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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 sources of noise, explosives, pile driving, swimmer defense airguns, vessel noise, and aircraft noise)
- Energy (electromagnetic devices)
- Physical disturbance or strikes (vessels and in-water devices, military expended materials, and seafloor devices)
- Entanglement (cables, wires, and parachutes)
- Ingestion (munitions and military expended materials other than munitions)
- Secondary (habitat, sediments, and water quality)

Preferred Alternative

- Per the Endangered Species Act (ESA), acoustic stressors may affect and are likely to adversely affect green, hawksbill, olive ridley, leatherback, and loggerhead sea turtles.
- Per the ESA, physical disturbance and strike stressors may affect and are likely to adversely affect green, hawksbill, olive ridley, leatherback, and loggerhead sea turtles.
- Per the ESA, the effects of energy sources used during training and testing activities may affect, but are not likely to adversely affect, ESA-listed green, hawksbill, olive ridley, leatherback, and loggerhead turtles.
- Per the ESA, the effects of entanglement stressors used during training and testing activities may affect, but are not likely to adversely affect, ESA-listed green, hawksbill, olive ridley, leatherback, and loggerhead sea turtles.
- Per the ESA, the effects of ingestion stressors used during training and testing activities may affect, but are not likely to adversely affect, ESA-listed green, hawksbill, olive ridley, leatherback, and loggerhead sea turtles.
- Per the ESA, secondary stressors would not affect sea turtles because changes in sediment, water, and air quality 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 3.5.3.

3.5.1.1 Endangered Species

Sea turtles are long-lived reptiles that are found throughout the world's tropical, subtropical, and temperate seas. Five of the seven living species of sea turtles are found in the Study Area (National Marine Fisheries Service [NMFS] and United States [U.S.] Fish and Wildlife Service 1998a, b, c, d, e, f).

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 mi. (3,218.7 km) depth contour (NMFS 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**
Family Dermochelyidae (leatherback sea turtle)					
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Yes	Yes	Yes

[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 (NMFS 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

3.5.2.1 Sea Turtles

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 2009).

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

3.5.2.1.1 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.

3.5.2.1.1.1 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).

3.5.2.1.1.2 Hawksbill Sea 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).

3.5.2.1.1.3 Loggerhead Sea 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. 2003; Soma 1985).

3.5.2.1.1.4 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 with a deep thermocline depth and an absence of strong horizontal temperature gradients and physical or biological fronts (Polovina et al. 2002).

3.5.2.1.1.5 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 (Eckert, et al. 2005; James, Myers, et al. 2005), 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, Eckert, Ponganis, 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.

3.5.2.1.2 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 1982, 1983). 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 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 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 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 2006). Auditory brainstem response recordings on green sea turtles showed a peak response at 300 Hz (Yudhana 2010). Juvenile Kemp's ridley turtles detected underwater sounds from 100 to 500 Hz, with a maximum sensitivity between 100 and 200 Hz (Bartol 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 kHz.

Few sea turtles were tested to determine auditory thresholds. Sub-adult green sea turtles show, on average, the lowest hearing threshold at 300 Hz (93 dB re 1 µPa), with thresholds increasing at frequencies above and below 300 Hz, when thresholds were determined by auditory brainstem response (Bartol 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 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 Moein 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 (Mrosovsky 1972).

3.5.2.1.3 General Threats

Each of 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. Sea turtles can mistake plastic bags for jellyfish, which are eaten by turtles, exclusively leatherbacks, throughout their lives. 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 (NMFS and U.S. Fish and Wildlife Service 1998a, b, c, d, e, f).

3.5.2.2 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).

3.5.2.2.1 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 (NMFS 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 (NMFS and U.S. Fish and Wildlife Service 1998a, b).

3.5.2.2.2 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 one to three years (Hirth 1997). Upon reaching the juvenile stage (estimated at five to six 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; NMFS 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 (NMFS 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 five to six 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 degrees (°) north (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; NMFS 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 3 to 5 times per season, laying an average of 115 eggs in each nest. 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 (NMFS 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 (NMFS 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; NMFS 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) (NMFS 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; NMFS 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 (NMFS 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 (NMFS 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, which attracted the resident turtle population to 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). During the summer, green sea turtles may venture into the northern part of the bay, or out of it entirely as water temperatures rise. 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.

3.5.2.2.3 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 (NMFS 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; NMFS 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 (NMFS 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 (NMFS and U.S. Fish and Wildlife Service 2007a). The Hawaiian population is composed of a single genetic stock (Dutton et al. 2008), with individuals spending 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, Work, et al. 2008b).

