present in the area. No effect is anticipated to corals. Marine mammals and sea turtles could potentially be injured (permanent threshold shifts in hearing) from sonar and other active acoustic sources. However, although marine mammals and sea turtles may occur within the Hawaiian Islands Humpback Whale National Marine Sanctuary, there is no evidence to suggest that they would be concentrated in this area; therefore, the likelihood of injury is low. Furthermore, the Navy implements mitigation measures to reduce the potential for marine mammals and sea turtles to be exposed to sonar and other active acoustic sources throughout the entire Study Area (Section 5.3.1.2.1, Acoustic Stressors – Non-Impulsive Sound, and Section 5.3.2.1.1, Non-Impulsive Sound). For a more detailed discussion of potential impacts to these resources from the use of sonar and other active acoustic sources, see the following sections:

   - Section 3.4.3.2.1 (Impacts from Sonar and Other Active Acoustic Sources) for marine mammals
   - Section 3.5.3.1.7 (Impacts from Sonar and Other Active Acoustic Sources) for sea turtles
   - Section 3.6.3.1.1 (Impacts from Sonar and Other Active Acoustic Sources) for birds
   - Section 3.8.3.1.1 (Impacts from Sonar and Other Active Acoustic Sources) for invertebrates
   - Section 3.9.3.1.2 (Impacts from Sonar and Other Active Sources) for fish

   - Electromagnetic devices

   Electromagnetic devices are expected to cause only a minor and temporary behavioral reaction for marine mammals, sea turtles, birds, invertebrates (arthropods, such as lobsters), or fish that may be present in the area. For a more detailed discussion of potential impacts to these resources from the use of electromagnetic devices, see the following sections:

   - Section 3.4.3.3.1 (Impacts from Electromagnetic Devices) for marine mammals
   - Section 3.5.3.2.1 (Impacts from Electromagnetic Devices) for sea turtles
   - Section 3.6.3.2.1 (Impacts from Electromagnetic Devices) for birds
   - Section 3.8.3.2.1 (Impacts from Electromagnetic Devices) for invertebrates
   - Section 3.9.3.2.1 (Impacts from Electromagnetic Devices) for fish

3. The following platforms, sources, or items are part of Navy activities, but are not planned to be used within the Hawaiian Islands Humpback Whale National Marine Sanctuary (including a 2.7 nm buffer) as part of the Proposed Action:

- Military expended materials resulting from non-exempted activities
- Seafloor devices

The Office of National Marine Sanctuaries has determined that no consultation is required for HSTT activities in the Hawaiian Islands Humpback Whale National Marine Sanctuary (Appendix C, Agency Correspondence).

6.1.2.1.3 Papahanaumokuakea Marine National Monument

Papahanaumokuakea Marine National Monument, established by Presidential Proclamation 8031 in June 2006, is the single largest conservation area in the U.S., encompassing 105,560 nm^2 in a chain of islands, reefs, and banks that extends to the northwest of the main Hawaiian Islands (Figure 6.1-2) (National Marine Sanctuaries 2009b). This monument is entirely within the Hawaii portion of the Study Area. The monument hosts a complex mix of reef, slope, bank, seamount (underwater mountains/volcanoes), abyssal (deep sea), and open ocean environments, and is managed by the monument's advisory council; the Department of Defense is a member of this council. The Papahanaumokuakea Marine National Monument also contains seamounts and approximately 30 submerged banks (U.S. Fish and Wildlife Service et al. 2008). The more than 4,450 square miles (m^2) (11,525 square kilometers) of shallow-water coral reef contains at least 57 coral species, 355 algae species, and 838 invertebrate species, with an exceptionally high number of corals and algae found only in the Hawaiian Islands (National Marine Sanctuaries 2009b). More than 260 fish species inhabit the reefs, with relatively fewer herbivores, such as surgeonfishes, and an abundance of carnivores, such as damselfishes, goatfishes, and scorpionfishes. Predators such as sharks and jacks dominate the reef fish communities. Most of the area is in the open ocean, with oceanic fish species, such as tuna, marlin, and wahoo. See Section 3.7 (Marine Vegetation), Section 3.8 (Marine Invertebrates), and Section 3.9 (Fish) for additional information on species and bathymetry in the Study Area.

The monument's ecosystem supports a range of marine mammals, including the Hawaiian monk seal, the Hawaiian spinner dolphin, and bottlenose dolphins (National Marine Sanctuaries 2009b). The Hawaiian monk seal, which does not exist outside of this area, is the most endangered marine mammal in the U.S. and the only seal that depends on coral reefs. Transient marine mammals in the Papahanaumokuakea Marine National Monument include spotted dolphins and humpback whales. Seasonally or periodically present whales include the sperm, blue, fin, sei, and North Pacific right whales. See Section 3.4 (Marine Mammals) for additional information on these species.

