3.5 Sea Turtles

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3.5 Sea Turtles

SEA TURTLE SYNOPSIS

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

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

Preferred Alternative (Alternative 1)

- Acoustic: Pursuant to the Endangered Species Act (ESA), the use of sonar and other active acoustic sources during training activities would have no effect on ESA-listed leatherback turtles. The use of sonar and other active acoustic sources during testing activities may affect, and is likely to adversely affect, leatherback turtles. Underwater explosives, and vessel and aircraft noise may affect, but are not likely to adversely affect, leatherback turtles. Weapons firing, launch, and impact noise during training may affect, but is not likely to adversely affect, leatherback turtles. Weapons firing, launch, and impact noise during testing would have no effect on leatherback turtles. The use of active acoustic sources would have no effect on leatherback turtle critical habitat.
- Energy: Pursuant to the ESA, the use of energy sources during training and testing activities would have no effect on ESA-listed leatherback turtles. The use of energy sources during training and testing activities would have no effect on leatherback turtle critical habitat.
- Physical Disturbance and Strike: Pursuant to the ESA, the use of vessels during training and testing activities may affect, and is likely to adversely affect, ESA-listed leatherback turtles. The use of in-water devices, military expended materials, and seafloor devices may affect, but is not likely to adversely affect, ESA-listed sea turtles. The use of active physical disturbance and strike sources would have no effect on leatherback turtle critical habitat.
- Entanglement: Pursuant to the ESA, the use of fiber optic cables, guidance wires, and decelerators/parachutes during training and testing activities may affect, but is not likely to adversely affect, ESA-listed leatherback turtles. The use of fiber optic cables, guidance wires, and decelerators/parachutes would have no effect on leatherback turtle critical habitat.
- Ingestion: Pursuant to the ESA, the use of munitions during training and testing activities would not affect ESA-listed leatherback turtles. Pursuant to the ESA, the use of military expended materials other than munitions during training and testing activities may affect, but is not likely to adversely affect, ESA-listed leatherback turtles. The use of munitions during training and testing activities would have no effect on leatherback turtle critical habitat.
- Secondary Stressors: Pursuant to the ESA, secondary stressors may affect but are not likely to adversely affect ESA-listed 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. Secondary stressors associated with training and testing activities would have no effect on leatherback turtle critical habitat.

3.5.1 INTRODUCTION

Sea turtles are long-lived reptiles that are found throughout the world's tropical, subtropical, and temperate seas. Four of the seven living species of sea turtles (leatherback [*Dermochelys coriacea*], loggerhead [*Caretta caretta*], olive ridley [*Lepidochelys olivacea*], and green [*Chelonia mydas*]) have the potential to be found in the Study Area (Alaska Department of Fish and Game 2011; Benson et al. 2011; Moore et al. 2009; National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998a, b, c, d, e, f). Of the four sea turtle species potentially found in the Northwest Training and Testing (NWTT) Study Area (Study Area), two are listed as endangered (the leatherback and North Pacific Ocean distinct population segment of the loggerhead sea turtle) (http://www.nmfs.noaa.gov/pr/species/turtles/). The olive ridley and green turtle are listed as threatened under the Endangered Species Act (ESA), with the exceptions of their Pacific coast of Mexico breeding colonies of each species, which are listed as endangered for both species.

Sea turtles primarily use three types of habitat: terrestrial (oceanic beaches for nesting), tropical and subtropical open ocean, and foraging grounds in coastal areas. The hard-shell turtles of the Cheloniidae family (loggerhead, olive ridley, and green) are considered tropical, subtropical, and warm temperate species that rarely stray into cold waters (Eckert 1993). Most hard-shell turtles seek optimal seawater temperatures near 65 degrees Fahrenheit (°F) (18.3 degrees Celsius [°C]) and are cold-stressed at seawater temperatures below 50°F (10°C) (Mrosovsky 1980; Schwartz 1978). In contrast, the leatherback sea turtles regularly occur in cold temperate waters of high latitudes (Pritchard 1980; Eckert et al. 1989).

The cold waters off Washington and Oregon are above the typical northern limits for the loggerhead, olive ridley, and green sea turtles, and these species are considered rare in the Study Area. However, under certain oceanographic conditions (e.g., warmer currents), all four species could occur off the Washington and Oregon coasts (and occasionally all the way to Alaska). However, as water temperatures drop or other oceanographic changes occur, all except the leatherback become cold stressed and strand on the beaches with no way to survive the return to warmer waters.

Loggerheads are circumglobal and occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian oceans. In the eastern Pacific, loggerheads have been reported as far north as Alaska, and as far south as Chile (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007c). In the United States, occasional sightings are reported from the coasts of Washington and Oregon, but most records are of juveniles off the coast of California (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998d; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007c). Of the two loggerhead occurrences between 1960 and 1998 in Alaska reported by Hodge and Wing (2000), one was a carcass and the other was a live sighting.

There are few documented occurrences of olive ridley sea turtles in waters off the west coast of the United States (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998a). In the eastern Pacific, the olive ridley typically occurs in tropical and subtropical waters as far south as Peru and as far north as California. The olive ridley has only twice been documented in Alaskan waters between 1960 and 1998, and both were carcasses (Hodge and Wing 2000).

The green turtle is globally distributed and generally found in tropical and subtropical waters along continental coasts and islands between latitudes 30° north (N) and 30° south (S) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a). In the eastern North Pacific, green turtles have been sighted from Baja California to southern Alaska, but they most commonly occur from San

Diego southward (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a). Increased numbers of stranded East Pacific green turtles have been reported along the coasts of California, Oregon, and Washington during associated El Niño events (Stinson 1984). Additionally, between 1960 and 1998, of the nine green sea turtle occurrences in Alaska (as reported in Hodge and Wing 2000), four were carcasses, one was cold-stressed and flown to San Diego for rehabilitation, and the remaining four were live sightings.

As described above, although sightings of sea turtles from the Cheloniidae family (loggerhead, olive ridley, and green) have been documented the Study Area, most of these involve individuals that were either cold stressed, likely to become cold stressed, or already deceased (Hodge and Wing 2000). Thus, the Study Area is considered to be outside the normal range for sea turtle species of the Cheloniidae family, and these species are not considered further for analysis in this Environmental Impact Statement (EIS)/Overseas EIS (OEIS).

The remainder of the section analyzes potential impacts on leatherback sea turtles found in the Study Area. 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.

3.5.2 Affected Environment

Leatherback sea turtles are highly migratory, and can be present in coastal and open ocean waters of the Study Area. Leatherbacks (*Dermochelys coriacea*), because of their unique physiology among sea turtles, occur with more regularity in colder waters at higher latitudes (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992). Thermoregulatory adaptations such as a counter current heat exchange system, high oil content, and large body size allow them to maintain an internal body temperature higher than that of the environment (Dutton 2006). Habitat and distribution of the leatherback sea turtle varies depending on species and life stages and is discussed further in the species profiles.

Sea turtles use a variety of mechanisms to guide their movements on land and at sea (Lohmann et al. 1997; Fuxjager et al. 2011). After emerging from the nest, hatchling turtles use visual cues, such as light wavelengths and shape patterns, to find the ocean (Lohmann et al. 1997). Once in the ocean, hatchlings use wave cues to navigate offshore (Lohmann and Lohmann 1992). In the open ocean, turtles in all life stages are thought to orient to the earth’s magnetic field to position themselves in oceanic currents; this helps them locate seasonal feeding and breeding grounds and return to their nesting sites (Benhamou et al. 2011, Lohmann and Lohmann 1996b, 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.

Little information is available regarding a sea turtle’s stage of life after hatching. Open-ocean juveniles spend an estimated 2–14 years drifting, foraging, and developing. Due to the general lack of knowledge of this period, it has been described as "the lost years." Early studies indicated that leatherbacks reached adulthood at 13–14 years (range 2–22 years) (Turtle Expert Working Group 2007, Zug and Parham 1996); however, recent studies have shown maturation ages averaging 24.5–29 years (Avens et al. 2009). Their lifespan is unknown, but is expected to be at least 30 years (Sarti-Martinez 2000, Avens et al. 2009). Leatherback turtles remain primarily in the open ocean throughout their lives, except for possibly mating in coastal waters and when females come ashore to lay eggs. Adults of all species are capable of migrating long distances across large expanses of the open ocean, primarily between nesting and feeding grounds.

3.5.2.1 Diving

The leatherback is the deepest diving sea turtle, with a recorded maximum depth of 4,200 feet (ft.) (1,280 meters [m]) (Doyle et al. 2008), although most dives are much shallower (usually less than 820 ft. [250 m]) (Hays et al. 2004a, b; 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 (Houghton et al. 2008; James et al. 2005b), 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. 2004a). While transiting, leatherbacks make longer and deeper dives (James et al. 2006; Jonsen et al. 2007). It is suggested that leatherbacks make scouting dives while transiting as an efficient means for sampling prey density and perhaps also to feed opportunistically at these times (James et al. 2006; Jonsen et al. 2007). In the Atlantic, Hays et al. (2004a, b) determined that migrating and foraging adult leatherbacks spent 71–94 percent of their diving time at depths from 230 to 361 ft. (70 to 110 m).

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. (475 m) was recorded (Eckert et al. 1986), although even deeper dives were inferred where dives exceeded the maximum range of the time depth recorder (Eckert et al. 1989). Shallow diving occurs where shallow water is close to the nesting beach in areas such as the China Sea (Eckert et al. 1996), Costa Rica (Southwood et al. 1999), and French Guiana (Fossette et al. 2007).

3.5.2.2 Hearing and Vocalization

The auditory system of the sea turtle appears to work via water and bone conduction, with lower frequency sound conducted through skull and shell, or via direct stimulation of the tympanum (Christensen-Dalsgaard et al. 2012).The water and bone conduction does not appear to function well for hearing in air (Lenhardt et al. 1983), though recent research has shown that sea turtles are capable of hearing in air. While it is difficult to compare aerial and underwater thresholds directly, frequencies of sensitivity are similar for several species tested (Dow Piniak et al. 2012, 2011).

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 (Ketten 2008), a function similar to that of the eardrum in mammals, or may serve to release energy received via bone conduction (Lenhardt et al. 1983). Sound is transmitted to the air-filled middle ear, where sound waves cause movement of cartilaginous and bony structures that interact with the inner ear (Ridgway et al. 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 (Martin et al. 2012; Lavender et al. 2011; Dow Piniak et al. 2012, 2011; Ridgway et al. 1969, Bartol et al. 1999).

Investigations suggest that sea turtle auditory sensitivity is limited to low-frequency bandwidths, such as the sound of waves breaking on a beach. The role of underwater low-frequency hearing in sea turtles is unclear. Sea turtles may use acoustic signals from their environment as guideposts during migration and as cues to identify their natal beaches (Lenhardt et al. 1983). 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 Hertz (Hz) to 2 kilohertz (kHz). Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 to 2,000 Hz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol et al. 1999, Ridgway et al. 1969, Lenhardt 1994, Bartol and Ketten 2006, Ketten 2008, 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 et al. 1969) and around 250 Hz or below for juvenile loggerheads (Bartol et al. 1999). Bartol et al. (1999) reported that the range of effective hearing for juvenile loggerhead sea turtles is from at least 250 to 750 Hz using the auditory brainstem response technique. Juvenile and sub-adult green sea turtles detect sounds from 100 to 500 Hz underwater, with maximum sensitivity at 200 and 400 Hz (Bartol and Ketten 2006). Juvenile Kemp's ridley turtles detected underwater sounds from 100 to 500 Hz, with a maximum sensitivity between 100 and 200 Hz (Bartol and Ketten 2006).

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 decibels [dB] referenced to [re] 1 micropascal [µPa]), with thresholds increasing at frequencies above and below 300 Hz, when thresholds were determined by auditory brainstem response (Bartol and Ketten 2006). Auditory brainstem response testing was also used to detect thresholds for juvenile green sea turtles (lowest threshold 93 dB re 1 µPa at 600 Hz) and juvenile Kemp's ridley sea turtles (thresholds above 110 dB re 1 µPa across hearing range) (Bartol and Ketten 2006). Auditory thresholds for yearling and 2-year-old loggerhead sea turtles were also recorded. Both yearling and 2-year-old loggerhead sea turtles had the lowest hearing threshold at 500 Hz (yearling: approximately 81 dB re 1 µPa; 2-year-olds: approximately 86 dB re 1 µPa), with thresholds increasing rapidly above and below that frequency (Bartol and Ketten 2006). Recent work using auditory evoked potentials has shown that hawksbill sea turtles are able to detect sounds in both air and water; however, ranges of maximum sensitivity and thresholds differed between the two media, though in general, sensitivities were higher at frequencies below 1,000 Hz (Dow Piniak et al. 2011).

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; Cook and Forrest 2005). These noises are guttural exhalations made during the nesting process; turtles do not make audible sounds for communication, navigation, or foraging (as observed in marine mammals).

3.5.2.3 General Threats

Bycatch in commercial fisheries, ship strikes, and marine debris are primary threats in the offshore environment (Lutcavage et al. 1997). One comprehensive study estimated that, worldwide, 447,000 sea turtles are killed each year from bycatch in commercial fisheries (Wallace et al. 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 et al. 1997; Hazel et al. 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 et al. 2008; Mrosovsky et al. 2009; Schofield et al. 2010; Witt et al. 2010). Impacts include embryo deaths caused by high nest temperatures, skewed sex ratios because of increased sand temperature, loss of nesting habitat to beach erosion, spatial shifts in habitat, 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 United States (U.S.) Pacific coast states and territories (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998a, b, c, d, e, f).

On nesting beaches (none of which are present in the Study Area), wild domestic dogs, pigs, and other animals ravage sea turtle hatchlings and 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). 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.

3.5.2.4 Leatherback Sea Turtle (*Dermochelys coriacea*)

3.5.2.4.1 Status and Management

The leatherback turtle is listed as a single population, is classified as endangered under the ESA, and has Critical Habitat designated within the Study Area. Sea turtles nesting on beaches in the United States are under the jurisdiction of the U.S. Fish and Wildlife Service, and sea turtles occurring in U.S. waters are under the jurisdiction of National Marine Fisheries Service (NMFS). Although the U.S. Fish and Wildlife Service and NMFS believe the current listing is valid, preliminary information indicates an analysis and review of the species (e.g., genetic differences between leatherback stocks) should be conducted to determine if some stocks should be designated as distinct populations (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b; 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 off the coast of Washington and Oregon. The designated areas comprise approximately 41,914 square miles (mi.^{2}) (108,557 square kilometers [km^2]) of marine habitat and include waters from the ocean surface down to a maximum depth of 262 ft. (80 m) (77 Federal Register [FR] 4170).This designation includes approximately 25,004 mi.^{2} (64,760 km^2) stretching from Cape Flattery, Washington, to Cape Blanco, Oregon, east of the 2,000 m depth contour (which overlaps with the Study Area [Figure 3.5-1]) as well as 16,910 mi.^{2} (43,797 km^2) stretching along the California coast from Point Arena to Point Arguello east of the 3,000 m depth contour (all of which is outside of the Study Area).

When defining critical habitat, the regulations require agencies to “focus on the principle biological or physical constituent elements” (referred to as “Primary Constituent Elements” or PCEs) within the specific areas considered for designation. NMFS identified one PCE essential for the conservation of leatherbacks in marine waters off the U.S. west coast. This PCE is the occurrence of prey species, primarily *scyphomedusae* of the order Semaeostomeae (Chrysaora, Aurelia, Phacellophora, and Cyanea) of sufficient condition, distribution, diversity, and abundance and density necessary to support individual as well as population growth, reproduction, and development.