3.5.2.2.4 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; NMFS 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).

3.5.2.3 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 (NMFS and U.S. Fish and Wildlife Service 2007b).

3.5.2.3.1 Status and Management

The hawksbill turtle is listed as endangered under the ESA (NMFS 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 (NMFS 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 (NMFS and U.S. Fish and Wildlife Service 2007b).

3.5.2.3.2 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 (NMFS 2010c). 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 (NMFS 2010c).

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 (NMFS 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; NMFS 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 (NMFS 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; NMFS 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 (NMFS 2008c).

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).

3.5.2.3.3 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 (NMFS 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.

Hawksbills are solitary nesters on beaches throughout the tropics and subtropics. During the nesting season, female hawksbills return to their birth beaches every two to three 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 (NMFS 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. (NMFS and U.S. Fish and Wildlife Service 2007b).

3.5.2.3.4 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).

3.5.2.4 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).

3.5.2.4.1 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 (NMFS 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 NMFS 2010a), critical habitat has yet to be proposed and designated for Pacific Ocean loggerheads.

3.5.2.4.2 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 (NMFS 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 north 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).

NMFS 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 (NMFS 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°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 (NMFS 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. (NMFS 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 (NMFS 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).

Loggerheads do not dive particularly deep in the open sea environment (about 80 ft. [24 m]), although they forage to bottom depths of at least 490 ft. (149 m) in coastal habitats (Hatase et al. 2007; Polovina et al. 2003; Soma 1985).

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 to 330 ft.) (50 to 101 m) and those in the open ocean habitat diving exclusively in the 0 to 80 ft. (0 to 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. 2003).

3.5.2.4.3 Population and Abundance

The global population of loggerhead turtles is estimated at 43,320 to 44,560 nesting females (NMFS 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 3 to 5 clutches of eggs, and sometimes lay additional clutches, during a single nesting season (NMFS 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° 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 (32°C) (90°F) produces all females, and an incubation temperature near the lower end (26°C) (79°F) 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.

3.5.2.4.4 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).

3.5.2.5 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 (NMFS 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.

3.5.2.5.1 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 (NMFS 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 (NMFS 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 (NMFS and U.S. Fish and Wildlife Service 1998f). Today, this population appears to be stable or increasing (NMFS 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 (NMFS 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).

3.5.2.5.2 Habitat and Geographic Range

Most olive ridley turtles lead a primarily open ocean existence (NMFS 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) (NMFS 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 (NMFS 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 (NMFS 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 (NMFS and U.S. Fish and Wildlife Service 1998f, NMFS 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 (NMFS 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 (NMFS 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) (NMFS and U.S. Fish and Wildlife Service 1998f).

Groups of sometimes more than 100 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 (NMFS 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) (NMFS 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. 2003). 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. 2003).

3.5.2.5.3 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 (NMFS 2010c). 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 (NMFS 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 (NMFS 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 to 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” (NMFS 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 (NMFS 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 two 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 (NMFS 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 (NMFS 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).

3.5.2.5.4 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) (NMFS and U.S. Fish and Wildlife Service 1998f).

3.5.2.6 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 sea turtles; adults can reach 6.5 ft. (2 m) in length (NMFS 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.

3.5.2.6.1 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 (NMFS 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 (NMFS 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) (NMFS 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).

3.5.2.6.2 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; NMFS 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) (NMFS 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 (NMFS 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 (NMFS and U.S. Fish and Wildlife Service 2007c). The remaining six 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 (NMFS 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 (Collard 1990; 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 (NMFS 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).

3.5.2.6.3 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 (NMFS 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 (NMFS 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 (NMFS 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).

3.5.2.6.4 Predator/Prey Interactions

Leatherbacks lack the crushing and chewing plates characteristic of sea turtles that feed on hard-bodied prey (NMFS 2010c). 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; NMFS 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, 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, Eckert, Ponganis, 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 on adult leatherbacks, fish and sharks on hatchlings, and various land predators on hatchlings (e.g., ants, crabs, birds, and mammals) (NMFS and U.S. Fish and Wildlife Service 2001).