Five species of sea turtles occur in the monument: the loggerhead, olive ridley, leatherback, hawksbill, and green sea turtles (U.S. Fish and Wildlife Service et al. 2008). The Papahanaumokuakea Marine National Monument islands provide important nesting habitat for the threatened green sea turtle, with French Frigate Shoals alone supporting more than 80 percent of the nesting population for all the Hawaiian Islands. See Section 3.5 (Sea Turtles) for additional information on these species.

The regulations implementing the Papahanaumokuakea Marine National Monument (50 C.F.R., § 404), state that "all activities and exercises of the Armed Forces shall be carried out in a manner that avoids, to the extent practicable and consistent with operational requirements, adverse impacts on monument resources and qualities." Additionally, these regulations require that "in the event of threatened or actual destruction of, loss of, or injury to a monument resource or quality resulting from an incident, including but not limited to spill and groundings, caused by a component of the [DoD] or the United States Coast Guard, the cognizant component shall promptly coordinate with the Secretaries for the purpose of taking appropriate actions to respond to and mitigate the harm and, if possible, restore or

replace the monument resource or quality." The Navy's proposed action includes activities conducted east of Nihoa Island and just inside the eastern edge of the monument boundaries. These activities may include:

- Anti-air warfare
- Anti-surface warfare
- Anti-submarine warfare
- Electronic warfare

The Navy does not propose new activities in the Papahanaumokuakea Marine National Monument, or activities that are different from those currently conducted in this area. Increases to military activities described in the proposed action would not occur in the monument. Therefore, proposed activities are consistent with those activities currently conducted in this area when the monument was designated, and are not being changed or modified in a way that would require consultation.

6.2 Relationship Between Short-Term Use of the Environment and Maintenance and Enhancement of long-Term Productivity

In accordance with the Council on Environmental Quality regulations (Part 1502), this EIS/OEIS analyzes of the relationship between the short-term impacts on the environment and the effects those impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This means that choosing one option may reduce future flexibility in pursuing other options, or that committing a resource to a certain use may often eliminate the possibility for other uses of that resource. The Navy, in partnership with NMFS, is committed to furthering the understanding of marine resources and developing ways to lessen or eliminate the impacts Navy training and testing activities may have on these resources. For example, the Navy and NMFS collaborate on the Integrated Comprehensive Monitoring Program for marine species to assess the impacts of training activities on marine species and investigate population-level trends in marine species distribution, abundance, and habitat use in various range complexes and geographic locations where Navy training occurs.

The Proposed Action could result in both short- and long-term environmental impacts. However, these are not expected to result in any impacts that would reduce environmental productivity, permanently narrow the range of beneficial uses of the environment, or pose long-term risks to health, safety, or general welfare of the public. The Navy is committed to sustainable military range management, including co-use of the Study Area with the general public and commercial and recreational interests. This commitment to co-use of the Study Area will maintain long-term accessibility of the HSTT EIS/OEIS training and testing areas. Sustainable range management practices are specified in range complex management plans under the Navy's Tactical Training Theater Assessment and Planning Program. Among other benefits, these practices protect and conserve natural and cultural resources and preserve access to training areas for current and future training requirements while addressing potential encroachments that threaten to impact range and training area capabilities.

6.3 Irreversible or Irretrievable Commitment of Resources

The National Environmental Policy Act requires that environmental analysis include identification of "any irreversible and irretrievable commitments of resources which would be involved in the Proposed Action should it be implemented" (42 U.S.C. § 4332). Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects that the uses of these

resources have on future generations. Irreversible effects primarily result from the use or destruction of a specific resource (e.g., energy or minerals) that cannot be replaced within a reasonable time frame. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the action (e.g., the disturbance of a cultural site).

For the Proposed Action, most resource commitments would be neither irreversible nor irretrievable. Most impacts would be short term and temporary, or long lasting but within historical or desired conditions. Because there would be no building or facility construction, the consumption of material typically associated with such construction (e.g., concrete, metal, sand, fuel) would not occur. Energy typically associated with construction activities would not be expended and irretrievably lost.

Implementation of the Proposed Action would require fuels used by aircraft and vessels. Since fixed- and rotary-wing aircraft and ship activities could increase relative to the baseline, total fuel use would increase. Therefore, total fuel consumption would increase under the Proposed Action (see Section 6.4), and this nonrenewable resource would be considered irretrievably lost (see Chapter 4, Cumulative Impacts) and the following discussion on the Navy's Climate Change Roadmap).