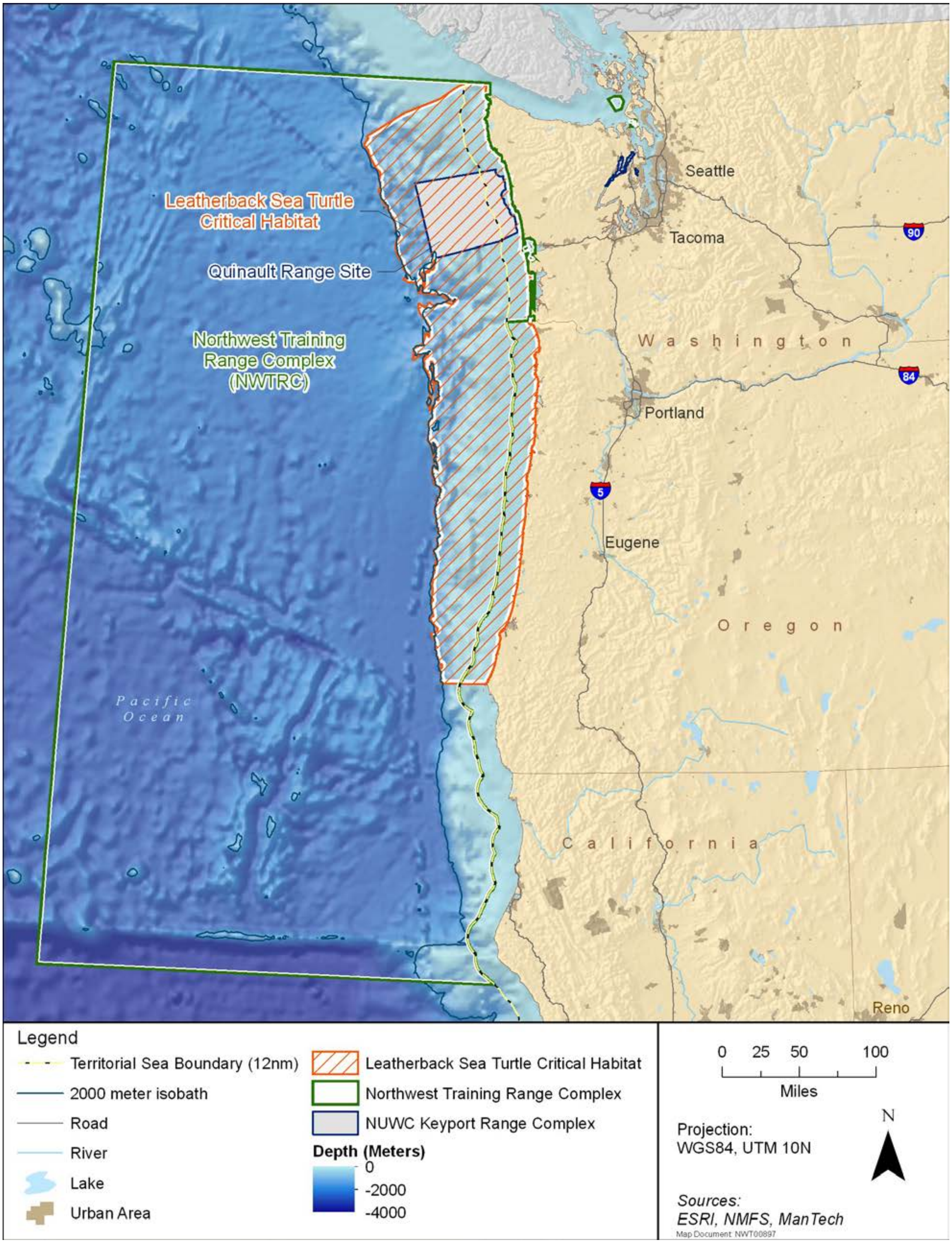

Figure 3.5-1: Critical Habitat Designation for the Leatherback Sea Turtle that Overlaps with the Study Area

Due to the high potential for interactions between leatherback turtles and drift gillnet fisheries off the U.S. west coast, NMFS designated a portion of the eastern North Pacific Ocean the Pacific Leatherback Conservation Zone (50 Code of Federal Regulations 660.713(c)) which is located off the coasts of California and Oregon and partially overlaps the Study Area. This area is closed to drift gillnet fishing from 15 August through 15 November of every year to heighten the protection of leatherback turtles in the area.

3.5.2.4.2 Habitat and Geographic Range

The leatherback turtle is the most widely distributed of all sea turtles, found in-water from tropical to subpolar oceans with nesting habitat on tropical and occasionally subtropical beaches (Myers and Hays 2006; National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992), none of which are located in the Study Area. Leatherbacks have a wide nesting distribution, primarily on isolated beaches in tropical oceans (mainly in the Atlantic and Pacific Oceans, with few in the Indian Ocean) and temperate oceans (southwest Indian Ocean) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992), and to a lesser degree on some islands. Limited information is available on the habitats used by post-hatchling and early juvenile leatherback sea turtles because these age classes are entirely oceanic (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992a). These life stages are restricted to waters warmer than 79°F; consequently, much time is spent in the tropics (Eckert 2002). The leatherback sea turtle has the most extensive range of any adult turtle, found from 71° N to 47° S (Eckert 1995). Adult leatherback turtles forage in temperate and subpolar regions in all oceans, and migrate to tropical nesting beaches between 30° N and 30° S (Eckert et al. 2012). Scientists are relatively certain that these individuals do not associate with floating debris or vegetation, as is the case for the other sea turtle species found in the eastern North Pacific Ocean (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998d).

3.5.2.4.2.1 Offshore Area

Few quantitative data are available concerning the seasonality, abundance, or distribution of leatherbacks in the central northern Pacific Ocean. The movements of adult leatherback sea turtles appear to be linked to the seasonal availability of their prey and the requirements of their reproductive cycles (Collard 1990; Davenport and Balazs 1991). Leatherbacks prefer convergence zones and upwelling areas in the open ocean, along continental margins, or near large archipelagos. 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 from nesting areas to summer foraging grounds off the coast of northern California (Benson et al. 2007), including a 6,385-mile (10,276-kilometer) migration from a nesting beach in Papua New Guinea to foraging grounds off the coast of Oregon (Benson et al. 2007). The waters off the Oregon and California coasts have been repeatedly recognized by scientists and agencies as comprising one of the most important leatherback foraging areas in the Pacific (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998b). It should be noted that the Eastern Tropical Pacific population of leatherbacks (nesting areas in Mexico, Costa Rica, Panama, Colombia, Ecuador, and Nicaragua; Section 3.5.2.4.3, Population and Abundance) has only been documented (via satellite telemetry) to migrate southward from their nesting areas (Schillinger et al. 2008; Eckert 1997).

Leatherback turtles are regularly seen off the western coast of the United States. Off the California coast, the highest densities of leatherback sea turtles were found off central California (Benson et al. 2007). Telemetry studies have shown areas of concentration along the central California coast and in the waters of Oregon and Washington (Benson et al. 2011). Stinson (1984) concluded that the leatherback was the most common sea turtle in U.S. waters north of Mexico. Aerial surveys off Washington, Oregon, and California, indicate that most leatherbacks occur in waters over the continental slope, with a few beyond the continental shelf (Eckert 1993). Green et al. (1992) conducted a study between 1989 and 1990 to assess the presence and abundance of federally listed species along the coasts of Washington and Oregon. During the study, 16 sea turtles were observed; all sightings were of leatherback sea turtles and all occurred between June and September, with most sightings (10) occurring in July (Green et al. 1992). Most (62.5 percent) of these sightings occurred over the continental slope waters, with the remainder found over the continental shelf.

3.5.2.4.2.2 Inland Waters

As noted in Section 3.5.2.4 (Leatherback Sea Turtle), the leatherback turtle is the only species of sea turtle regularly anticipated in the Study Area. Sea turtles are occasionally sighted within the Strait of Juan de Fuca but are rare in Puget Sound (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998d, National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b) and are not expected to occur near any of the inshore action areas. While leatherback sea turtles are capable of foraging in inland waters, they prefer offshore areas for foraging. Therefore, the leatherback sea turtle is not analyzed further for military activities occurring in the inshore waters of the Study Area.

3.5.2.4.2.3 Western Behm Canal, Alaska

As noted in Section 3.5.2.4 (Leatherback Sea Turtle), the leatherback turtle is the only species of sea turtle regularly anticipated in the Study Area. However, Stinson's (1984) archival search of 363 sea turtles sighted along the Pacific coast from Baja California, Mexico to the Gulf of Alaska from 1917 to 1982 indicated that only 6 of the recorded leatherback sightings occurred in sightings in Alaskan waters. Hodge and Wing (2000) presented leatherback occurrences in Alaskan waters between 1960 and 1998. During this period, 19 sightings of leatherback turtles in Alaska waters have been recorded (11 were sightings, 3 were netted and released, 3 were netted and killed, and 2 were carcasses). While leatherback sea turtles are physically capable of foraging in Alaskan waters, they are rare in the area and prefer offshore waters to the south (as described in Section 3.5.2.4.2.1, Offshore Area). Therefore, the leatherback sea turtle is not analyzed further for military activities occurring in the Western Behm Canal portion of the Study Area.

3.5.2.4.3 Population and Abundance

Worldwide estimates of leatherback sea turtle populations have varied dramatically over the years as a result of both significant declines in the population and the discovery of new nesting colonies, particularly a colony in Gabon, Africa. Pritchard (1982) estimated 115,000 females worldwide with 60 percent nesting along the Pacific coast of Mexico. However, in 1995, a revised estimate incorporating information from 28 nesting beaches throughout the world yielded about 34,500 females, with a lower limit of about 26,200 and an upper limit of about 42,900 (Spotila et al. 1996). According to the International Union for Conservation of Nature, analysis of published estimates of global population sizes (Pritchard 1982; Spotila et al. 1996) suggest a reduction of greater than 70 percent of the global population of adult females in less than one generation. The populations in the Pacific Ocean have declined drastically in the last decade, with current annual nesting female mortalities estimated at around 30 percent (Sarti-Martinez 2000).

There are no known nesting habitats for the leatherback sea turtle in the Study Area. 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 5,000–9,100 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).

Leatherbacks have been in decline in all major Pacific basin rookeries (nesting areas/groups) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007c, Turtle Expert Working Group 2007) for at least the last two decades (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, 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.

The leatherback sea turtle is documented to deliberately return annually (only in the summer and fall) to feed on jellyfish aggregations off the southern Oregon and California coasts (Center for Biological Diversity et al. 2007, National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b). It is likely that the leatherback could travel farther north into Washington, British Columbia, and Alaska waters during these foraging expeditions. The range of densities (leatherbacks per km^2) was estimated off California based on 1990–2003 aerial surveys (Benson et al. 2007). Data from recent surveys in Washington and Oregon do not yet support density estimates, so the Northern California densities presented in Benson et al. (2007) were used as an estimator (0.003 leatherback per km^2) for turtle densities in Washington and Oregon waters. It is likely that leatherback densities differ from those estimated for northern California, however, recent data is only now being developed for Washington and Oregon waters area based on more recent surveys by Benson et al. (2007).

3.5.2.4.4 Predator/Prey Interactions

Leatherbacks lack the crushing and chewing plates characteristic of sea turtles that feed on hard-bodied prey (National Marine Fisheries Service 2010). Instead, they have pointed tooth-like cusps and sharp-edged jaws that are perfectly adapted for a diet of soft-bodied prey, such as jellyfish and salps (Bjorndal 1997; Grant and Ferrell 1993; James and Herman 2001; National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992; Salmon et al. 2004). Foraging areas off the U.S. west coast have been shown to have high seasonal dense aggregations of scyphozoan jellyfish (*Chrysaora spp., Aurelia spp.*) (Benson et al. 2011; Harris et al. 2011; Graham 2009). Leatherbacks feed from the surface as well as at depth, diving to 4,035 ft. (1,240 m) though most dives are shallower than 600 ft. (183 m) (Davenport 1988; Eckert et al. 1989; Eisenberg and Frazier 1983; Grant and Ferrell 1993; James et al. 2005a; Salmon et al. 2004).

Predators of leatherback sea turtles eggs include feral pigs, dogs, raccoons, ghost crabs, and fire ants. As with other sea turtle species, leatherback hatchlings are preyed on by birds and large fish such as tarpon and snapper. Sharks and killer whales are predators of adult leatherbacks (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007).

3.5.2.4.5 Species-Specific Threats

In addition to the general threats described at the beginning of Section 3.5.2.3 (General Threats), harvest of leatherback sea turtle eggs and adult turtles continues to be a threat in many parts of the world. Additionally, incidental capture in longline and coastal gillnet fisheries has caused a substantial number of leatherback sea turtle deaths, likely because leatherback sea turtles dive to depths targeted by fishermen and are less maneuverable than other sea turtle species (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007c).Mortality was observed most commonly occurring from incidental capture in driftnets, rather than from longlines (Alfaro-Shigueto et al. 2011). Further, because leatherback sea turtles distribution is so closely associated with jellyfish aggregations, any changes in jellyfish distribution or abundance may be a threat to this species.

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 2.8-3 present the baseline and proposed training and testing activity locations for each alternative (including number of events and ordnance expended). Each sea turtle sub-stressor is introduced, analyzed by alternative, and analyzed for training activities and testing activities, and then an ESA determination is made by sub-stressor. Stressors applicable to sea turtles in the Study Area analyzed below include the following:

- Acoustic (sonar and other active acoustic sources; explosions; weapons firing, launch, and impact noise; vessel noise; and aircraft noise)
- Energy (electromagnetic devices)
- Physical disturbance or strikes (vessels and in-water devices, military expended materials, and seafloor devices)
- Entanglement (fiber optic cables, guidance wires, and parachutes)
- Ingestion (munitions and military expended materials other than munitions)
- Secondary stressors (e.g., sediments and water quality)

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. As described in Section 3.5.2.4.2.2 (Inland Waters) and Section 3.5.2.4.2.3 (Western Behm Canal, Alaska), sea turtles are not expected in either the Inland Waters or the Western Behm Canal areas of the Study Area. Therefore, only training and testing activities conducted in the Offshore Area will be analyzed.

Table 3.5-1 presents the stressor categories and components of those stressors that are applicable to sea turtles and are used in the analysis of training and testing activities. Due to the anticipated level of impact, some of the analysis in the following sections will be qualitative and has been noted as such. In addition to the analysis here, the details of all training and testing activities, stressors, components that cause the stressor, and geographic occurrence within the Study Area are included in Section 3.0.5.3 (Identification of Stressors for Analysis).

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 (Appendix H, Biological Resource Methods). Additional research specific to sea turtles is presented where available.