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 and other active sources of noise, including explosives, pile driving, swimmer defense airguns, vessels, and aircraft)
- Energy (electromagnetic devices)
- Physical disturbance or strikes (vessels and in-water devices, military expended materials, seafloor devices)
- Entanglement (cables, wires, and parachutes)
- Ingestion (munitions and military expended materials other than munitions)
- Secondary stressors

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; Craig Jr. 2001), 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 hearing loss 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 (Ketten and Bartol 2006; Moein 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 1991; 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. 2000, 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 sonars. 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 and Explosive 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., sonars, 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. 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 3.5-2: 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

Notes: dB = decibels; PTS = permanent threshold shift; TTS = temporary threshold shift; SEL = sound exposure level; SPL = sound pressure level

[1] (T): Turtle Weighting Function

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

Impulsive Sound Exposure Impact	Threshold Value
Onset Mortality[1] (1% Mortality Based on Extensive Lung Injury)	$= 91.4M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1/2} Pa-s$
Onset Slight Lung Injury[1]	$= 39.1M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1/2} Pa-s$
Onset Slight Gastrointestinal Tract Injury	237 dB re 1 μPa SPL (104 psi)
Onset PTS	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]

Notes: PTS = permanent threshold shift; TTS = temporary threshold shift; SEL = sound exposure level; SPL = sound pressure level

[1] M = mass of animals (kg) as shown for each species in Table 3.5-4, D_{Rm} = depth of animal (m)

[2] Turtle Weighting Function

[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.

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 s or shorter). Rapid pressure changes may produce mechanical damage to the ear or other structures that would not occur with slower rise times found in non-impulsive signals. Impulsive sources analyzed in this document include explosives, airguns, sonic booms, weapons firing, and impact pile-driving.

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., sonars 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 Explosions

There is a considerable body of laboratory data on actual injuries from impulsive sounds, usually from explosive pulses, obtained from tests with a variety of vertebrate species (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 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.

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

Common Name	Juvenile Mass (kg)	Reference
Loggerhead turtle	8.4	Southwood et al (2007)
Green turtle	8.7	Wood and Wood (1993)
Hawksbill turtle	7.4	Okuyama et al. (2010)
Olive ridley turtle	6.3	McVey and Wibbels (1984) and Caillouet (1986)[1]
Leatherback turtle	34.8	Jones (2009)

Note: [1]McVey and Wibbles (1984) and Caillouet (1986) measured masses for Kemp's ridley turtles, a closely related species to the olive ridley.

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).

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.

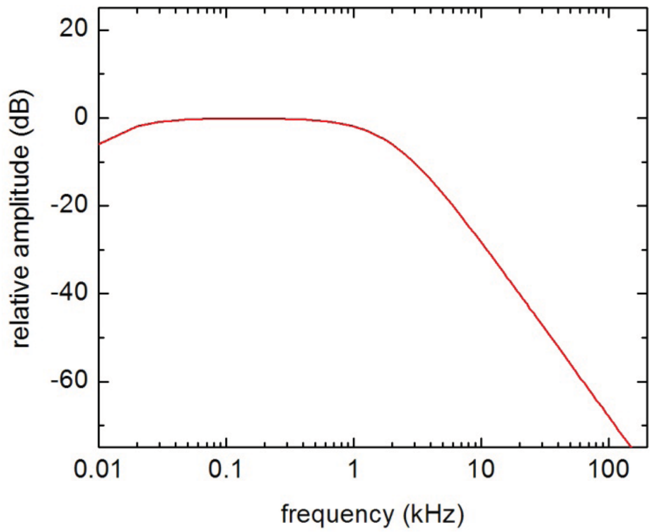

Figure 3.5-1: Auditory Weighting Function for Sea Turtles (T-weighting)

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 195 dB re 1 μPa^2-s is used to estimate exposures resulting in TTS for sea turtles. The T-weighting function is used in conjunction with this non-pulse criterion, which effectively provides an upper cutoff of 2 kHz.

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 183 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

Because 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 temporary threshold shift and permanent threshold shift 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 (Kryter et al. 1966; Miller et al. 1963; Southall et al. 2007; Ward 1960; 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 temporary threshold shift growth of 1.5 to 1.6 dB for every 1 dB increase in sound exposure level. The difference between minimum measureable TTS onset (6 dB) and the 40 dB upper safe limit of TTS yields a difference of 34 dB. When divided by a TTS growth rate of 1.6 dB TTS per dB sound exposure level, there is an indication that an increase in exposure of a 21.25 dB sound exposure level would result in 40 dB of TTS. For simplicity and conservatism, the number was rounded down to 20 dB sound exposure level.

Therefore, non-impulsive exposures of 20 dB sound exposure level above those producing a TTS may be assumed to produce a PTS. The onset of TTS threshold of 195 dB re 1 µPa^2-s for sea turtles has a corresponding onset of PTS threshold of 215 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).