6.4 Energy Requirements and Conservation Potential of Alternatives and Mitigation Measures

The federal government consumes two percent of the total U.S. energy share (Jean 2010). Of that 2 percent, the DoD consumes 93 percent. The Navy consumes one quarter of the total DoD share. The Navy consumes 1.2 billion to 1.6 billion gallons of fuel each year. The Navy expects a 25 percent increase in fuel consumption in the future because of new ships coming into the fleet and the growth in mission areas (Jean 2010).

Increased training and testing activities within the Study Area would result in an increase in energy demand over the No Action Alternative. The increased energy demand would arise from an increase in fuel consumption, mainly from aircraft and vessels participating in training and testing. Details of fuel consumption by training and testing activities on an annual basis are set forth in the air quality emissions calculation spreadsheets available on the project website. Vessel and aircraft fuel consumption is estimated to increase by 6.9 and 5.8 million gallons per year under Alternative 1 and Alternative 2, respectively, when compared to the No Action Alternative. Conservative assumptions were made in developing the estimates, and therefore the actual amount of fuel consumed during training and testing events may be less than estimated. Nevertheless, the demand for fuel consumption would increase from baseline levels, given the proposed increases in training and testing activities.

Energy requirements would be subject to any established energy conservation practices. The use of energy sources has been minimized wherever possible without compromising safety, training, or testing activities. No additional conservation measures related to direct energy consumption by the proposed activities are identified.

The Navy is committed to improving energy security and environmental stewardship by reducing its reliance on fossil fuels. The Navy is actively developing and participating in energy, environmental, and climate change initiatives that will increase use of alternative energy and help conserve the world's resources for future generations. The Navy Climate Change Roadmap identifies actions the Environmental Readiness Division is taking to implement EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*. The Navy's Task Force Energy is responding to the

Secretary of the Navy's Energy Goals through energy security initiatives that reduce the Navy's carbon footprint.

Two Navy programs—the Incentivized Energy Conservation Program and the Naval Sea Systems Command's Fleet Readiness, Research and Development Program—are helping the fleet conserve fuel via improved operating procedures and long-term initiatives. The Incentivized Energy Conservation Program encourages the operation of ships in the most efficient manner while conducting their mission and supporting the Secretary of the Navy's efforts to reduce total energy consumption on naval ships. The Naval Sea Systems Command's Fleet Readiness, Research, and Development Program includes the High-Efficiency Heating, Ventilating, and Air Conditioning and the Hybrid Electric Drive for DDG-51 class ships, which are improvements to existing shipboard technologies that will both help with fleet readiness and decrease the ships' energy consumption and greenhouse gas emissions. These initiatives are expected to greatly reduce the consumption of fossil fuels (see Section 3.2, Air Quality). Furthermore, to offset the impact of its expected near-term increased fuel demands and achieve its goals to reduce fossil fuel consumption and greenhouse gas emissions, the Navy plans to deploy by 2016 a green strike group (a "great green fleet") composed of nuclear vessels and ships powered by biofuel in local operations and with aircraft flying only with biofuels (Jean 2010).

REFERENCES

Jean, G. V. (2010). Navy's energy reform initiatives raise concerns among shipbuilders. *National Defense Business and Technology Magazine*. Retrieved from http://www.nationaldefensemagazine.org/archive/2010/April/Pages/NavyEnergyReformRaiseConcerns.aspx as accessed on 2011, September 16.

National Marine Sanctuaries. (2009a). Channel Islands National Marine Sanctuary Condition Report 2009. Silver Spring, MD, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries: 60.

National Marine Sanctuaries. (2009b). Papahanaumokuakea Marine National Monument Condition Report 2009. Silver Spring, MD, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries: 54.

National Marine Sanctuary Program. (2002). Hawaiian Islands Humpback Whale National Marine Sanctuary Management Plan, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries: 154.

National Oceanic and Atmospheric Administration. (1997). Hawaiian Islands Humpback Whale National Marine Sanctuary Final Environmental Impact Statement/Management Plan, February 1997.

National Oceanic and Atmospheric Administration. (2008). Channel Islands National Marine Sanctuary Final Management Plan/Final Environmental Impact Statement, Volume II of II, November 2008.

National Oceanic and Atmospheric Administration. (2010). Hawaiian Islands Humpback Whale National Marine Sanctuary Requesting Public Comment Through October 16, 2010, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, National Marine Sanctuary Program.

Office of National Marine Sanctuaries. (2010). Hawaiian Islands Humpback Whale National Marine Sanctuary Condition Report 2010. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Silver Spring, MD. 63 pp.

U.S. Department of the Navy. (2007). Environmental Readiness Program Manual OPNAV Instruction 5090.1C. (pp. 836). Prepared by Chief of Naval Operations.

U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, and State of Hawaii Department of Land and Natural Resources. (2008). Papahanaumokuakea Marine National Monument. Management Plan. I: 372.

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