Table 3.5-1: Stressors Applicable to Sea Turtles for Training and Testing Activities

Components	Area	Number of Components or Activities					
		No Action Alternative		Alternative 1		Alternative 2	
		Training	Testing	Training	Testing	Training	Testing
Acoustic Stressors							
Sonar and other active sources	Offshore Area	See Table 3.0-9					
	Inland Waters						
	W. Behm Canal						
Explosives	Offshore Area	378	0	502	148	502	164
	Inland Waters	4	0	42	0	42	0
	W. Behm Canal	0	0	0	0	0	0
Weapons firing, launch, and impact noise	Offshore Area	QUALITATIVE					
	Inland Waters						
	W. Behm Canal						
Activities including vessel noise	Offshore Area	996	37	1,096	138	1,096	162
	Inland Waters	4	337	31	582	31	640
	W. Behm Canal	0	28	0	60	0	83
Activities including aircraft noise	Offshore Area	3,826	2	6,471	74	6,471	84
	Inland Waters	124	2	127	20	127	25
	W. Behm Canal	0	0	0	0	0	0
Energy Stressors							
Activities including electromagnetic devices	Offshore Area	0	0	0	0	0	0
	Inland Waters	0	0	1	0	1	0
	W. Behm Canal	0	0	0	0	0	0
Physical Disturbance and Strike Stressors							
Activities including vessels	Offshore Area	996	37	1,088	138	1,088	162
	Inland Waters	4	337	28	582	28	640
	W. Behm Canal	0	28	0	60	0	83
Activities including in-water devices	Offshore Area	429	40	484	154	484	183
	Inland Waters	0	379	1	648	1	716
	W. Behm Canal	0	0	0	0	0	0
Military expended materials	Offshore Area	189,668	621	196,888	2,511	196,888	2,764
	Inland Waters	8	446	85	517	85	568
	W. Behm Canal	0	0	0	0	0	0
Activities including seafloor devices	Offshore Area	0	5	0	6	0	7
	Inland Waters	2	210	16	225	16	239
	W. Behm Canal	0	0	0	0	0	0

Table 3.5-1: Stressors Applicable to Sea Turtles for Training and Testing Activities (continued)

Components	Area	Number of Components or Activities					
		No Action Alternative		Alternative 1		Alternative 2	
		Training	Testing	Training	Testing	Training	Testing
Entanglement Stressors							
Fiber optic cables and guidance wires	Offshore Area	2	16	0	20	0	24
	Inland Waters	0	105	1	122	1	133
	W. Behm Canal	0	0	0	0	0	0
Parachutes	Offshore Area	8,382	17	8,382	1,229	8,382	1,351
	Inland Waters	0	4	0	4	0	5
	W. Behm Canal	0	0	0	0	0	0
Ingestions Stressors							
Military expended materials from munitions	Offshore Area	177,778	200	182,804	1,946	182,804	2,139
	Inland Waters	4	6	42	6	42	6
	W. Behm Canal	0	0	0	0	0	0
Military expended materials other than munitions	Offshore Area	11,890	421	9,084	565	9,084	625
	Inland Waters	4	440	43	511	43	562
	W. Behm Canal	0	0	0	0	0	0
Secondary Stressors							
Habitat (sediments and water quality; air quality)	Offshore Area	QUALITATIVE					
	Inland Waters						
	W. Behm Canal						
Prey	Offshore Area	QUALITATIVE					
	Inland Waters						
	W. Behm Canal						

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-explosive sound sources, such as sonar, is unlikely because of relatively lower peak pressures and slower rise times than potentially injurious sources such as explosions. Non-explosive 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-impulse sources such as sonar, and are only considered for explosive detonations.

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

Auditory Trauma

Components of the auditory system that detect smaller or more gradual pressure changes can also be damaged when overloaded at high pressures with rapid rise times. Rupture of the tympanic membrane, while not necessarily a serious or life-threatening injury, may lead to permanent hearing loss (Ketten 1995, 1993). No data exist to correlate the sensitivity of the tympanic membrane and middle and inner ear to trauma from shock waves from underwater explosions (Viada et al. 2008).

The specific impacts of bulk cavitation (the collapse of air spaces created by explosive detonations) on sea turtles are unknown. 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. 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 (National Research Council 2003), 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 (Moein Bartol and Ketten 2006; Bartol and Musick 2003), sea turtles may be able to detect objects within the water column (e.g., vessels, prey, predators) via some combination of auditory and visual cues. However, research examining the ability of sea turtles to avoid collisions with vessels shows they may rely more on their vision than auditory cues (Hazel et al. 2007). Similarly, while sea turtles may rely on acoustic cues to identify nesting beaches, they appear to rely on other non-acoustic cues for navigation, such as magnetic fields (Lohmann and Lohmann 1996a, b) and light (Avens and

Lohmann 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.

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). Immature Kemp's ridley 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). Captive olive ridley hatchlings showed heightened blood glucose levels indicating physiological stress (Rees et al. 2008, Zenteno et al. 2007).

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 (Hazel et al. 2007).

3.5.3.1.2.5 Behavioral Reactions

Little is known about the hearing ability of the leatherback turtle and its response to acoustic disturbance and thus analogous species for which data are available are used to estimate the potential behavioral reactions to sound. 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, though a few studies examined sea turtle reactions to airguns, which produce broadband impulse 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 25–1,000 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 175–176 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. Further, DeRuiter and Doukara (2012) noted diving behavior following airgun shots in loggerhead turtles, and noted a decreased dive probability with increasing distance from the airgun array.

No studies have been performed to examine the response of sea turtles to sonar. However, based on the limited range of hearing, they may respond to sources operating below 2 kHz but are unlikely to sense higher frequency sounds, as described in Section 3.5.2.2 (Hearing and Vocalization).

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 U.S. Department of the Navy (Navy) considers two primary categories of sound sources in its analyses of sound impacts on sea turtles: impulse sources (e.g., explosions, airguns, and weapons firing) and non-impulse sources (e.g., sonar, pingers, and countermeasure devices). General definitions of impulse and non-impulse 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 training and testing activities that emit sound or explosive energy, as well as the severity of the immediate impacts. These criteria are used to quantify impacts from explosions, 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 Impulse Sources

Impulse Sound Exposure Impact	Threshold Value
Onset Mortality[1] (1 percent 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 (GTI)	237 dB re 1 μPa SPL (104 psi)
Onset PTS	187 dB re 1 μPa^2-s SEL (T) or 230 dB re 1 μPa Peak SPL
Onset TTS	172 dB re 1 μPa^2-s SEL (T) or 224 dB re 1 μPa Peak SPL

[1] M = mass of juvenile leatherback sea turtle (34.8 kilograms) based on Jones (2009), D_{Rm} = depth of animal (m)

Notes: μPa^2-s = micropascal squared second, dB re 1 μPa = decibels referenced to 1 micropascal, psi = pounds per square inch, PTS = permanent threshold shift, SEL = sound exposure level, SPL = sound pressure level, T = Turtle Weighting Function, TTS = temporary threshold shift

Table 3.5-3: Sea Turtle Impact Threshold Criteria Used in Acoustic Modeling for Non-Impulse Sources

Onset PTS	Onset TTS
198 dB SEL (T)	178 dB SEL (T)

Notes: dB = decibels, PTS = permanent threshold shift, SEL = sound exposure level, T = Turtle Weighting Function, TTS = temporary threshold shift

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 (Introduction to Acoustics). Impulse and non-impulse sounds are described again below with details specific to assigning acoustic and explosive criteria for predicting impacts on sea turtles.

3.5.3.1.3.2 Impulse Sounds

Impulse 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-impulse sounds. Impulse sounds usually rapidly decay with only one or two peak oscillations and are of very short duration (usually 0.1 second or shorter). Rapid pressure changes may produce mechanical damage to the ear or other structures that would not occur with slower rise times found in non-impulse signals. Impulse sources analyzed in this document include explosions, airguns, sonic booms, and weapons firing.

3.5.3.1.3.3 Non-Impulse Sounds

Non-impulse 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-impulse sources in this document.

Intermittent non-impulse sound sources produce sound for only a small fraction of the time that the source is in use (a few seconds or a fraction of a second, e.g., sonar and pingers), with longer silent periods in between the sound. Continuous sources are those that transmit sound for all of the time they are being used, often for many minutes, hours, or days. Vessel 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 impulse 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 on protected marine mammals are also used to assess impacts on 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 1 percent mortality (most survivors have moderate blast injuries and should survive) and 0 percent mortality (recoverable, slight blast injuries) in the exposed population, respectively. Criteria for onset mortality and onset slight lung injury were developed using data from explosive impacts on mammals (Yelverton and Richmond 1981).

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

Juvenile body mass was selected for analysis given the early rapid growth of these reptiles (newborn turtles weigh less than 0.5 percent of maximum adult body mass). In addition, small turtles tend to remain at shallow depths in the surface pressure release zone, reducing potential exposure to injurious impulses. Therefore, use of hatchling weight would provide unrealistically low thresholds for estimating injury to sea turtles. The use of juvenile body mass rather than hatchling body mass was chosen to produce reasonably conservative estimates of injury. The juvenile body mass of the leatherback turtle used for determining onset of extensive and slight lung injury is 34.8 kilograms (kg) (Jones 2009).

The scaling of lung volume to depth is conducted 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.

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 (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–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 3.5-2 shows the sea turtle auditory weighting function with lower and upper boundaries of 10 Hz and 2 kHz, respectively.

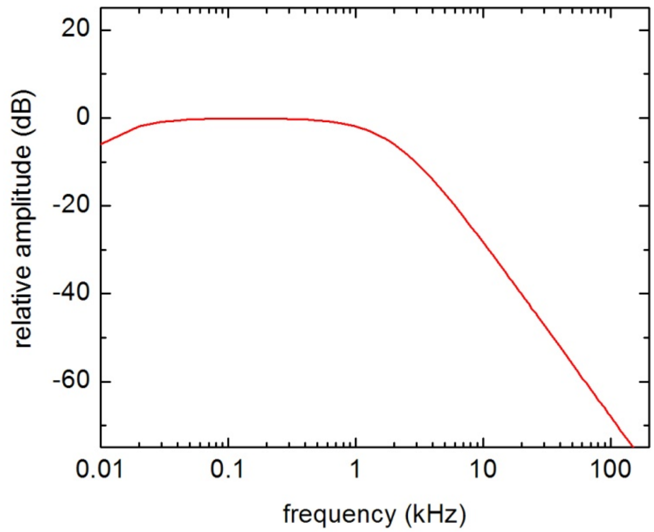

Figure 3.5-2: Auditory Weighting Function for Sea Turtles (T-Weighting)

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 (Introduction to Acoustics).

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; 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 on 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-impulse and impulse sources) and peak pressure (for impulse 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 impulse 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 impulse and non-impulse sounds are summarized in Table 3.5-2 and Table 3.5-3.

3.5.3.1.3.8 Criteria for Non-Impulse Temporary Threshold Shift

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

3.5.3.1.3.9 Criteria for Impulse Temporary Threshold Shift

Based on best available science regarding TTS in marine vertebrates (Finneran et al. 2005; Finneran et al. 2000; Finneran et al. 2002; Nachtigall et al. 2003; Nachtigall et al. 2004; Schlundt et al. 2000) and the lack of information regarding TTS in sea turtles, the respective total T-weighted sound exposure level of 172 dB re 1 µPa^2-s or peak pressure of 224 dB re 1 µPa (23 pounds per square inch 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-Impulse 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 TTS and PTS established in terrestrial mammals. PTS 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 40–50 dB may be recoverable, and that 40 dB is a reasonable upper limit of a threshold shift that does not induce PTS (Southall et al. 2007; Ward et al. 1958; Ward et al. 1959). This analysis assumes that continuous-type exposures producing threshold shifts of 40 dB or more always result in some amount of PTS.

Data from terrestrial mammal testing (Ward et al. 1958, 1959) show TTS growth of 1.5–1.6 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-impulse 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 178 dB re 1 µPa^2-s for sea turtles has a corresponding onset of PTS threshold of 198 dB re 1 µPa^2-s. The T-weighting function is applied when using the sound exposure level-based thresholds to predict PTS (see Table 3.5-3).

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

3.5.3.1.3.11 Criteria for Impulse Permanent Threshold Shift

Because marine mammal and sea turtle PTS data from impulse 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 impulse noise TTS growth rates in chinchillas. This results in onset of PTS thresholds of total weighted sound exposure level of 187 dB re 1 µPa^2-s or peak pressure of 230 dB re 1 µPa for sea turtles. The T-weighting function is applied when using the sound exposure level-based thresholds to predict PTS. As with non-impulse PTS, the incorrect TTS data for cetaceans were applied for sea turtles when measuring PTS from impulse sources. Because an incorrectly lowered threshold was used to quantitatively analyze acoustic impacts to sea turtles in this EIS/OEIS, the quantitative impacts presented herein for impulse TTS are conservative (i.e., over-predicted).

3.5.3.1.3.12 Criteria for Behavioral Responses

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

A few studies reviewed in Section 3.5.3.1.2.5 (Behavioral Reactions), investigated behavioral responses of sea turtles to impulse 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). Because information about sea turtle responses to non-impulse sounds or sounds generated by explosives is limited, the distance from a sound source or explosion within which behavioral responses may occur are estimated using the values associated with sea turtle avoidance of airguns in the above studies.

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.

3.5.3.1.4 Quantitative Analysis

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

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

3.5.3.1.5 Navy Acoustic Effects Model

For this analysis of Navy training and testing activities at sea, the Navy developed a set of software tools and compiled data for quantifying predicted acoustic impacts. These databases and tools collectively form the Navy Acoustic Effects Model (NAEMO). Details of the NAEMO 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 NAEMO process and its more critical data inputs.

The NAEMO improves upon previous modeling efforts in several ways. First, unlike earlier methods that modeled sources individually, the NAEMO has the capability to 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 NAEMO, animals are distributed non-uniformly based on higher resolution species-specific density, depth distribution, and group size information and animals 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 animate exposure in the NAEMO, rather than a two-dimensional environment where the worse case sound pressure level across the water column is always encountered. Finally, current efforts incorporate site-specific bathymetry, sound speed profiles, wind speed, and bottom properties into the propagation modeling process rather than the flat-bottomed provinces used during earlier modeling. The following paragraphs provide an overview of the NAEMO 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 NAEMO derives an abundance (total number individuals) and distributes the resulting number of virtual animals ("animats") into an area bounded by the maximum distance that energy propagates out to a criterion threshold value (energy footprint). These animats are distributed based on density differences across the area and known depth distributions (dive profiles). Animats change depths every 4 minutes but do not otherwise mimic actual animal behaviors (such as avoidance or attraction to a stimulus).

Schecklman et al. (2011) argue that static distributions underestimate acoustic exposure compared to a model with fully three-dimensionally moving animals. However, their static method is different from the NAEMO in several ways. First, they distribute the entire population at depth with respect to the species-typical depth distribution histogram, and those animals remain static at that position throughout the entire simulation. In the NAEMO, 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 animals that occur within that volume, rather than using the animals themselves as dosimeters, as in the NAEMO. 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 NAEMO 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 NAEMO. For position updates occurring more frequently than every 5 minutes, the number of estimated exposures was similar between the NAEMO and the fully moving distribution; however, computational time was much longer for the fully moving distribution.

The NAEMO 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 activity. This is done taking into account an activity 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 activity 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 NWTT Study Area where similar activities might occur in the future.

The NAEMO then tracks the energy received by each animat within the energy footprint of the activity 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 animat could be impacted during each independent scenario or 24-hour period. In few instances, although the activities themselves all occur within the Study Area, sound may propagate beyond the boundary of the Study Area. Any exposures occurring outside the boundary of the NWTT Study Area are counted as if they occurred within the NWTT Study Area boundary.

3.5.3.1.6 Model Assumptions

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

- Animats are modeled as being underwater and facing the source and therefore always predicted to receive the maximum sound level at their position within the water column (e.g., the model does not account for conditions such as body shading or an animal raising its head above water).
- Multiple exposures within any 24-hour period are considered one continuous exposure for the purposes of calculating temporary or permanent hearing loss, because there are insufficient data to estimate a hearing recovery function for the time between exposures.
- Animats do not move horizontally (but change their position vertically within the water column), which may overestimate physiological impacts such as hearing loss, especially for slow-moving or stationary sound sources in the model.
- Animats are stationary horizontally and therefore do not avoid the sound source, unlike in the wild where animals would most often avoid exposures at higher sound levels, especially those exposures that may result in permanent hearing loss (PTS).
- Animats receive the full impulse of the initial positive pressure wave due to an explosion, although the impulse-based thresholds (onset mortality and onset slight lung injury) assume an impulse delivery time adjusted for animal size and depth. Therefore, these impacts are overestimated at greater distances and increased depths.
- Mitigation measures implemented during training and testing activities that reduce the likelihood of exposing a sea turtle to higher levels of acoustic energy near the most powerful sound sources (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) were not considered in the model.

3.5.3.1.6.1 Sea Turtle Densities

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. 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 NAEMO in their original temporal and spatial resolution.

3.5.3.1.7 Impacts from Sonar and Other Active Acoustic Sources

Sonar and other active acoustic sound sources emit sound waves into the water to detect objects, safely navigate, and communicate. These systems are used for anti-submarine warfare (ASW), mine warfare, navigation, sensing of oceanographic conditions (e.g., sound speed profile), and communication. General categories of sonar systems are described in Section 2.3 and Section 3.0.5.3.1 (Acoustic Stressors).