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 198 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.

3.5.3.1.3.12 Criteria for Behavioral Responses

A sea turtle's behavioral responses to sound is 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 175-179 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

Existing NMFS risk criteria are applied to the unique sounds generated by pile-driving. 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 (NMFS 2005). Therefore, the threshold value for injury to sea turtles from impact and vibratory pile driving is 190 dB re 1 μPa sound pressure level root mean square.

3.5.3.2 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 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.

3.5.3.2.1 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 quantifying predicted 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 (NUWC 2011 NAEMO TR). 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 four minutes but do not otherwise mimic actual animal behaviors (such as avoidance or attraction to a stimulus).

Schecklman et al. (2011) argue that static distributions underestimate acoustic exposure compared to a model with fully three-dimensionally moving animals. However, their static method is different from the Navy Acoustic Effects Model in several ways. First, they distribute the entire population at depth with respect to the species-typical depth distribution histogram, and those animats remain static at that position throughout the entire simulation. In the Navy Acoustic Effects Model, animats are placed horizontally dependent upon 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 five minutes, the number of estimated exposures were similar between the Navy Acoustic Effects Model and the fully moving distribution, however, computational time was much longer for the fully moving distribution.

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.

3.5.3.2.2 Model Assumptions

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).
- 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) were not considered in the model.

3.5.3.2.2.1 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.

3.5.3.2.3 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 and Explosive 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 sonars 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 to 2 kHz). Therefore, most of these sources have no impact on sea turtle hearing. Only sonars 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 sonars, 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 3.5.3.2.1). 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. Most sonars and active acoustic sources used during testing and training use frequencies outside of the estimated hearing range of turtles.

3.5.3.2.3.1 Model-Predicted Impacts

Table 3.5-5 lists each acoustic source modeled and analyzed for each training and testing activity. 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 for additional details).

3.5.3.2.3.2 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. 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.

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	LF6, 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

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

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

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	Permanent Threshold Shift	Temporary Threshold Shift	Permanent Threshold Shift	Temporary Threshold Shift	Permanent Threshold Shift
Green sea turtle	0	0	0	0	0	0
Pacific Guild	397	0	412	0	412	0

Notes: The timing, locations, and numbers of these activities would not substantially differ from year to year under each alternative.

[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 3.5-7: 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	Permanent Threshold Shift	Temporary Threshold Shift	Permanent Threshold Shift	Temporary Threshold Shift	Permanent Threshold Shift
Green sea turtle	549	119	616	97	616	97
Pacific Guild	185	0	400	0	400	0

Notes: The timing, locations, and numbers of these activities would not substantially differ from year to year under each alternative.

[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.

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.

Under the ESA, sound from training activities involving sonar or other active acoustic sources as described 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. 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 training 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.

Under the ESA, sound from testing activities involving sonar or other active acoustic sources as described under the No Action Alternative may affect, and is likely to adversely affect, green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.5.3.2.3.3 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 3.5.3.2.3.2 (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.

Under the ESA, sound from training activities involving sonar or other active acoustic sources as described 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 the No Action Alternative 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. The impacts are predicted to increase 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 sonars 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 3.5.3.2.3.2 (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.

Under the ESA, sound from testing activities involving sonar or other active acoustic sources as described under Alternative 1 may affect, and is likely to adversely affect green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.5.3.2.3.4 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 3.5.3.2.3.2 (No Action Alternative).

Under the ESA, sound from training activities involving sonar or other active acoustic sources as described under Alternative 2 may affect, and is likely to adversely affect green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

Testing Activities

The number and location of testing 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 3.5.3.2.3.2 (No Action Alternative).

Under the ESA, sound from testing activities involving sonar or other active acoustic sources as described under Alternative 2 may affect, and is likely to adversely affect green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.5.3.2.4 Explosions

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 explosions is capable of causing mortalities, injuries to the lungs or gastrointestinal tract (Section 3.5.3.1.2.1), TTS or PTS (Section 3.5.3.1.2.2), or behavioral responses (Section 3.5.3.1.2.5). 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. The limited information on sea turtle behavioral responses to sounds is discussed in Section 3.5.3.1.2.5.

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, Criteria for 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.

3.5.3.2.4.1 Model-Predicted Impacts

The ranges of impacts from explosions 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 3.5-8: 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	30	88	227	369
Permanent Threshold Shift[2]	94	277	798	1,980
Temporary Threshold Shift[2]	212	699	1,887	4,306
Avoidance Behavior (for multiple impulses)	381	1,367	3,419	8,012

Notes: NEW = net explosive weight; m = meters, lb. = pound

Ranges determined using REFMS, Navy's explosive propagation model

[1] Criteria for impacts are discussed in Section 3.5.3.1.3, Acoustic and Explosive Thresholds and Criteria.

[2] Modeling for sound exposure level-based impulsive criteria assumed explosive event durations of one second. Actual durations may be less, resulting in smaller ranges to impact.

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 3.5-9: Annual Model-Predicted Impacts of Explosions 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]	135	36	11	0	4

Notes: [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 3.5-10: Annual Model-Predicted Impacts of Explosions 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]	167	44	13	0	5

Notes: The timing, locations, and numbers of these activities would not substantially differ from year to year under each alternative.

[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 3.5-11: Annual Model-Predicted Impacts of Explosions 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]	1	4	0	0	0

Notes: [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 of Explosions 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	0	0	0

Notes: [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 3.5-13: Annual Model-Predicted Impacts of Explosions 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	5	0	0	0

Notes: [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.

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 occur upon impact with above-water targets. For this analysis, sources such as these were modeled as exploding at depths of 1 m (3.3 ft.), 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 the range to which these impacts are predicted to occur compared to the range that would be predicted using adult turtle masses.
- The predicted acoustic impacts do not take into account mitigation measures implemented during many testing and training activities, such as exclusion zones around detonations. Smaller hatchling and early juvenile hardshell turtles tend to be near the surface and are often associated with *Sargassum*, which is subject to avoidance mitigation measures (see Section 5.0, Standard Operating Procedures, Mitigation, and Monitoring).

The ranges of impacts from explosions to the threshold of specific criteria are shown in Table 3.5-14. Sea turtles within these ranges are predicted 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. The low value for each range of impact is the minimum range and the high value is the maximum range within which the impact could occur for various events modeled for each explosive source class.

Table 3.5-14: Ranges of Impacts of In-water Explosions on Sea Turtles from Representative Sources

Criteria/Predicted Impact[1]	**Impact Predicted to Occur When Sea Turtle is at this Range (m) or Closer to a Detonation (Minimum Range Predicted to Maximum Range Predicted)**			
	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)	10,150	36,250	173,266	202,932
Onset Slight Lung Injury	18,150	65,301	298,486	3,271,269
Onset Slight GI Tract Injury	2,325	50,150	221,246	326,552
Permanent Threshold Shift[2]	102,116	150,552	542,769	701,887
Temporary Threshold Shift[2]	159,273	3,261,617	10,091,315	1,373 3,880

Notes: NEW = net explosive weight; m = meters; lb. = pound.
Ranges determined using REFMS, Navy's explosive propagation model
[1] Criteria for impacts are discussed in Section 3.5.3.1.3.
[2] Modeling for Sound Exposure Level-based impulsive criteria assumed explosive event durations of one second. Actual durations may be less, resulting in smaller ranges to impact.

3.5.3.2.4.2 No Action Alternative

Training Activities

Training activities under the No Action Alternative using explosives at or beneath the water surface would expose sea turtles to underwater impulsive sound. The largest source class used during training under the No Action Alternative would be E12 (651 to 1,000 pounds [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 (Explosions).

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), TRACKEX/TORPEX- 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 and gastrointestinal tract injury over any training year for explosives use in open ocean habitats. 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.

Under the ESA, in-water explosions associated with training activities under the No Action Alternative may affect, and are 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 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).

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, or slight lung injury over any training year. Any injured sea turtles could suffer reduced fitness and long-term survival. Sea turtles that experience PTS would have permanently reduced perception of sound within a limited frequency range. It is uncertain whether some permanent hearing loss over a part of a sea turtle's hearing range would have long-term consequences for that individual, 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 small 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 may experience long-term impacts and potential mortality, population-level impacts are not expected.

Under the ESA, in-water explosions associated with testing activities under the No Action Alternative may affect, and are likely to adversely affect green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.5.3.2.4.3 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 the No Action Alternative would be E12 (651 to 1,000 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), TRACKEX/TORPEX- 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 gastrointestinal tract injury over any training year for explosives use in open ocean habitats. Exposures modeled under Alternative 1 are expected to increase by approximately 10 percent, relative to the No Action Alternative. 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.