Potential direct impacts on sea turtles from exposure to sonar or other non-impulse 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. 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 training and testing 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. However, there are no resident leatherback sea turtles within the Study Area. A sea turtle could be exposed to sonar or other active acoustic sources several times in its lifetime, but the potential for habituation is unknown. Most exposures would be intermittent and short-term when considered over the duration of a sea turtle's life span. In addition, most sources emit sound at frequencies that are higher than the best hearing range of sea turtles.

Most sonar and other active acoustic sources used during training and testing use frequency ranges that are higher than the estimated hearing range of sea turtles (10 Hz–2 kHz). Therefore, most of these sources have no impact on sea turtle hearing. Only sonar with source levels greater than 160 dB re 1 µPa using frequencies within the hearing range of sea turtles have 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 on 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 on protected species, including sea turtles, and therefore were not modeled and are addressed qualitatively in this EIS. These sources generally have frequencies greater than 200 kHz and source levels less than 160 dB re 1 µPa. The types of sources with source levels less than 160 dB are primarily hand-held sonar, range pingers, transponders, and acoustic communication devices.

Within this acoustics analysis, sea turtles that may experience some form of hearing loss were predicted using the NAEMO (see Section 3.5.3.1.5, Navy Acoustic Effects Model). To quantify the impacts of acoustic exposures to sea turtles, training and testing activities that employ acoustic sources using frequencies in the hearing range of sea turtles were analyzed. Most sonar and active acoustic sources used during testing and training use frequencies outside of the estimated hearing range of turtles.

3.5.3.1.7.1 No Action Alternative

Training Activities

Offshore Area

Training activities under the No Action Alternative include activities that produce non-impulse noise from the use of sonar and other active acoustic sources that fall within the hearing range of sea turtles. The number of events and their proposed locations within the Offshore Area (Warning Area 237, Quinault Range Site, or the entire Offshore Area) are presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). Use of sonar and other active acoustic sources during training activities is discussed in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources). Table 3.5-4 presents the annual total model-predicted impacts on leatherback sea turtles from 1 year of training activities.

Table 3.5-4: Annual Total Model-Predicted Impacts on Leatherback Sea Turtles for Training Activities Using Sonar and Other Active Non-Impulse Acoustic Sources

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
0	0	0	0	0	0

Based on NAEMO modeling, no sea turtles are anticipated to be impacted by activities utilizing sonar under the No Action Alternative. As stated in Section 3.5.3.1.3.11 (Criteria for Impulse Permanent Threshold Shift), because an incorrectly lowered threshold was used to quantitatively analyze acoustic impacts to sea turtles in this EIS/OEIS, the quantitative impacts presented herein for impulse TTS are conservative (i.e., over-predicted).

Sea turtles may exhibit short-term behavioral reactions, such as swimming away or diving to avoid the immediate area around a source, although studies examining sea turtle behavioral responses to sound have used impulse sources, not non-impulse sources. 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 any 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.

Within the Offshore Area, critical habitat has been designated in the marine environment for the leatherback sea turtle. There is one PCE essential for the conservation of leatherbacks in the marine waters of the U.S. west coast: the occurrence of prey species. Since jellyfish, the main prey species of leatherbacks, do not possess the ability to hear, it is unlikely that noise from testing activities would impact this prey species.

Pursuant to the ESA, sonar and other active acoustic sources associated with training activities under the No Action Alternative would have no effect on leatherback sea turtles.

Pursuant to the ESA, sonar and other active acoustic sources associated with training activities under the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

Testing activities under the No Action Alternative include activities that produce non-impulse noise from the use of sonar and other active acoustic sources that fall within the hearing range of sea turtles. The number of events is presented in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives). Use of sonar and other active acoustic sources during training activities is discussed in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources). Table 3.5-5 presents the annual total model-predicted impacts on leatherback sea turtles from 1 year of testing activities.

Table 3.5-5: Annual Total Model-Predicted Impacts on Leatherback Sea Turtles for Testing Activities Using Sonar and Other Active Non-Impulse Acoustic Sources

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
0	0	5	0	5	0

Under the No Action Alternative, no sea turtles are predicted to experience TTS or PTS. As stated in Section 3.5.3.1.3.11 (Criteria for Impulse Permanent Threshold Shift), because an incorrectly lowered threshold was used to quantitatively analyze acoustic impacts to sea turtles in this EIS/OEIS, the quantitative impacts presented herein for impulse TTS are conservative (i.e., over-predicted).Sea turtles may exhibit short-term behavioral reactions, such as swimming away or diving to avoid the immediate area around a source, although studies examining sea turtle behavioral responses to sound have used impulse sources, not non-impulse sources. 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 any 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.

Within the Study Area, critical habitat has been designated in the marine environment for the leatherback sea turtle. There is one PCE essential for the conservation of leatherbacks in the marine waters of the U.S. west coast: the occurrence of prey species. Since jellyfish, the main prey species of leatherbacks, do not possess the ability to hear, it is unlikely that noise from testing activities would impact this prey species.

Pursuant to the ESA, sonar and other active acoustic sources associated with testing activities under the No Action Alternative would have no effect on leatherback sea turtles.

Pursuant to the ESA, sonar and other active acoustic sources associated with testing activities under the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

3.5.3.1.7.2 Alternative 1

Training Activities

Offshore Area

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) and increases under Alternative 1. However, based on NAEMO modeling, the increase in use of sonar and other active acoustic sources does not correlate with an increase in TTS or PTS. No sea turtles are anticipated to be impacted by activities utilizing sonar under Alternative 1 (see Table 3.5-5). Sea turtles may exhibit short-term behavioral reactions, such as swimming away or diving to avoid the immediate area around a source, although studies examining sea turtle behavioral responses to sound have used impulse sources, not non-impulse sources. 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 any 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. Similar to the No Action Alternative, it is unlikely that noise from training activities would impact the main prey species of leatherback sea turtles.

Pursuant to the ESA, sonar and other active acoustic sources associated with training activities under Alternative 1 would have no effect on leatherback sea turtles.

Pursuant to the ESA, sonar and other active acoustic sources associated with training activities under Alternative 1 would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

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) and increases under Alternative 1. Based on NAEMO modeling, under Alternative 1, five sea turtles are predicted to experience TTS as a result of ASW testing, which would result in short-term reduced perception of sound within a limited frequency range, lasting from minutes to days, depending on the exposure. Cues preceding the commencement of the event (e.g., vessel presence and noise) may result in some animals departing the immediate area, even 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 TTS predicted near sound sources. No sea turtles are predicted to experience PTS.

Sea turtles may exhibit short-term behavioral reactions, such as swimming away or diving to avoid the immediate area around a source, although studies examining sea turtle behavioral responses to sound have used impulse sources, not non-impulse sources. 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 any 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. Similar to the No Action Alternative, it is unlikely that noise from testing activities would impact the main prey species of leatherback sea turtles.

Pursuant to the ESA, sonar and other active acoustic sources associated with testing activities under Alternative 1 may affect, and is likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, sonar and other active acoustic sources associated with testing activities under Alternative 1 would have no effect on leatherback sea turtle critical habitat.

3.5.3.1.7.3 Alternative 2

Training Activities

Offshore Areas

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). Based on NAEMO modeling, no sea turtles are anticipated to be impacted by activities utilizing sonar under Alternative 2 (see Table 3.5-5). Sea turtles may exhibit short-term behavioral reactions, such as swimming away or diving to avoid the immediate area around a source, although studies examining sea turtle behavioral responses to sound have used impulse sources, not non-impulse sources. 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 any 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. Similar to the No Action Alternative, it is unlikely that noise from training activities would impact the main prey species of leatherback sea turtles.

Pursuant to the ESA, sonar and other active acoustic sources associated with training activities under Alternative 2 would have no effect on leatherback sea turtles.

Pursuant to the ESA, sonar and other active acoustic sources associated with training activities under Alternative 2 would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Areas

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) and increases under Alternative 2. Based on NAEMO modeling, under Alternative 2, five sea turtles are predicted to experience TTS as a result of ASW testing, which if experienced would result in short-term reduced perception of sound within a limited frequency range, lasting from minutes to days, depending on the exposure. No sea turtles are predicted to experience PTS. Cues preceding the commencement of the event (e.g., vessel presence and noise) may result in some animals departing the immediate area, even 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 TTS predicted near sound sources.

Sea turtles may exhibit short-term behavioral reactions, such as swimming away or diving to avoid the immediate area around a source, although studies examining sea turtle behavioral responses to sound have used impulse sources, not non-impulse sources. 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 any 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. Similar to the No Action Alternative, it is unlikely that noise from testing activities would impact the main prey species of leatherback sea turtles.

Pursuant to the ESA, sonar and other active acoustic sources associated with testing activities under Alternative 2 may affect, and is likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, sonar and other active acoustic sources associated with testing activities under Alternative 2 would have no effect on leatherback sea turtle critical habitat.

3.5.3.1.8 Impacts from Explosives

Explosives in the water or near the water's surface can introduce loud, impulse, 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 (see Section 3.5.3.1.2.1, Direct Injury), TTS or PTS (see Section 3.5.3.1.2.2, Hearing Loss), or behavioral responses (see Section 3.5.3.1.2.5, Behavioral Reactions). The impacts on sea turtles of at-sea explosive use depend on the net explosive weight (NEW) 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 NEW accounts for the weight and the type of explosive material. Criteria for determining physiological impacts of impulse sound on sea turtles are discussed in Section 3.5.3.1.3 (Acoustic and Explosive Thresholds and Criteria). The limited information on sea turtle behavioral responses to sounds is discussed in Section 3.5.3.1.2.5 (Behavioral Reactions).

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

There is some limited information on sea turtle behavioral responses to impulse noise from airgun studies (see 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.

3.5.3.1.8.1 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 3.5-6. Sea turtles within these ranges are predicted by the model (see Appendix G, Acoustic Primer, for a detailed description of 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 impulse 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 3.5-6. If exposed to a single impulse sound, a sea turtle is assumed to exhibit a brief startle reaction that would likely be biologically insignificant.

Table 3.5-6: Ranges of Impacts from In-Water Explosives 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							
	Bin E1 (0.0–0.5 lb. NEW)	Bin E3 (0.6–2.6 lb. NEW)	Bin E4 (2.6–6 lb. NEW)	Bin E5 (6–10 lb. NEW)	Bin E8 (21–60 lb. NEW)	Bin E10 (251–500 lb. NEW)	Bin E11 (501–1,000 lb. NEW)	Bin E12 (1,000–1,651 lb. NEW)
Onset Mortality (1% Mortality)	4	26	51	46	102	164	458	199
Onset Slight Lung Injury	17	50	130	85	179	284	816	343
Onset Slight GI Tract Injury	40	60	175	55	106	184	201	250
Permanent Threshold Shift[2]	67	196	215	162	424	873	809	1,251
Temporary Threshold Shift[2]	90	724	421	288	844	1,975	1,693	2,640
Behavioral Response	144	1,512	796	565	1,458	3,217	3,015	3,962

[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 impulse criteria assumed explosive event durations of 1 second. Actual durations may be less, resulting in smaller ranges to impact.

Notes: (1) lb. = pound(s), m = meters, NEW = net explosive weight; (2) Ranges determined using REFMS, the Navy's explosive propagation model.

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

- Many explosions from ordnance such as bombs and missiles actually explode upon impact with above-water targets. For this analysis, sources such as these were modeled as exploding at depths of 1 m, overestimating the amount of explosive and acoustic energy entering the water.
- For predicting TTS and PTS based on sound exposure level, the duration of an explosion is assumed to be 1 second. Actual detonation durations may be much shorter, so the actual sound exposure level at a particular distance may be lower.
- Mortality and slight lung injury criteria are based on juvenile turtle masses, which substantially increases that range to which these impacts are predicted to occur compared to the ranges that would be predicted using adult turtle masses.
- Animats are assumed to receive the full impulse of the initial positive pressure wave due to an explosion, although the impulse-based thresholds (onset mortality and onset slight lung injury)

assume an impulse delivery time adjusted for animal size and depth. Therefore, these impacts are overestimated at farther distances and increased depths.

- The predicted acoustic impacts do not take into account mitigation measures implemented during many training and testing activities, such as exclusion zones around detonations. Smaller hatchling and early juvenile hardshell turtles tend to be near the surface, which is subject to avoidance mitigation measures (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

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

3.5.3.1.8.2 No Action Alternative

<u>Training Activities</u>

Offshore Area

Up to 378 training activities under the No Action Alternative would use explosives at or beneath the water surface which would expose sea turtles to underwater impulse sound (see Table 3.5-1). The largest source class used during training under the No Action Alternative would be E12 (> 650–1,000 pounds [lb.] NEW), which would be used 16 times in the Operating Area (OPAREA). The number of training events using explosions and their proposed locations are presented in Table 2.8-1 of Chapter 2 and Table 3.0-12 of Chapter 3. Explosions associated with torpedoes and explosive sonobuoys would occur in the water column; mines and demolition charges could occur near the surface, in the water column, or the ocean bottom. Most detonations would occur in waters greater than 200 ft. (61 m) in depth, and greater than 3 nautical miles (nm) from shore, although mine warfare could occur in shallow water close to shore. Detonations associated with ASW would typically occur in waters greater than 600 ft. (182.9 m) depth.

The ranges of impacts from in-water explosions are listed in Table 3.5-6. While the number of leatherback turtles anticipated in the Study Area is low, if a leatherback turtle was within the ranges listed in Table 3.5-6, the respective impact would be anticipated. However, results from modeling indicate no leatherback sea turtles 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 (Table 3.5-7). Further, zero sea turtles were modeled to experience TTS or PTS from the use of explosives in the Offshore Area of the Study Area.

Table 3.5-7: Annual Model-Predicted Impacts on Leatherback Sea Turtles from Explosions for Training and Testing Activities under the No Action Alternative, Alternative 1, and Alternative 2

Temporary Threshold Shift	Permanent Threshold Shift	GI Tract Injury	Slight Lung Injury	Mortality
0	0	0	0	0

Note: GI = gastrointestinal

Some sea turtles beyond the ranges of the above impacts may behaviorally react if they hear a detonation. Activities consisting of single detonations, such as bombing and missile exercise, are expected to only elicit short-term startle reactions. If a sea turtle hears multiple 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 activities would consist of a limited number of detonations and exposures would not occur over long durations, there would be an opportunity to recover from an incurred energetic cost.

Because model-predicted impacts are negligible 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.

Within the Study Area, critical habitat has been designated in the marine environment for the leatherback sea turtle. There is one PCE essential for the conservation of leatherbacks in the marine waters of the U.S. west coast: the occurrence of prey species. While some of the leatherback sea turtle's preferred prey may be impacted by explosions during training activities, effects are expected to be minor and temporary, and will have no significant impact to the overall prey base in the designated critical habitat.

Pursuant to the ESA, in-water explosions associated with training activities under the No Action Alternative may affect, but are not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, in-water explosions associated with training activities under the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

<u>Testing Activities</u>

Offshore Areas

No testing activities in the Offshore Area of the Study Area under the No Action Alternative use explosives at or beneath the water surface that would expose sea turtles to underwater impulse sound.

3.5.3.1.8.3 Alternative 1

<u>Training Activities</u>

Offshore Area

Up to 502 training activities under Alternative 1 using explosives at or beneath the water surface would expose sea turtles to underwater impulse sound (see Table 3.5-1). The largest source class used during training under Alternative 1 would be E12 (> 650–1,000 lb. NEW), which would be used 10 times in the OPAREA. This decrease in the number of largest source class explosives is a result of the cessation of sinking exercise (SINKEX) activities.