Under the ESA, in-water explosions associated with training activities under Alternative 1 may affect, and are 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 the No Action Alternative 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 of explosions 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. Compared to the No Action Alternative, exposures are expected to decrease by approximately 10 percent under Alternative 1. Despite the decrease, the impacts on sea turtles are expected to be similar to the No Action Alternative. 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.

Under the ESA, in-water explosions associated with testing activities under Alternative 1 may affect, and are likely to adversely affect green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.5.3.2.4.4 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 the No Action Alternative 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. These results are the same as for Alternative 1; therefore, the impacts under Alternative 2 are expected to be the same as Alternative 1.

Under the ESA, in-water explosions associated with training activities under Alternative 2 may affect, and are 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 training 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 2.8-1 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 testing activities under Alternative 2 are shown in Table 3.5-13. The results shown are the impacts on sea turtles predicted for one year of training. These results are the same as for Alternative 1, therefore, the impacts under Alternative 2 are expected to be the same as Alternative 1.

Under the ESA, in-water explosions associated with testing activities under Alternative 2 may affect, and are likely to adversely affect green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.5.3.2.5 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 30-50 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 (Laughlin 2010), 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 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 6, Cumulative Impacts.

3.5.3.2.5.1 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 µPam, 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 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.

Under 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.

3.5.3.2.6 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 airguns would not cause direct trauma to sea turtles. Impulses from these small airguns lack the strong shock wave and rapid pressure increases of explosions that can cause primary blast injury or barotraumas (criteria for determining impacts to sea turtles from impulsive sound are discussed in Section 3.5.3.1.3.3). 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 airguns as part of Navy training 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.

3.5.3.2.6.1 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.

3.5.3.2.6.2 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.

Under the ESA, noise from swimmer defense airgun testing activities under the No Action Alternative may affect, but is not likely to adversely affect, green sea turtles. Swimmer defense airguns would have no effect on hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.2.6.3 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.

Under the ESA, noise from swimmer defense airgun testing activities under Alternative 1 may affect, but is not likely to adversely affect, green sea turtles. Swimmer defense airguns would have no effect on hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.2.6.4 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 include a small increase 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.

Under the ESA, noise from swimmer defense airgun testing activities under Alternative 2 may affect, but is not likely to adversely affect, green sea turtles. Swimmer defense airguns would have no effect on hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.2.7 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.

3.5.3.2.7.1 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. Sea turtles that experience PTS would have permanently reduced perception of sound within a limited frequency range. It is uncertain whether some permanent hearing loss over a part of a sea turtle's hearing range would have long-term consequences for that individual, as the sea turtle hearing range is already limited. A long-term consequence could be an impact on an individual turtle's ability to sense biologically important sounds, such as predators or prey, reducing that animal's fitness. TTS would 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.

Under the ESA, sound 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. Sea turtles that experience PTS would have a permanently reduced perception of sound within a limited frequency range. It is uncertain whether some permanent hearing loss over a part of a sea turtle's hearing range would have long-term consequences for that individual, as the sea turtle hearing range is already limited. A long-term consequence could be an impact on an individual turtle's ability to sense biologically important sounds, such as predators or prey, reducing that animal's fitness. TTS would 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.

Under the ESA, sound 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.

3.5.3.2.7.2 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 3.5.3.2.7.1 (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.

Under the ESA, sound 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, littoral combat ship 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 3.5.3.2.7.1 (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.

Under the ESA, sound 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.

3.5.3.2.7.3 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 3.5.3.2.7.1, No Action Alternative.

Under the ESA, sound 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 3.5.3.2.7.1 (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.

Under the ESA, sound 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.

3.5.3.2.8 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 3.0.3.6, 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 3.0.3.5.2 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 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 3.0.3.5.3 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.

3.5.3.2.8.1 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.

Under the ESA, sound 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.

Under the ESA, sound 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.

3.5.3.2.8.2 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 3.5.3.2.8.1 (No Action Alternative), even though vessel noise may cause short-term impacts, no long-term consequences for individuals or populations would be expected.

Under the ESA, sound 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 and 2.8-3 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 3.5.3.2.8.1 (No Action Alternative), even though vessel noise may cause short-term impacts, no long-term consequences for individuals or populations would be expected.

Under the ESA, sound 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.

3.5.3.2.8.3 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 3.5.3.2.8.1 (No Action Alternative).

Under the ESA, sound 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. The number of events and proposed locations are discussed in further detail in Tables 2.8-2 and 2.8-3 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 3.5.3.2.8.1 (No Action Alternative), even though vessel noise may cause short-term impacts, no long-term consequences for individuals or populations would be expected.

Under the ESA, sound 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.

3.5.3.3 Impacts of 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 (Churnside 2004). 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.

3.5.3.3.1 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). 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.

3.5.3.3.1.1 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), 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.

Under the ESA, electromagnetic devices during training activities under the No Action Alternative may affect, but are 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), 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.

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

3.5.3.3.1.2 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), 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.

Under the ESA, electromagnetic devices during training activities under Alternative 1 may affect, but are 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), under Alternative 1, 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.

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.

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

3.5.3.3.1.3 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 3.5.3.3.1.2 (Alternative 1).

Under the ESA, electromagnetic devices used during training activities under Alternative 2 may affect, but are 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), 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.

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

3.5.3.4 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 (Sound Producing and Explosive Activities) through 3.5.3.2.7 (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.

3.5.3.4.1 Impacts of 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 (Vessel Strikes). 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 2000, 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 (NMFS 2008a). 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. The locations and movement patterns of San Diego Bay green sea turtles in the northern portion of San Diego Bay are not well understood. This absence of data inhibits efforts to quantify the impacts of marine vessel strikes in the northern portion of San Diego Bay, although there are ongoing efforts in San Diego Bay by the Navy and the academic community to gather data on turtle movements. 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 3.0-16) (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 [Vessel Strikes]).

3.5.3.4.1.1 No Action Alternative, Alternative 1, and Alternative 2

Training Activities

As indicated in Section 3.0.5.3.3.1 (Vessel Strikes), 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 because if a sea turtle were struck, it could lead to injury or death. 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 result in population-level impacts. The stressor does not overlap with any designated sea turtle critical habitat.

Under 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 (Vessel Strikes), 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 because if a sea turtle were struck, it could lead to injury or death. 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.

Under 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.

3.5.3.4.2 Impacts of 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. 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.

3.5.3.4.2.1 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 two 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 because if a sea turtle were struck, it could lead to injury or death. However, 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.

Under 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, and is 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 because if a sea turtle were struck, it could lead to injury or death. However, 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.

Under 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, and is likely to adversely affect, green, hawksbill, olive ridley, leatherback, and loggerhead turtles.

3.5.3.4.3 Impacts of 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 very likely because the objects generally sink through the water slowly and can be avoided by most sea turtles. Therefore, the discussion of military expended materials strikes will focus on the potential of a strike at the surface of the water.

There is a remote 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]).

3.5.3.4.3.1 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 because if a sea turtle were struck, it could lead to injury or death. However, sea turtles are generally at the surface only for short periods and spend most of their time submerged, so the likelihood of being struck by a projectile is very low. Projectiles are aimed at targets, which will absorb the impact of the projectile. 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.

Under the ESA, the use military expended materials 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, 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 because if a sea turtle were struck, it could lead to injury or death. However, sea turtles are generally at the surface only for short periods and spend most of their time submerged, so the likelihood of being struck by a projectile is very low. Projectiles are aimed at targets, which will absorb the impact of the projectile. The model results 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.

Under the ESA, the use military expended materials 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.

3.5.3.4.4 Impacts of 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 3.5.3.4 (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.

3.5.3.4.4.1 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 because if a sea turtle were struck, it could lead to injury or death. However, 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.

Under 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 because if a sea turtle were struck, it could lead to injury or death. However, 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.

Under 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.

3.5.3.4.4.2 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 because if a sea turtle were struck, it could lead to injury or death. However, 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.

Under 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 because if a sea turtle were struck, it could lead to injury or death. However, 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.

Under 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.

3.5.3.4.4.3 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).

Under the ESA, seafloor devices used in training activities as described under Alternative 2 may affect, but are 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.

Under 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.

3.5.3.5 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) cables and 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).

3.5.3.5.1 Impacts of Cables and 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 cables and wires, refer to Section 3.0.5.3.4.1 (Cables and Wires). For a list of Navy activities that involve the use of guidance wires, refer to Section 3.0.5.3.4.2 (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 wires are expended in deeper waters.

3.5.3.5.1.1 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), 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 cables or 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.

Under the ESA, the use of cables and 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), under the No Action Alternative, Airborne mine neutralization activities (with High Explosives neutralizers) would expend fiber optic cables in SOCAL and HRC.

Sea turtle species in the Study Area could at some point encounter expended cables or 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.

Under the ESA, the use of cables and 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.

3.5.3.5.1.2 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), 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 3.0.5.3.4.2 (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 cables or 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.

Under the ESA, the use of cables and 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), 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 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 cables or 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.