The ranges of impacts from in-water explosions are listed in Table 3.5-6. While the number of leatherback turtles anticipated in the Study Area is low, if a leatherback turtle was within the ranges listed in Table 3.5-6, the respective impact would be anticipated. However, results from modeling indicate no leatherback sea turtles 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 (see Table 3.5-7). Further, zero sea turtles were modeled to experience TTS or PTS from the use of explosives in the Offshore Area of the Study Area.

Some sea turtles beyond the ranges of the above impacts may behaviorally react if they hear a detonation. Activities consisting of single detonations, such as bombing and missile exercise, are expected to only elicit short-term startle reactions. If a sea turtle hears multiple 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 activities would consist of a limited number of detonations and exposures would not occur over long durations, there would be an opportunity to recover from an incurred energetic cost.

Because impact estimations are negligible 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. Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected.

Similar to the No Action Alternative, while some of the leatherback sea turtle's preferred prey may be impacted by explosions during training activities, effects are expected to be minor and temporary, and will have no significant impact to the overall prey base in the designated critical habitat.

Pursuant to the ESA, in-water explosions associated with training activities in the Offshore Area of Study Area under Alternative 1 may affect, but are not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, in-water explosions associated with training activities under Alternative 1 would have no effect leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

Testing activities under Alternative 1 using explosives at or beneath the water surface would expose sea turtles to underwater impulse sound. Explosives at or beneath the water surface would be used only in the OPAREA, a total of 148 annual events (see Table 3.5-1) using high-explosive torpedoes (12), sound underwater signal buoys (72), or Improved Extended Echo Ranging (IEER) sonobuoy detonations (70) (see Tables 2.8-2 and 2.8-3).

The ranges of impacts from in-water explosions are listed in Table 3.5-6. While the number of leatherback turtles anticipated in the Study Area is low, if a leatherback turtle was within the ranges listed in Table 3.5-6, the respective impact would be anticipated. However, results from modeling indicate no leatherback sea turtles are predicted to be exposed to impulse levels associated with the onset of mortality and gastrointestinal tract injury over any testing year for explosives use in open ocean habitats (see Table 3.5-7). Further, zero sea turtles were modeled to experience TTS or PTS from the use of explosives from testing activities under Alternative 1.

Some sea turtles beyond the ranges of the above impacts may behaviorally react if they hear a detonation. Activities consisting of single detonations, such as bombing and missile exercise, are expected to only elicit short-term startle reactions. If a sea turtle hears multiple 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 activities would consist of a limited number of detonations and exposures would not occur over long durations, there would be an opportunity to recover from an incurred energetic cost.

Because modeled impacts are negligible and any 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. Similar to training activities, while some of the leatherback sea turtle's preferred prey may be impacted by explosions during testing activities, effects are expected to be minor and temporary, and will have no significant impact to the overall prey base in the designated critical habitat.

Pursuant to the ESA, in-water explosions associated with testing activities in the Offshore Area of Study Area under Alternative 1 may affect, but are not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, in-water explosions associated with testing activities under Alternative 1 would have no effect leatherback sea turtle critical habitat.

3.5.3.1.8.4 Alternative 2

Training Activities

Offshore Area

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 will also be identical as described for Alternative 1.

Pursuant to the ESA, in-water explosions associated with training activities in the Offshore Area of Study Area under Alternative 2 may affect, but are not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, in-water explosions associated with training activities under Alternative 2 would have no effect on the leatherback sea turtle critical habitat.

Testing Activities

Testing activities under Alternative 2 using explosives at or beneath the water surface would expose sea turtles to underwater impulse sound, a total of 164 annual events using high-explosive torpedoes, sound underwater signal buoys, or IEER sonobuoy detonations (see Tables 3.5-1, 2.8-2, and 2.8-3). Results from modeling indicate no leatherback sea turtles are predicted to be exposed to impulse levels associated with the onset of mortality and gastrointestinal tract injury over any testing year for explosives use in open ocean habitats. Further, zero sea turtles were modeled to experience TTS or PTS from the use of explosives from testing activities under Alternative 2.

Some sea turtles beyond the ranges of the above impacts may behaviorally react if they hear a detonation. Activities consisting of single detonations, such as bombing and missile exercise, are expected to only elicit short-term startle reactions. If a sea turtle hears multiple 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 activities would consist of a limited number of detonations and exposures would not occur over long durations, there would be an opportunity to recover from an incurred energetic cost.

Because modeled impacts are negligible and any 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. Similar to training activities, while some of the leatherback sea turtle’s preferred prey may be impacted by explosions during testing activities, effects are expected to be minor and temporary, and will have no significant impact to the overall prey base in the designated critical habitat.

Pursuant to the ESA, in-water explosions associated with testing activities in the Offshore Area of Study Area under Alternative 2 may affect, but are not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, in-water explosions associated with testing activities under Alternative 2 would have no effect on leatherback sea turtle critical habitat.

3.5.3.1.9 Impacts from Weapons Firing, Launch, and Impact Noise

Sea turtles may be exposed to weapons firing and launch noise and sound from the impact of non-explosive ordnance on the water's surface (see Section 3.0.5.3.1.3, 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). Tables F-3 and F-4 in Appendix F (Training and Testing Activities Matrices) indicate the activities that include these noises.

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 impulse 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 impulse 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.

There are no testing activities under any Alternative that produce in water noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface. Therefore, there are no impacts on sea turtles that may be present in the Study Area from testing activities.

3.5.3.1.9.1 No Action Alternative

<u>**Training Activities**</u>

Offshore Area

Training under the No Action Alternative includes activities that produce in-water noise from weapons firing, launch, and non-explosive ordnance or sonobuoy impact with the water's surface. Noise associated with weapons firing and the impact of non-explosive practice munitions could happen at any location within the Offshore Area but generally would occur at locations greater than 12 nm from shore for safety reasons. The probability of in-water noise and sea turtle exposures in the Study Area depends on factors such as the presence or absence and density of sea turtles; and the duration and spatial extent of activities. The low densities of leatherback sea turtles in the Study Area naturally minimize the potential for overlap with military training activities causing in-water sounds. Further, as indicated in Section 3.5.2.1 (Diving), sea turtles spend a portion of each day diving, which would further reduce the amount of time the animal would be close to the surface where exposures levels would be highest.

Though the potential for exposure is inherently low, 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.

Within the Study Area, critical habitat has been designated in the marine environment for the leatherback sea turtle. There is one PCE essential for the conservation of leatherbacks in the marine waters of the U.S. west coast: the occurrence of prey species. Since jellyfish, the main prey species of leatherbacks, do not possess the ability to hear, it is unlikely that in-water noise from weapons firing, launch, and non-explosive ordnance or sonobuoy impact with the water's surface would impact this prey species.

Pursuant to 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 leatherback sea turtles.

Pursuant to the ESA, sound from weapons firing, launch, and non-explosive impact during training activities under the No Action Alternative would have no effect on the leatherback sea turtle critical habitat.

3.5.3.1.9.2 Alternative 1

Training Activities

Offshore Area

Training activities under Alternative 1 that produce in-water noise from weapons firing, launch, and non-explosive ordnance or sonobuoy impact with the water's surface would increase compared to the No Action Alternative, although SINKEX activities would no longer be conducted. The locations and types of activities would be similar to those under the No Action Alternative. Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives) presents the number of weapons firing and launch noise events by alternative.

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

Pursuant to the ESA, sound from weapons firing, launch, and non-explosive impact during training activities under Alternative 1 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, sound from weapons firing, launch, and non-explosive impact during training activities under Alternative 1 would have no effect on leatherback sea turtle critical habitat.

3.5.3.1.9.3 Alternative 2

Training Activities

Offshore Area

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 will also be identical, as described for Alternative 1.

Pursuant to 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 leatherback sea turtles.

Pursuant to the ESA, sound from weapons firing, launch, and non-explosive impact during training activities under Alternative 2 would have no effect on leatherback sea turtle critical habitat.

3.5.3.1.10 Impacts from Vessel and Aircraft Noise

Vessel Noise

Vessels could move throughout the Study Area, although some portions would have limited or no activity. Many ongoing and proposed training and testing activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels). Operations involving vessel movements occur intermittently, and are variable in duration, ranging from a few hours up to 2 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 3.0.5.3.1.4 (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 (see Section 3.5.3.1.2.3, Auditory Masking); 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 ports and harbors, 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 (see Figure 3.0-4 in Section 3.0.5.3.1.4, Vessel Noise), 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. Some auditory masking to sea turtles is likely from non-combatant Navy vessels, especially in quieter, open-ocean environments.

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 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 3.0.5.3.1.5 (Aircraft Overflight Noise).

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 3.0.5.3.1.3 (Weapons Firing, Launch, and Impact Noise). Underwater sounds from aircraft are strongest just below the surface and directly under the aircraft. The maximum sound levels in water (1–2 m under the water surface) 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 3.0.5.3.1.5, Aircraft Overflight Noise, 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, due to the transient nature of both the animals as well as the noise source.

3.5.3.1.10.1 No Action Alternative

Training Activities

Offshore Area

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 the Study Area, the vast majority of vessel traffic would be concentrated in the Offshore Area (see Table 3.5-1), with 996 of 1,000 annual events including vessel traffic. The number of Navy vessels in the Study Area at any given time varies and is dependent on local training or testing requirements. Most activities include either one or two vessels and may last from a few hours up to an entire day. Vessel movement as part of 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.

The vast majority of events including aircraft movement are within the Offshore Area of the Study Area, with 3,826 of 3,950 events occurring annually (see Table 3.5-1). Typical fixed-wing aircraft include (but are not limited to) F-35 and E/A-18G, both fast-moving aircraft. As mentioned above, exposure of a sea turtle to fixed-wing or rotary-wing aircraft would last for only seconds as the aircraft quickly passes overhead.

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.

Within the Study Area, critical habitat has been designated in the marine environment for the leatherback sea turtle. There is one PCE essential for the conservation of leatherbacks in the marine waters of the U.S. west coast: the occurrence of prey species. Since jellyfish, the main prey species of leatherbacks, do not possess the ability to hear, it is unlikely that vessel or aircraft noise would impact this prey species.

Pursuant to the ESA, sound associated with vessels and aircraft during training activities under the No Action Alternative may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, sound associated with vessels and aircraft during training activities under the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

Testing activities under the No Action Alternative include noise from vessel movements and fixed- and rotor-wing aircraft overflights. Within the Study Area, vessel traffic would be concentrated in the Inland Waters (see Table 3.5-1), with only 37 of 402 testing events occurring in the Offshore Area. Therefore, the majority of sound introduced into the water by vessel movements would be concentrated in these areas. Only two testing activities occur annually involving aircraft (see Table 3.5-1). As mentioned above, exposure of a sea turtle to fixed-wing or rotary-wing aircraft would last for only seconds as the aircraft quickly passes overhead.

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.

Within the Study Area, critical habitat has been designated in the marine environment for the leatherback sea turtle. There is one PCE essential for the conservation of leatherbacks in the marine waters of the U.S. west coast: the occurrence of prey species. Since jellyfish, the main prey species of leatherbacks, do not possess the ability to hear, it is unlikely that vessel or aircraft noise from testing activities would impact this prey species.

Pursuant to the ESA, sound associated with vessels and aircraft during testing activities under the No Action Alternative may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, sound associated with vessels and aircraft during testing activities under the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

3.5.3.1.10.2 Alternative 1

Training Activities

Offshore Area

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. Similar to the No Action Alternative, the vast majority (approximately 95 percent) of vessel traffic would be concentrated in the Offshore Area of the Study Area (see Table 3.5-1), with 1,096 of 1,127 annual activities involving vessel traffic. The number of activities involving aircraft would increase from the No Action Alternative (from 3,826 annual events to 6,471), and 98 percent of all aircraft activities are within the Offshore Area of the Study Area (see Table 3.5-1).

The difference between the No Action Alternative and Alternative 1 includes an increase in the number of many activities. Because multiple activities usually occur from the same vessel, the increased activities would not necessarily result in an increase in vessel use or transit. The concentration of activities and the manner in which the Navy uses vessels to accomplish its training and testing activities is likely to remain consistent with the range of variability observed over the last decade. Consequently, the Navy is not proposing appreciable changes in the levels, frequency, or locations where vessels have been used over the last decade.

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 for the No Action Alternative, even though vessel noise may cause short-term impacts, no long-term consequences for individuals, populations, or critical habitat PCEs would be expected.

Pursuant to the ESA, sound associated with vessels and aircraft during training activities under Alternative 1 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, sound associated with vessels and aircraft during training activities under Alternative 1 would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

Testing Activities proposed under Alternative 1 in the Offshore Area would not increase Navy vessel traffic but would increase aircraft overflights compared to the No Action Alternative, increasing overall amounts of aircraft noise. Within the Study Area, vessel traffic would be concentrated in the Inland Waters (see Table 3.5-1), with only 138 of 780 testing events occurring in the Offshore Area. Therefore, the majority of sound introduced into the water by vessel movements would be concentrated in these areas. Only 74 testing activities occur in the Offshore Area annually involving aircraft (see Table 3.5-1). As mentioned above, exposure of a sea turtle to fixed-wing or rotary-wing aircraft would last for only seconds as the aircraft quickly passes overhead.

The difference between the No Action Alternative and Alternative 1 includes an increase in the number of many activities. Because multiple activities usually occur from the same vessel, the increased activities would not necessarily result in an increase in vessel use or transit. The concentration of activities and the manner in which the Navy uses vessels to accomplish its training and testing activities is likely to remain consistent with the range of variability observed over the last decade. Consequently, the Navy is not proposing appreciable changes in the levels, frequency, or locations where vessels have been used over the last decade.

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 for the No Action Alternative, even though vessel noise may cause short-term impacts, no long-term consequences for individuals, populations, or critical habitat PCEs would be expected.

Pursuant to the ESA, sound associated with vessels and aircraft during testing activities under Alternative 1 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, sound associated with vessels and aircraft during testing activities under Alternative 1 would have no effect on leatherback sea turtle critical habitat.

3.5.3.1.10.3 Alternative 2

Training Activities

Offshore Area

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 will also be identical.

Pursuant to the ESA, sound associated with vessels and aircraft during training activities under Alternative 2 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, sound associated with vessels and aircraft during training activities under Alternative 2 would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

Testing Activities proposed under Alternative 2 in the Offshore Area would not increase Navy vessel traffic but would increase aircraft overflights compared to the No Action Alternative, increasing overall amounts of aircraft noise. Within the Study Area, vessel traffic would be concentrated in the Inland Waters (see Table 3.5-1), with only 162 of 885 testing events occurring in the Offshore Area. Only 84 testing activities occur annually involving aircraft (see Table 3.5-1). As mentioned above, exposure of a sea turtle to fixed-wing or rotary-wing aircraft would last for only seconds as the aircraft quickly passes overhead.

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 for the No Action Alternative, even though vessel noise may cause short-term impacts, no long-term consequences for individuals, populations, or critical habitat PCEs would be expected.

Pursuant to the ESA, sound associated with vessels and aircraft during testing activities under Alternative 2 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, sound associated with vessels and aircraft during testing activities under Alternative 2 would have no effect on leatherback sea turtle critical habitat.

3.5.3.2 Energy Stressors

This section evaluates the potential for sea turtles to be impacted by electromagnetic devices used during training and testing activities in the Study Area. Several different types of electromagnetic devices are used during training and testing activities. As indicated in Section 3.0.5.3.2.1 (Electromagnetic), only Maritime Homeland Defense/Security Mine Countermeasures activities use electromagnetic devices. As indicated in Table 3.5-1, training activities involving electromagnetic devices would occur inside Puget Sound or the Strait of Juan de Fuca. As previously discussed, sea turtles are not anticipated within these areas. Therefore, the use of electromagnetic devices would have no effect on sea turtles.

Pursuant to the ESA, energy stressors associated with training and testing activities under the No Action Alternative, Alternative 1, or Alternative 2 would have no effect on leatherback sea turtles.

Pursuant to the ESA, energy stressors associated with training and testing activities under the No Action Alternative, Alternative 1, or Alternative 2 would have no effect on leatherback sea turtle critical habitat.