Under the ESA, the use of cables and 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.

3.5.3.5.1.3 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 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 affect reproduction.

Under the ESA, the use of cables and 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), 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 3.0.5.3.4.2 (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 cables or 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.

Under the ESA, the use of cables and 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.

3.5.3.5.2 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.

3.5.3.5.2.1 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 3.0-82, 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.

Under 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 3.0-82, 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.

Under 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.

3.5.3.5.2.2 Alternative 1

Training Activities

Under Alternative 1, 54,200 parachutes would be expended in the Study Area during training activities.

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.

Under 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.

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.

Under 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.

3.5.3.5.2.3 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.

Under 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.

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.

Under 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.

3.5.3.6 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. 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 3.5.2.1 through 3.5.2.6 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).

3.5.3.6.1 Impacts of 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 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. Parachutes will not be carried forward in the analysis, because a bottom-feeding turtle is not expected to attempt to ingest a large piece of material from the seafloor. 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.

3.5.3.6.1.1 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 3.0-64 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.

Under the ESA, the use of materials 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 3.0-64 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.

Under the ESA, the use of materials 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.

3.5.3.6.1.2 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 3.0-64 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.

Under the ESA, the use of materials 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.

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 3.0-64 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.

Under the ESA, the use of materials 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.

3.5.3.6.1.3 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).

Under the ESA, the use of materials 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 3.0-64 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.

Under the ESA, the use of materials 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.

3.5.3.6.2 Impacts of 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, this analysis focuses on leatherback sea turtles and those materials expended in the open ocean.

3.5.3.6.2.1 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 inches in diameter and 5.8 inches 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.

Under the ESA, the use of materials 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 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.

Under the ESA, the use of materials 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.

3.5.3.6.2.2 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 3.0.5.3.4.3 (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 3.0.5.3.5.4 (Target-Related Materials), 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 Sections 3.0.5.3.5.5 (Chaff) and 3.0.5.3.5.6 (Flares), 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.

Under the ESA, the use of materials of ingestible size during training 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 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 3.0.5.3.4.3 (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 3.0.5.3.5.4 (Target-Related Materials), 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 Sections 3.0.5.3.5.5 (Chaff) and 3.0.5.3.5.6 (Flares), 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.

Under the ESA, the use of materials 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.

3.5.3.6.2.3 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 3.0.5.3.4.3 (Parachutes), under Alternative 2 the number of parachutes expended is approximately 22 percent higher than under the No Action Alternative. As indicated in Section 3.0.5.3.5.4 (Target-Related Materials), 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 Sections 3.0.5.3.5.5 (Chaff) and 3.0.5.3.5.6 (Flares), 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.

Under the ESA, the use of materials 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 3.0-65, 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 3.0.5.3.4.3 (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 3.0.5.3.5.4 (Target-Related Materials), 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 Sections 3.0.5.3.5.5 (Chaff) and 3.0.5.3.5.6 (Flares), 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.

Under the ESA, the use of materials 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.

3.5.3.7 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 explosives and by-products, metals, chemicals, and impacts on habitat. 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).

3.5.3.7.1 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.

3.5.3.7.2 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). Explosion by-products 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. 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). 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]).

3.5.3.7.3 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). 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.

3.5.3.7.4 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. 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 by-products (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.

Under the ESA, secondary stressors associated with training and testing activities under the No Action Alternative, Alternative 1, or Alternative 2 would have no effect on green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles.

3.5.3.8 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 3.5.4.2 (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 3.5.4.2 (Endangered Species Act Determinations) with respect to the ESA.

3.5.3.9 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 3.5-15 summarizes the Navy's determination of effect on ESA listed sea turtles for the Proposed Action.

Table 3.5-15: 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	No Effect	No Effect	No Effect	No Effect	No Effect
	Testing Activities	May affect, not likely to adversely affect	No Effect	No Effect	No Effect	No Effect

Table 3.5-15: Summary of Effects and Impact Conclusions: Sea Turtles (continued)

Stressor		Sea Turtle Species				
		Green	Hawksbill	Olive Ridley	Loggerhead	Leatherback
Acoustic Stressors (continued)						
Weapons Firing, Launch, and Impact Noise	Training Activities	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
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
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, 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
Military Expended Materials	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
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						
Cables and 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

Table 3.5-15: Summary of Effects and Impact Conclusions: Sea Turtles (continued)

Stressor		Sea Turtle Species				
		Green	Hawksbill	Olive Ridley	Loggerhead	Leatherback
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
Impacts from 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	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

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