3.5.3.3 Physical Disturbance and Strike Stressors

This section analyzes the potential impacts of the various types of physical disturbance and strike stressors used by Navy during training and testing activities within the Study Area. For a list of Navy activities that involve this stressor, refer to Tables F-3 and F-4. 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 3.5.3.1.10 (Impacts from Vessel and Aircraft Noise) contain the analysis of the potential for disturbance visual or acoustic cues.

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

3.5.3.3.1 Impacts from Vessels

The majority of the training and testing activities under all alternatives involve some level of vessel activity. For a discussion of the types of activities that include the use of vessels, where they are used, and the speed and size characteristics of vessels used, see Section 3.0.5.3.3.1 (Vessels). Vessels include ships, submarines, and boats ranging in size from small, 22 ft. (6.7 m) rigid hull inflatable boats to aircraft carriers with lengths up to 1,092 ft. (332.8 m). Large Navy ships generally operate at speeds in the range of 10–15 knots, and submarines generally operate at speeds in the range of 8–13 knots (see Table 3.0-16). 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.

Exposure to vessels would be greatest in the areas of highest naval vessel traffic. In an attempt to determine traffic patterns for Navy and non-Navy vessels, a review by the Center for Naval Analysis

(Mintz and Parker 2006) was conducted on commercial vessels, coastal shipping patterns, and Navy vessels. Commercial and non-Navy traffic, which included cargo vessels, bulk carriers, passenger vessels, and oil tankers (all over 65 ft. [20 m] in length), was heaviest near the Strait of Juan de Fuca and the Columbia River mouth, and could be seen in the east to west and north to south international shipping lanes (see Figure 3.0-4). While commercial traffic is relatively steady throughout the year, Navy traffic is episodic in the ocean. 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 2 weeks. Vessel movement under the Proposed Action would be widely dispersed throughout the Study Area, but more concentrated in portions of the Northwest Training Range Complex (NWTRC) OPAREA.

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.

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 and are more likely to spend more time at the surface in northern latitudes to bask and help thermoregulate. 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. Sea turtles can detect approaching vessels, likely by sight rather than by sound (Bartol and Ketten 2006c; Hazel et al. 2007). Sea turtles seem to react more to slower-moving vessels (2.2 knots) than to faster vessels (5.9 knots or greater). Vessel-related injuries to sea turtles are more likely to occur in areas with high boating traffic. Although sea turtles likely hear and see approaching vessels, they may not be able to avoid all collisions.

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 (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring). Some vessels associated with training and testing can travel at high speeds, which increase the strike risk to sea turtles (see Table 3.0-16) (Hazel et al. 2007).

3.5.3.3.1.1 No Action Alternative, Alternative 1, and Alternative 2

<u>Training Activities</u>

Offshore Area

Within the Study Area, the vast majority of vessel traffic would be concentrated in the Offshore Area (see Table 3.5-1). 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. Leatherback sea turtles can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. Given the concentration of Navy vessel movements within the Offshore Area, training activities utilizing vessels 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 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.

Within the Study Area, critical habitat has been designated in the marine environment for the leatherback sea turtle. There is one PCE essential for the conservation of leatherbacks in the marine waters of the U.S. west coast: the occurrence of prey species. While some of the leatherback sea turtle's preferred prey may be impacted by vessels during training activities, effects are expected to be minor and temporary, and will have no significant impact to the overall prey base in the designated critical habitat.

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

Pursuant to the ESA, the use of vessels during training activities as described in the No Action Alternative, Alternative 1, and Alternative 2 would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

As indicated in Section 3.0.5.3.3.1 (Vessels), most testing activities involve the use of vessels. However, the number of vessels used for testing activities is comparatively lower than the number of vessels used for training (less than 25 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 in nearshore waters of the Quinault Range Site, removed from the offshore portion of Study Area. The likelihood of vessel strikes would be low in the offshore portion of Study Area because of the concentration of vessel movement inshore waters.

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 testing activities 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.

Within the Study Area, critical habitat has been designated in the marine environment for the leatherback sea turtle. There is one PCE essential for the conservation of leatherbacks in the marine waters of the U.S. west coast: the occurrence of prey species. While some of the leatherback sea turtle's preferred prey may be impacted by vessels during testing activities, effects are expected to be minor and temporary, and will have no significant impact to the overall prey base in the designated critical habitat.

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

Pursuant to the ESA, the use of vessels during testing activities as described in the No Action Alternative, Alternative 1, and Alternative 2 would have no effect on leatherback sea turtle critical habitat.

3.5.3.3.2 Impacts from In-Water Devices

In-water devices are generally smaller (several inches [in.] to 111 ft. [33.8 m]) than most Navy vessels. For a discussion of the types of activities that use in-water devices, where they are used, and how many activities would occur under each alternative, see Section 3.0.5.3.3.2 (In-Water Devices). See Table 3.0-18 for the types, sizes, and speeds of Navy in-water devices used in the Study Area.

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

3.5.3.3.2.1 No Action Alternative

<u>Training Activities</u>

Offshore Area

Under the No Action Alternative, there are 429 training activities that utilize in-water devices in the Study Area (see Table 3.5-1). Leatherback sea turtles can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. The likelihood of a strike by an in-water device would be low in the offshore portion of Study Area because of the low number of in-water devices used throughout the offshore waters. Additionally, certain devices do not have a realistic potential to strike living marine resources because they either move slowly through the water column (e.g., most unmanned underwater vehicles [UUVs]) or are closely monitored by observers manning the towing platform. Although the likelihood of being struck is minimal, sea turtles that overlap with Navy testing activities are more likely to encounter in-water devices. 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 have population-level impacts.

Within the Study Area, critical habitat has been designated in the marine environment for the leatherback sea turtle. There is one PCE essential for the conservation of leatherbacks in the marine waters of the U.S. west coast: the occurrence of prey species. While some of the leatherback sea turtle’s preferred prey may be impacted by in-water devices during training activities, effects are expected to be minor and temporary, and will have no significant impact to the overall prey base in the designated critical habitat.

Pursuant to the ESA, the use of in-water devices during training activities as described in the No Action Alternative may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of in-water devices during training activities as described in the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

As indicated in Section 3.0.5.3.3.2 (In-Water Devices), 40 activities occur annually that utilize in-water devices. Most testing activities involve the use of vessels. The likelihood of a strike by an in-water device would be low in the offshore portion of Study Area because vessel movement is more concentrated in inshore waters. Additionally, certain devices do not have a realistic potential to strike living marine resources because they either move slowly through the water column (e.g., most UUVs) or are closely monitored by observers manning the towing platform. Although the likelihood of being struck is minimal, sea turtles that overlap with Navy testing activities are more likely to encounter in-water devices. 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 have population-level impacts.

Within the Study Area, critical habitat has been designated in the marine environment for the leatherback sea turtle. There is one PCE essential for the conservation of leatherbacks in the marine waters of the U.S. west coast: the occurrence of prey species. While some of the leatherback sea turtle’s preferred prey may be impacted by in-water devices during testing activities, effects are expected to be minor and temporary, and will have no significant impact to the overall prey base in the designated critical habitat.

Pursuant to the ESA, the use of in-water devices during testing activities as described in the No Action Alternative may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of in-water devices during testing activities as described in the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

3.5.3.3.2.2 Alternative 1

Training Activities

Offshore Area

Under Alternative 1, there are 484 training activities that utilize in-water devices in the Study Area as compared to 429 activities under the No Action Alternative (see Table 3.5-1). Leatherback sea turtles can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. Though the number of activities increase compared to the No Action Alternative, the likelihood of a strike by an in-water device would remain low in the offshore portion of Study Area because of the low number of in-water devices used throughout the offshore waters. Additionally, certain devices do not have a realistic potential to strike living marine resources because they either move slowly through the water column (e.g., most UUVs) or are closely monitored by observers manning the towing platform. Although the likelihood of being struck is minimal, sea turtles that overlap with Navy testing activities are more likely to encounter in-water devices. 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 have population-level impacts.

Within the Study Area, critical habitat has been designated in the marine environment for the leatherback sea turtle. There is one PCE essential for the conservation of leatherbacks in the marine waters of the U.S. west coast: the occurrence of prey species. While some of the leatherback sea turtle’s preferred prey may be impacted by in-water devices during training activities, effects are expected to be minor and temporary, and will have no significant impact to the overall prey base in the designated critical habitat.

Pursuant to the ESA, the use of in-water devices during training activities as described in Alternative 1 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of in-water devices during training activities as described in Alternative 1 would have no effect on leatherback sea turtle critical habitat.

<u>Testing Activities</u>

Offshore Area

As indicated in Section 3.0.5.3.3.2 (In-Water Devices), 138 activities occur annually that utilize in-water devices. Certain devices do not have a realistic potential to strike living marine resources because they either move slowly through the water column (e.g., most UUVs) or are closely monitored by observers manning the towing platform. Although the likelihood of being struck is minimal, sea turtles that overlap with Navy testing activities are more likely to encounter in-water devices. Exposure to in-water devices may change an individual's behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to in-water devices is not expected to have population-level impacts or impacts on critical habitat PCEs.

Pursuant to the ESA, the use of in-water devices during testing activities as described in Alternative 1 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of in-water devices during testing activities as described in Alternative 1 would have no effect on leatherback sea turtle critical habitat.

3.5.3.3.2.3 Alternative 2

<u>Training Activities</u>

Offshore Area

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 will also be identical.

Pursuant to the ESA, the use of in-water devices during training activities as described under Alternative 2 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of in-water devices during training activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat.

<u>Testing Activities</u>

Offshore Area

As indicated in Section 3.0.5.3.3.2 (In-Water Devices), 162 activities occur annually that utilize in-water devices. Certain devices do not have a realistic potential to strike living marine resources because they either move slowly through the water column (e.g., most UUVs) or are closely monitored by observers manning the towing platform. Although the likelihood of being struck is minimal, sea turtles that overlap with Navy testing activities are more likely to encounter in-water devices. Exposure to in-water devices may change an individual's behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to in-water devices is not expected to have population-level impacts or impacts on critical habitat PCEs.

Pursuant to the ESA, the use of in-water devices during testing activities as described in Alternative 2 may affect, but is not likely to adversely affect leatherback turtles.

Pursuant to the ESA, the use of in-water devices during testing activities as described in Alternative 2 would have no effect on leatherback sea turtle critical habitat.

3.5.3.3.3 Impacts from Military Expended Materials

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

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.

While no strike from military expended materials has ever been reported or recorded, the possibility of a strike still exists. 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. However, using the methodology presented in Appendix I (Statistical Probability Analysis for Estimating Direct Air Strike Impact and Number of Potential Exposures), the potential for a leatherback sea turtle was less than 0.00001 percent per year. 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 (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

3.5.3.3.3.1 No Action Alternative, Alternative 1, and Alternative 2

<u>**Training Activities**</u>

Offshore Area

Table 3.5-1, Table 3.0-20, and Table 3.0-21 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 Offshore Area of the Study Area. Leatherback sea turtles can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. 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, leatherback 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 on leatherback sea turtles or to their prey items.

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

Pursuant to the ESA, the use of military expended materials during training activities as described in the No Action Alternative, Alternative 1, and Alternative 2 would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

Table 3.5-1, Table 3.0-20, and Table 3.0-21 list the number and location of military expended materials used during testing activities. Military expended materials include torpedoes used within the Quinault Range Site and sonobuoys used within the NWTRC OPAREA. Leatherback sea turtles can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe.

Though the numbers of sea turtles possibly present is inherently low, 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.

The probability of a strike is also low for individual prey species of the leatherback turtles. Exposure to military-expended materials is not expected to result in population-level impacts on sea turtle prey.

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

Pursuant to the ESA, the use of military expended materials during testing activities as described in the No Action Alternative, Alternative 1, and Alternative 2 would have no effect on leatherback sea turtle critical habitat.

3.5.3.3.4 Impacts from Seafloor Devices

For a discussion of the types of activities that use seafloor devices, where they are used, and how many activities would occur under each alternative, see Section 3.0.5.3.3.4 (Seafloor Devices). These include items that are placed on, dropped on, or moved along the seafloor such as mine shapes, anchor blocks, anchors, bottom-placed instruments, bottom-crawling UUVs, and bottom-placed targets that are recovered (not expended). As stated earlier, only the Offshore Area is analyzed for impacts to sea turtles; therefore, only activities occurring in the Offshore Area are considered. The only seafloor devices proposed for use in the Offshore Area are crawler UUVs that "crawl" across the seafloor as part of testing activities that would occur in the surf zone area of the Quinault Range Site.

There are no Offshore Area training activities under any Alternative in which seafloor devices would be used. Therefore, there are no impacts on sea turtles that may be present in the Study Area from training activities.

3.5.3.3.4.1 No Action Alternative

Testing Activities

Offshore Area

Table 3.5-1 lists the number and location where seafloor devices are used. Under the No Action Alternative, five activities include the use of crawler UUVs annually. The leatherback turtle can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe.

Under the No Action Alternative, exposure to seafloor devices used in testing activities may cause short-term disturbance to an individual turtle or, if struck, could lead to injury or death. 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, wide distribution of habitats, and low number of seafloor devices used. Further, the likelihood is low that a sea turtle would be struck by the slow moving bottom crawling UUV. Exposure to seafloor devices is not expected to change an individual's behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to seafloor devices is not expected to result in population-level impacts.

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

Pursuant to the ESA, the use of seafloor devices during testing activities as described under the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

3.5.3.3.4.2 Alternative 1

Testing Activities

Offshore Area

Table 3.5-1 lists the number and location where seafloor devices are used. Under Alternative 1, six activities include the use of seafloor devices annually, an increase of one over the No Action Alternative. These activities are the same as described under the No Action Alternative and occur in the same location; therefore, the potential for impacts would be the same. Exposure to seafloor devices is not expected to change an individual's behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to seafloor devices is not expected to result in population-level impacts.

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

Pursuant to the ESA, the use of seafloor devices during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat.

3.5.3.3.4.3 Alternative 2

Testing Activities

Offshore Area

Table 3.5-1 lists the number and location where seafloor devices are used. Under Alternative 2, seven activities include the use of seafloor devices annually, an increase of two over the No Action Alternative. These activities are the same as described under the No Action Alternative and occur in the same location; therefore, the potential for impacts would be the same. Exposure to seafloor devices is not expected to change an individual's behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Exposure to seafloor devices is not expected to result in population-level impacts.

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

Pursuant to the ESA, the use of seafloor devices during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat.

3.5.3.4 Entanglement Stressors

This section analyzes the potential entanglement impacts of the various types of expended materials used by the Navy during training and testing activities within the Study Area. This analysis includes the potential impacts of two types of military expended materials, including: (1) cables and wires, and (2) decelerator/parachutes.

3.5.3.4.1 Impacts from Fiber Optic Cables and Guidance Wires

Fiber optic cables and guidance wires are used in several different training and testing activities. For a list of Navy activities that involve the use of cables and guidance wires, refer to Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires). A sea turtle that becomes entangled in nets, lines, ropes, or other foreign objects under water may suffer only a temporary hindrance to movement before it frees itself. The turtle may suffer minor injuries but recover fully, or it may die as a result of the entanglement. Because of the physical characteristics of guidance wires and fiber optic cables, detailed in Section 3.0.5.3.4 (Entanglement Stressors), these items pose a potential, although unlikely, entanglement risk to sea turtles. The Navy analyzed the potential for entanglement of sea turtles by guidance wires and concluded that the potential for entanglement is low. For instance, the physical characteristics of the fiber optic material render the cable brittle and easily broken when kinked, twisted, or bent sharply (i.e., to a radius greater than 360 degrees). Thus, the fiber optic cable would not loop, greatly reducing or eliminating any potential issues of entanglement with regard to marine life. In addition, based on degradation times, the guidance wires would break down within 1–2 years and therefore no longer pose an entanglement risk.

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. However, the leatherback is known to forage on jellyfish at or near the surface, rather than at depth.

3.5.3.4.1.1 No Action Alternative

Training Activities

Offshore Area

Table 3.5-1 lists the number and locations of activities that expend fiber optic cables and guidance wires. Only two events occur annually under the No Action Alternative that expend guidance wires, and those occur during SINKEX activities in the Offshore Area. Leatherback sea turtles can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. Leatherback sea turtles that occur in the Offshore Area of the Study Area could at some point encounter expended cables or wires.

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 of: (1) the number of cables and wires expended being 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.

Within the Study Area, critical habitat has been designated in the marine environment for the leatherback sea turtle. There is one PCE essential for the conservation of leatherbacks in the marine waters of the U.S. west coast: the occurrence of prey species. Activities involving fiber optic cables and guidance wires are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of prey species at the population level.

Pursuant to 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 leatherback sea turtles.

Pursuant to the ESA, the use of cables and wires during training activities as proposed under the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

Table 3.5-1 lists the number and locations of activities that expend fiber optic cables and guidance wires. Leatherback sea turtles in the Study Area could at some point encounter expended cables or wires. 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 cables or wires 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 of: (1) the number of cables and wires expended being relatively low, with only 16 events annually utilizing cables or wires in the Offshore Area, 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. Activities involving fiber optic cables and guidance wires are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of prey species at the population level.

Pursuant to 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 leatherback sea turtles.

Pursuant to the ESA, the use of cables and wires during testing activities as proposed under the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

3.5.3.4.1.2 Alternative 1

Training Activities

Table 3.5-1 lists the number and locations of activities that expend fiber optic cables and guidance wires. No training events occur under Alternative 1 that expend fiber optic cables or guidance wires. Therefore, the decrease in activities presented in Alternative 1 eliminates the risk of exposing sea turtles to cables and wires.

Testing Activities

Offshore Area

The number and location of testing activities under Alternative 1 increases slightly, from 16 activities under the No Action Alternative to 20 activities (see Table 3.5-1). However, cables and wires are generally not expected to cause disturbance to sea turtles because of: (1) the number of cables and wires expended being relatively low, with only 20 events annually utilizing cables or wires in the Offshore Area, decreasing the likelihood of encounter; (2) the physical characteristics of the cables and wire; and (3) the behavior of the species, as sea turtles are unlikely to become entangled in an object that is resting on the seafloor. Exposure to cables and wires is not expected to result in population-level impacts.

Pursuant to the ESA, the use of cables and wires during testing activities as proposed under Alternative 1 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of cables and wires during testing activities as proposed under Alternative 1 would have no effect on leatherback sea turtle critical habitat.

3.5.3.4.1.3 Alternative 2

Training Activities

Table 3.5-1 lists the number and locations of activities that expend fiber optic cables and guidance wires. No training events occur under Alternative 2 that expend fiber optic cables or guidance wires. Therefore, the decrease in activities presented in Alternative 2 eliminates the risk of exposing sea turtles to cables and wires.

Testing Activities

Offshore Area

The number and location of testing activities under Alternative 2 increases slightly, from 16 activities under the No Action Alternative to 24 activities (see Table 3.5-1). However, cables and wires are generally not expected to cause disturbance to sea turtles because of: (1) the number of cables and wires expended being relatively low, with only 24 events annually utilizing cables or wires in the Offshore Area, decreasing the likelihood of encounter; (2) the physical characteristics of the cables and wires; and (3) the behavior of the species, as sea turtles are unlikely to become entangled in an object that is resting on the seafloor. Exposure to cables and wires is not expected to result in population-level impacts.

Pursuant to the ESA, the use of cables and wires during testing activities as proposed under Alternative 2 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of cables and wires during testing activities as proposed under Alternative 2 would have no effect on leatherback sea turtle critical habitat.

3.5.3.4.2 Impacts from Decelerator/Parachutes

Sonobuoys, lightweight torpedoes, targets, and other devices deployed by aircraft use nylon decelerator/parachutes of various sizes. Aircraft-launched sonobuoys, lightweight torpedoes (such as the MK 46 and MK 54), illumination flares, and targets use nylon decelerator/parachutes ranging in size from 18 to 48 in. (46 to 122 centimeters [cm]) in diameter. The majority of expended parachutes are cruciform decelerators associated with sonobuoys, which are relatively small (see Figure 3.0 5), and have short attachment lines. Decelerator/parachutes are made of cloth and nylon, and many have weights attached to the lines for rapid sinking. At water impact, the decelerator/parachute assembly is expended, and it sinks away from the unit. The decelerator/parachute assembly may remain at the surface for 5–15 seconds before the decelerator/parachute and its housing sink to the seafloor, where it becomes flattened. Some decelerator/parachutes are weighted with metal clips that facilitate their descent to the seafloor. Once settled on the bottom, the canopy may temporarily billow if bottom currents are present. Conversely, it could settle to the bottom, where it would be buried by sediment in most softbottom areas. Decelerator/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 decelerator/parachute, and swim into the decelerator/parachute or its lines.

While in the water column, a sea turtle is less likely to become entangled because the decelerator/parachute would have to land directly on the turtle, or the turtle would have to swim into the decelerator/parachute before it sank. If the decelerator/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. However, the leatherback is known to forage on jellyfish at or near the surface, rather than at depth. Decelerators/parachutes may resemble jellyfish and are addressed below. However, the potential for a sea turtle to encounter an expended decelerator/parachute at the surface or in the water column is extremely low given the general improbability of a sea turtle being near the deployed decelerator/parachute.

3.5.3.4.2.1 No Action Alternative

<u>Training Activities</u>

Offshore Area

Under the No Action Alternative, activities that involve air-dropped sonobuoys, torpedoes, or targets (and therefore the expending of unrecoverable decelerator/parachutes) include tracking and torpedo exercises involving helicopter platforms and fixed-wing aircraft. Under the No Action Alternative, 8,382 decelerator/parachutes would be expended during training activities (see Table 3.5-1). These decelerator/parachutes would be expended in the Study Area. Leatherback sea turtles can occur at or near the surface in open-ocean areas, whether feeding or periodically surfacing to breathe. Leatherback sea turtles that occur in the Offshore Area of the Study Area could at some point encounter decelerator/parachutes.

These exercises are widely dispersed in open ocean habitats, however, where sea turtles are lower in abundance. Furthermore, entanglement of a sea turtle in a decelerator/parachute assembly is unlikely because the decelerator/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 decelerator/parachute on the ocean floor. The potential for sea turtles to encounter an expended decelerator/parachute assembly is extremely low, given the low densities of leatherback sea turtles present in the Offshore Area, the unlikely event of a sea turtle being at the exact point where the decelerator/parachute lands, and the negative buoyancy of decelerator/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 leatherback is known to forage on jellyfish at or near the surface and thus the potential for a sea turtle encountering a decelerator/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 decelerator/parachute assemblies is considered to be highly unlikely. If a sea turtle became entangled in a decelerator/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.

Activities involving decelerator/parachutes are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of prey species at the population level.

Pursuant to the ESA, the use of decelerator/parachutes during training activities as proposed under the No Action Alternative may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of decelerator/parachutes during training activities as proposed under the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

Under the No Action Alternative, only 17 decelerator/parachutes would be expended during testing activities (see Table 3.5-1). These would be expended in the Quinault Range Site. The leatherback sea turtle can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe.

As stated above, the entanglement of sea turtles in decelerator/parachute assemblies is considered to be highly unlikely. If a sea turtle became entangled in a decelerator/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.

Activities involving decelerator/parachutes are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of prey species at the population level.

Pursuant to the ESA, the use of decelerator/parachutes during testing activities as proposed under the No Action Alternative may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of decelerator/parachutes during testing activities as proposed under the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

3.5.3.4.2.2 Alternative 1

Training Activities

The number and location of training activities under Alternative 1 are identical to those of training activities under the No Action Alternative. Therefore, impacts of Alternative 1 will also be identical to those described in the No Action Alternative.

Pursuant to the ESA, the use of decelerator/parachutes during training activities as proposed under Alternative 1 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of decelerator/parachutes during training activities as proposed under Alternative 1 would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

Under Alternative 1, up to 1,229 decelerator/parachutes would be expended throughout the Study Area (see Table 3.5-1), with approximately 99 percent of them being expended in the Offshore Area of the Study Area.

The increase in expended decelerator/parachutes would increase the risk of a leatherback sea turtle entanglement. These exercises are widely dispersed in open ocean habitats, however, where the turtles are lower in abundance. The potential for a leatherback sea turtle to encounter an expended decelerator/parachute assembly is extremely low, given the generally low probability of a sea turtle being at the exact point where the decelerator/parachute lands, and the negative buoyancy of decelerator/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 leatherback is known to forage on jellyfish at or near the surface and thus the probability of a sea turtle encountering a decelerator/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 leatherback sea turtles in decelerator/parachute assemblies is considered to be highly unlikely. If a turtle became entangled in a decelerator/parachute assembly, however, the turtle would suffer a temporary or permanent impairment of normal activities. Impairment of some activities (e.g., foraging) could indirectly result in mortality while impairment of other activities (e.g., migration) could impair reproduction.

Pursuant to the ESA, the use of decelerator/parachutes during testing activities as proposed under Alternative 1 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of decelerator/parachutes during testing activities as proposed under Alternative 1 would have no effect on leatherback sea turtle critical habitat.

3.5.3.4.2.3 Alternative 2

Training Activities

The number and location of training activities under Alternative 2 are identical to those of training activities under the No Action Alternative. Therefore, impacts of Alternative 2 will also be identical to those described in the No Action Alternative.

Pursuant to the ESA, the use of decelerator/parachutes during training activities as proposed under Alternative 2 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of decelerator/parachutes during training activities as proposed under Alternative 2 may would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

Under Alternative 2, up to 1,351 decelerator/parachutes would be expended throughout the Study Area (see Table 3.5-1), with approximately 80 percent of them being expended in the Offshore Area of the Study Area.

The net increase in exercises that would expend decelerator/parachutes would increase the risk of entangling leatherback sea turtles. These exercises are widely dispersed in open ocean habitats, however, where sea turtles are lower in abundance. The potential for leatherback sea turtles to encounter an expended decelerator/parachute assembly is extremely low, given the generally low probability of a sea turtle being at the exact point where the decelerator/parachute lands, and the negative buoyancy of decelerator/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 leatherback is known to forage on jellyfish at or near the surface and thus the probability of a sea turtle encountering a decelerator/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 decelerator/parachute assemblies is considered to be highly unlikely. If a sea turtle became entangled in a decelerator/parachute assembly, however, the sea turtle would suffer a temporary or permanent impairment of normal activities. Impairment of some activities (e.g., foraging) could indirectly result in mortality while impairment of other activities (e.g., migration) could impair reproduction.

Pursuant to the ESA, the use of decelerator/parachutes during testing activities as proposed under Alternative 2 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of decelerator/parachutes during testing activities as proposed under Alternative 2 would have no effect on leatherback sea turtle critical habitat.

3.5.3.5 Ingestion Stressors

This section analyzes the potential ingestion impacts of expended materials used by the Navy during training and testing activities within the Study Area. The Navy expends the following types of materials that could become ingestion stressors during training and testing in the Study Area: (1) non-explosive practice munitions (small- and medium-caliber) and fragments from high-explosives, and (2) military expended materials other than munitions (including decelerator/parachutes and fragments from targets, chaff, and flares). Other military expended materials such as targets, large-caliber projectiles, intact training and testing bombs, guidance wires, 55-gallon drums, sonobuoy tubes, and marine markers are too large for marine organisms to consume and are eliminated from further discussion.

Sea turtles could ingest expended materials at the surface, in the water column, or at the seafloor, depending on the size and buoyancy of the expended object. 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). 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 sublethal 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.

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 3.0.5.3.5 (Ingestion Stressors).

3.5.3.5.1 Impacts from Munitions

Types of non-explosive practice munitions generally include projectiles, missiles, and bombs. Of these items, only small- or medium-caliber projectiles would be small enough for a sea turtle to ingest. Small- and medium-caliber projectiles include all sizes up to and including 2.25 in. (57 millimeters [mm]) in diameter. These solid metal materials would quickly move through the water column and settle to the seafloor. Ingestion of non-explosive practice munitions is not expected to occur in the water column because the ordnance sinks quickly. The types, numbers, and locations of activities using these devices under each alternative are discussed in Section 3.0.5.3.3.3 (Military Expended Material).

There are no testing activities that expend small- and medium-caliber projectiles or expend fragments of high-explosive ordnance and munitions under any Alternative. Therefore, there are no associated impacts on leatherback sea turtles in the Study Area.

3.5.3.5.1.1 No Action Alternative

Training Activities

Offshore Area

Table 3.5-1, Table 3.0-20, and Table 3.0-21 list the number and location of small- and medium-caliber projectiles and activities that expend fragments of high-explosive ordnance and munitions (e.g., demolition charges, grenades, bombs, missiles, and rockets). Under the No Action Alternative, the areas with the greatest amount of small- and medium-caliber projectiles would occur within the Offshore Area of the Study Area. The leatherback is known to forage on jellyfish at or near the surface and thus the probability of a sea turtle encountering munitions would be restricted to the brief time the munition is at the water surface or sinking through the water column.

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 leatherback 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.

Munitions used in training activities are generally not expected to cause disturbance to sea turtles because: (1) leatherback sea turtles are not expected to encounter most small- and medium-caliber projectiles or high-explosive fragments on the seafloor because the depth at which these would sink to would be greater than the foraging depths of the leatherback; 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. Further, jellyfish, the sea turtle's preferred prey, are filter feeders and would not ingest expended materials. Thus, the critical habitat PCEs would not be impacted from expended materials.

Pursuant to the ESA, the use of materials of ingestible size during training activities under the No Action Alternative size would have no effect on leatherback sea turtles.

Pursuant to the ESA, the use of materials of ingestible size during training activities under the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

3.5.3.5.1.2 Alternative 1

Training

Offshore Area

The number and location of training activities under Alternative 1 decreases from training activities by less than 1 percent under the No Action Alternative (see Table 3.5-1). Therefore, impacts of Alternative 1 will also be identical, as those described for the No Action Alternative.

Pursuant to the ESA, the use of materials of materials of ingestible size would have no effect on leatherback sea turtles.

Pursuant to the ESA, the use of materials of ingestible size during training activities under Alternative 1 would have no effect on leatherback sea turtle critical habitat.

3.5.3.5.1.3 Alternative 2

Training

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

Pursuant to the ESA, the use of materials of ingestible size would have no effect on leatherback sea turtles.

Pursuant to the ESA, the use of materials of ingestible size during training activities under Alternative 2 would have no effect on leatherback sea turtle critical habitat.

3.5.3.5.2 Impacts from Military Expended Materials Other than Munitions

Decelerator/parachutes and fragments of targets, chaff, and flare casings 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.

3.5.3.5.2.1 No Action Alternative

<u>Training Activities</u>

Offshore Area

Under the No Action Alternative, 8,382 decelerators/parachutes would be expended in the Study Area during training activities. The decelerators/parachutes sink, so they are not expected to drift into another portion of the Study Area. Because of the rapid sink rate of the decelerator/parachute, the likelihood of a leatherback encountering and ingesting a decelerator/parachute is extremely low.

Under the No Action Alternative, 184 flares would be expended annually in the Study Area during training activities, all within the Offshore Area (see Table 3.0-28). The flare consists of a cylindrical cartridge 1.4 in. in diameter and 5.8 in. long. Flare components that may be ingested include plastic end caps and pistons, which may float in the water column for some period. For estimation purposes, the Offshore Area includes the 121,614 square nautical miles (nm^2) of surface/subsurface ocean off the coast of Washington, Oregon, and northern California, which equates to less than one cartridge per 661 square meters. The likelihood of a sea turtle encountering and ingesting an end cap anywhere in the Study Area is very low.

Under the No Action Alternative, 2,900 events releasing chaff cartridges would be expended by ships and aircraft during training activities (see Table 3.0-27). Chaff consists of reflective, aluminum-coated glass fibers used to obscure ships and aircraft from radar guided systems and is a very light material, similar to fine human hair. 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. Additionally, due to the low number of events used in the Offshore Area, the likelihood of a sea turtle encountering chaff is extremely low.

Though the potential for encounter with military expended materials other than munitions is inherently low due to the low numbers of leatherback sea turtles anticipated in 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 leatherback 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 military expended materials other than munitions 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 most materials on the seafloor because of the depth at which these would be expended would be greater than the foraging depth of the leatherback; (2) in some cases, a turtle would likely pass the object through its digestive tract and expel the item without impacting the individual; and (3) there is a low probability of encounter anywhere in the OPAREA due to low numbers of leatherback sea turtles anticipated to be present. Exposure to military expended materials other than munitions is not expected to result in population-level impacts. Further, jellyfish, the sea turtle's preferred prey, are filter feeders and would not ingest expended materials. Thus, the critical habitat PCE would not be impacted from expended materials.

Pursuant to the ESA, the use of military expended materials other than munitions of ingestible size utilized during training activities under the No Action Alternative may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of military expended materials other than munitions of ingestible size utilized during training activities under the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

Under the No Action Alternative, 17 decelerators/parachutes would be expended annually in the Offshore Area of the Study Area during testing activities (see Table 3.5-1). The decelerators/parachutes sink, so they are not expected to drift into another portion of the Study Area. Because of the low number of decelerator/parachutes expended in the open ocean and the rapid sink rate of the decelerator/parachute, the likelihood of a leatherback sea turtle encountering and ingesting a decelerator/parachute is extremely low.

During torpedo testing activities (in which the torpedoes themselves are recovered), aluminum doors, 36 lb. (16 kg) lead dropper weights (for buoyancy), and stainless steel suspension bands may be released and not recovered. During heavyweight torpedo tests, 0.04 in. (1 mm) diameter plastic-coated copper guidance wire and flex hoses may also be released. During aircraft tests of lightweight torpedoes, decelerator/parachutes may also be expended. Concrete anchor clumps (some with attached line); sandbag anchors and attached line; torpedo fragments; countermeasures; and expendable bathymetric thermographs with uncoated copper wire are used and expended during ASW tests and mine tests. Certain fleet activities and deployment system tests can result in the use of marine location markers, nose caps, and release wires. As presented in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), the majority of these materials are all relatively large and would not present an ingestion risk. However, some torpedo fragments or nose caps could present an ingestion risk, if encountered at the surface or while sinking through the water column.

The probability of encounter with these materials would be low. It is not anticipated that encounter rates with sea turtles will be more than a rare event, as the total range area is approximately 2,039 nm^2, which would equate to less than one item per 6.2 nm^2.

Though the potential for encounter with military expended materials other than munitions is inherently low due to the low numbers of leatherback sea turtles anticipated in the Study Area, 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 leatherback 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 military expended materials other than munitions 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) leatherback sea turtles are not expected to encounter most materials on the seafloor because of the depth at which these would be expended in comparison with their foraging depth; (2) in some cases, a turtle would likely pass the object through its digestive tract and expel the item without impacting the individual; and (3) there is a low probability of encounter anywhere in the Offshore Area due to low numbers of leatherback sea turtles anticipated to be present. Exposure to military expended materials other than munitions is not expected to result in population-level impacts. Further, jellyfish, the sea turtle's preferred prey, are filter feeders and would not ingest expended materials. Thus, the critical habitat PCE would not be impacted from expended materials.

Pursuant to the ESA, the use of military expended materials other than munitions of ingestible size utilized during testing activities under the No Action Alternative may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of military expended materials other than munitions of ingestible size utilized during testing activities under the No Action Alternative would have no effect on leatherback sea turtle critical habitat.

3.5.3.5.2.2 Alternative 1

Training Activities

Offshore Area

Under Alternative 1, the same number decelerator/parachute as expended under the No Action Alternative would be deployed, also entirely within the Offshore Area. Because of the low number expended in the open ocean and the rapid sink rate of decelerator/parachutes, the likelihood of a sea turtle encountering and ingesting a decelerator/parachute is extremely low.

Under Alternative 1, the number of flares would increase slightly as compared to the No Action Alternative; 224 flares would be expended annually in the Study Area during training activities, all within the Offshore Area (see Table 3.0-28). The distribution of the flares would continue to be over a large area, which equates to less than one cartridge per 543 nm^2. The likelihood of a leatherback sea turtle encountering and ingesting an end cap anywhere in the Study Area is very low.

Under Alternative 1, the number of events using chaff would increase as compared to the No Action Alternative; 5,000 events releasing chaff cartridges would be expended by ships and aircraft during training activities (see Table 3.0-27). Although these fibers are too small for leatherback 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 turtles, due to the low concentration that would be ingested and the small size of the fibers. Additionally, due to the low number of events used in the Offshore Area, the likelihood of a leatherback sea turtle encountering chaff is extremely low.

Leatherback sea turtles could be exposed to decelerator/parachutes, target materials, chaff, or flares in the areas listed above, but given the very low probability of species encountering and ingesting materials at the surface, these exposure rates would likely be extremely low. 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 decelerator/parachutes, target materials, and flares; however, the expected impact on any exposed sea turtle would remain the same. For the same reasons stated for the No Action Alternative, 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. Exposure to military expended materials other than munitions 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 most materials on the seafloor because of the depth at which these would be expended is greater than the leatherback's foraging depths; (2) in some cases, a turtle would likely pass the object through its digestive tract and expel the item without impacting the individual; and (3) there is a low probability of encounter anywhere in the OPAREA due to low numbers of sea turtles anticipated to be present. Exposure to military expended materials other than munitions is not expected to result in population-level impacts. Further, jellyfish, the sea turtle's preferred prey, are filter feeders and would not ingest expended materials. Thus, the critical habitat PCEs would not be impacted from expended materials.

Pursuant to the ESA, the use of materials of ingestible size used during training activities under Alternative 1 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of materials of ingestible size used during training activities under Alternative 1 would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

Under Alternative 1, the number of expended materials is expected to increase from 421 under the No Action Alternative to 565 (see Table 3.5-1). The number of decelerator/parachutes expended annually would also increase, from 17 to 1,229. However, the encounter rates of decelerator/parachutes will remain quite low, and the potential for impacts on leatherback sea turtles would remain the same as for the No Action Alternative.

In comparison to the No Action Alternative, the increase in testing activities under Alternative 1 would increase the risk of leatherback sea turtles being exposed to decelerator/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), 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. Exposure to munitions is not expected to result in population-level impacts. Further, jellyfish, the sea turtle's preferred prey, are filter feeders and would not ingest expended materials. Thus, the critical habitat PCEs would not be impacted from expended materials.

Pursuant to the ESA, the use of materials of ingestible size used during testing activities under Alternative 1 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of materials of ingestible size used during testing activities under Alternative 1 would have no effect on leatherback sea turtle critical habitat.

3.5.3.5.2.3 Alternative 2

Training Activities

Offshore Area

The number and location of training activities under Alternative 2 are identical to those of training activities under Alternative 1. Therefore, impacts of Alternative 2 will also be identical to those described in Alternative 1.

In comparison to the No Action Alternative, the increase in testing activities under Alternative 2 would increase the risk of leatherback sea turtles being exposed to decelerator/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), 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. Exposure to munitions is not expected to result in population-level impacts. Further, jellyfish, the sea turtle’s preferred prey, are filter feeders and would not ingest expended materials. Thus, the critical habitat PCEs would not be impacted from expended materials.

Pursuant to the ESA, the use of materials of ingestible size used during training activities under Alternative 2 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of materials of ingestible size used during training activities under Alternative 2 would have no effect on leatherback sea turtle critical habitat.

Testing Activities

Offshore Area

Under Alternative 1, the number of expended materials is expected to remain the same as that for the No Action Alternative, with the exception being an increase in decelerator/parachute use in the Offshore Area. The number of decelerator/parachutes expended annually would increase from 17 to 1,351. However, the encounter rates of decelerator/parachutes will remain quite low, and the potential for impacts on leatherback sea turtles would remain the same as for the No Action Alternative.

In comparison to the No Action Alternative, the increase in testing activities under Alternative 2 would increase the risk of leatherback sea turtles being exposed to decelerator/parachutes, target materials, chaff, and flares; however, the expected impact on any exposed sea turtle remains the same. For the same reasons stated for the No Action Alternative, 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. Exposure to munitions is not expected to result in population-level impacts. Further, jellyfish, the sea turtle’s preferred prey, are filter feeders and would not ingest expended materials. Thus, the critical habitat PCEs would not be impacted from expended materials.

Pursuant to the ESA, the use of materials of ingestible size used during testing activities under Alternative 2 may affect, but is not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, the use of materials of ingestible size used during testing activities under Alternative 2 would have no effect on leatherback sea turtle critical habitat.

3.5.3.6 Secondary Stressors

This section analyzes potential impacts on sea turtles exposed to stressors indirectly through effects on habitat, sediment, or water quality. Secondary effects on sea turtles via sediment or water (not by trophic transfer—e.g., bioaccumulation) are considered here. The terms "indirect" and "secondary" do not imply reduced severity of environmental consequences, but instead describe *how* the impact may occur to an organism.

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 explosions and by-products, metals, chemicals, and impacts on habitat, and their potential impacts are discussed in Section 3.1 (Sediments and Water Quality) and Section 3.3 (Marine Habitats).

3.5.3.6.1 Offshore Area

Explosions

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. 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 leatherback 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.

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. Leatherback 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 (RDX), 98 percent of the products are common seawater constituents and the remainder is rapidly diluted below threshold effect level (see Section 3.1, Sediments and Water Quality). Explosion by-products from high-order detonations present no secondary stressors to leatherback sea turtles through sediment or water. However, low-order detonations and unexploded ordnance could have an impact on leatherback sea turtles.

Secondary effects of explosives and unexploded ordnance on leatherback sea turtles via sediment are possible near the ordnance. Degradation of explosives proceeds via several pathways discussed in Section 3.1 (Sediments and Water Quality). Degradation products of RDX 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 6–12 in. (15.2–30.5 cm) away from degrading ordnance, concentrations of these compounds were not statistically distinguishable from background beyond 3–6 ft. (0.9–1.8 m) from the degrading ordnance. Various lifestages of turtles could be impacted by the indirect effects of degrading explosives within a small radius of the explosive (1–6 ft. [0.3–1.8 m]).

Metals

Metals are introduced into seawater and sediments by training and testing activities involving vessel hulks, targets, ordnance, munitions, and other military expended materials (see Section 3.1, Sediments and Water Quality). 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 leatherback sea turtles via sediment and water involve concentrations several orders of magnitude lower than concentrations achieved via bioaccumulation. 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.

Chemicals

Several Navy training and testing activities introduce potentially harmful chemicals into the marine environment; principally, flares and propellants for rockets, missiles, and torpedoes. Polychlorinated biphenyls (PCBs) are discussed in Section 3.1 (Sediments and Water Quality). 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 SINKEXs are selected from a list of Navy-approved vessels that have been cleaned in accordance with U.S. Environmental Protection Agency 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 leatherback sea turtles via sediment. In contrast, the principal toxic components of torpedo fuel, propylene glycol dinitrate, and nitrodiphenylamine adsorb to sediments, have relatively low toxicity, and are readily degraded by biological processes. Various lifestages of sea turtles could be indirectly impacted by propellants via sediment near the object (e.g., within a few inches), but these potential effects would diminish rapidly as the propellant degrades.

Pursuant to the ESA, secondary stressors resulting from training and testing activities as described under the No Action Alternative, Alternative 1, and Alternative 2 may affect, but are not likely to adversely affect leatherback sea turtles.

Pursuant to the ESA, secondary stressors resulting from training and testing activities as described under the No Action Alternative, Alternative 1, and Alternative 2 would have no effect on leatherback sea turtle critical habitat.

3.5.3.7 Summary of Impacts on Sea Turtles

3.5.3.7.1 Combined Impacts of All Stressors

As described in Section 3.0.5.5 (Resource-Specific Impacts Analysis for Multiple Stressors), this section evaluates the 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 3.5.3.7.2 (Endangered Species Act Determinations).

There are generally two ways that a leatherback 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 explosions 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 leatherback 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 SINKEX or composite training unit exercise).

Secondly, an individual leatherback 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., routine activity locations) and in areas that individual 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 leatherback 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, leatherback 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. 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 (Standard Operating Procedures, Mitigation, and Monitoring). The potential impacts of the Proposed Action are summarized in Section 3.5.3.7.2 (Endangered Species Act Determinations) with respect to the ESA.

3.5.3.7.2 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 and no turtles have nesting beaches within the Study Area, consultation with U.S. Fish and Wildlife Service is not required for sea turtles. Table 3.5-8 summarizes the Navy's determination of effect on ESA-listed sea turtles for the Preferred Alternative.

Table 3.5-8: Summary of Effects and Impact Conclusions for the Preferred Alternative: Leatherback Sea Turtles in the Offshore Areas of the Northwest Training and Testing Study Area

Stressor		Leatherback Sea Turtle
Acoustic Stressors		
Sonar and Other Active Acoustic Sources	Training Activities	No Effect
	Testing Activities	May Affect, Likely To Adversely Affect
Explosions	Training Activities	May Affect, Not Likely To Adversely Affect
	Testing Activities	May Affect, Not Likely To Adversely Affect
Weapons Firing, Launch, and Impact Noise	Training Activities	May Affect, Not Likely To Adversely Affect
	Testing Activities	No Effect
Vessel and Aircraft Noise	Training Activities	May Affect, Not Likely To Adversely Affect
	Testing Activities	May Affect, Not Likely To Adversely Affect
Energy Stressors		
Electromagnetic Devices	Training Activities	No Effect
	Testing Activities	No Effect
Physical Disturbance and Strike		
Vessels	Training Activities	May Affect, Likely To Adversely Affect
	Testing Activities	May Affect, Likely To Adversely Affect
In-Water Devices	Training Activities	May Affect, Not Likely To Adversely Affect
	Testing Activities	May Affect, Not Likely To Adversely Affect
Military Expended Materials	Training Activities	May Affect, Not Likely To Adversely Affect
	Testing Activities	May Affect, Not Likely To Adversely Affect
Seafloor Devices	Training Activities	May Affect, Not Likely to Adversely Affect
	Testing Activities	May Affect, Not Likely to Adversely Affect

Table 3.5-8: Summary of Effects and Impact Conclusions for the Preferred Alternative: Leatherback Sea Turtles in the Offshore Areas of the Northwest Training and Testing Study Area (continued)

Stressor		Leatherback Sea Turtle
Entanglement Stressors		
Cables and Wires	Training Activities	May Affect, Not Likely To Adversely Affect
	Testing Activities	May Affect, Not Likely To Adversely Affect
Parachutes	Training Activities	May Affect, Not Likely To Adversely Affect
	Testing Activities	May Affect, Not Likely To Adversely Affect
Ingestion		
Munitions	Training Activities	No Effect
	Testing Activities	No Effect
Impacts from Military Expended Materials other than Munitions	Training Activities	May Affect, Not Likely To Adversely Affect
	Testing Activities	May Affect, Not Likely To Adversely Affect
Secondary Stressors		
Explosions	Training Activities	May Affect, Not Likely To Adversely Affect
	Testing Activities	May Affect, Not Likely To Adversely Affect
Explosion By-Products and Unexploded Ordnance	Training Activities	May Affect, Not Likely To Adversely Affect
	Testing Activities	May Affect, Not Likely To Adversely Affect
Metals	Training Activities	May Affect, Not Likely To Adversely Affect
	Testing Activities	May Affect, Not Likely To Adversely Affect
Chemicals	Training Activities	May Affect, Not Likely To Adversely Affect
	Testing Activities	May Affect, Not Likely To Adversely Affect

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