3.10 Sea Turtles

3.10 SEA TURTLES

3.10.1 Affected Environment

3.10.1.1 Introduction

3.10.1.1.1 Definition

Sea turtles are long-lived reptiles that can be found throughout the world's tropical, subtropical, and temperate seas (Caribbean Conservation Corporation and Sea Turtle Survival League 2003). There are seven living species of sea turtles from two distinct families: the Cheloniidae (hardshelled sea turtles; six species), and the Dermochelyidae (leatherback turtle; one species). These two families can be distinguished from one another on the basis of their carapace (upper shell) and other morphological features.

Over the last few centuries, sea turtle populations have declined dramatically due to anthropogenic (human-related) activities such as coastal development, oil exploration, commercial fishing, marine-based recreation, pollution, and overharvesting (Eckert 1995). As a result, all six species of sea turtles found in United States (U.S.) waters are listed as either threatened or endangered under the Endangered Species Act (ESA).

Sea turtles are highly adapted for life in the marine environment. Sea turtles possess powerful, modified forelimbs (or flippers) that enable them to swim continuously for extended periods of time (Wyneken 1997), unlike terrestrial and freshwater turtles. They also have compact and streamlined bodies that help to reduce drag. Additionally, sea turtles are among the longest and deepest diving of the air-breathing vertebrates, spending as little as 3 to 6 percent of their time at the water's surface (Lutcavage and Lutz 1997). Sea turtles often travel thousands of miles between their nesting beaches and feeding grounds, which makes their adaptations very important (Ernst et al. 1994; Meylan 1995).

Although they are specialized for life at sea, sea turtles begin their lives on land. Aside from this brief terrestrial period, which lasts approximately 8 to 10 weeks as eggs and an additional few minutes to a few hours as hatchlings scrambling to the surf, sea turtles are rarely encountered out of the water. Sexually mature females return to land in order to nest, while certain species in the Hawaiian Islands, Australia, and the Galapagos Islands haul-out on land in order to bask (Carr 1995; Spotila et al. 1997). Sea turtles bask to thermoregulate, elude predators, avoid mating; and possibly to accelerate the development of their eggs, accelerate their metabolism, and destroy aquatic algae growth on their carapaces (Whittow and Balazs 1982; Spotila et al. 1997).

Female sea turtles nest in tropical, subtropical, and warm-temperate latitudes, often in the same region or on the same beach where they hatched (Miller 1997). Upon selecting a suitable nesting beach, most sea turtles renest in proximity during subsequent nesting attempts. The leatherback turtle diverges from this pattern. This species nests primarily on beaches with little reef or rock offshore, where erosion reduces the probability of nest survival. To compensate, leatherbacks scatter their nests over larger geographic areas and lay, on average, two times as many clutches as other species (Eckert 1987).

Four species of sea turtles have been reported in the Southern California Bight (SCB) (National Marine Fisheries Service and U.S. Fish and Wildlife Service) [NMFS and USFWS] 1998a, 1998d, 1998e, 1998f). The east Pacific green sea turtle (*Chelonia mydas*), the loggerhead sea turtle (*Caretta caretta*), and the olive ridley sea turtle (*Lepodochelys olivacea*) are members of the family Cheloniidae; the leatherback sea turtle (*Dermochelys coriacea*) is the sole living species of the Dermochelidae family. None of the four species is known to nest on southern California beaches. Nesting by olive ridley turtles occurs along the Pacific coast of Baja California Sur, which is the northernmost known nesting site in the eastern north Pacific (Fritts et al. 1982; Sarti-M. et al. 1996; NMFS 1998f, López-Castro et al. 2000). Due to the oceanic distributions of the leatherback, loggerhead, and olive ridley turtles off southern California, the coastal waters of the Pacific Ocean are designated as an area of primary occurrence for all sea turtle species (NMFS 1998a, 1998 b, 1998c, 1998d, 1998e, 1998f), although their presence within southern California is considered rare, with the exception of south San Diego Bay.

The leatherback turtles found off the U.S. west coast migrate from the western north Pacific (Indochina and Papua New Guinea) or from eastern north Pacific nesting beaches (Central America and Mexico) and are predominantly a pelagic species that forages in productive coastal waters north of Point Conception, California or off the coast of Peru and Chile. Stinson (1984) has provided evidence that most of the leatherbacks in northern California and Oregon enter the coastal zone in July from offshore in association with the 13º to 15ºC isotherms. The arrival of these turtles is associated with the arrival and occurrence of the 18º to 20ºC isotherms not characteristic of the coastal regions near Silver Strand Training Complex (SSTC) during late spring and early summer when loggerhead turtles are found off the U.S. west coast migrating from nesting beaches in Japan.

This section discusses the east Pacific green, loggerhead, leatherback and olive ridley sea turtles for the purpose of comparing environmental consequences of the Proposed Action and alternatives.

3.10.1.1.2 Regional Setting

The offshore project area is part of the Pacific Ocean region referred to as the SCB. The colder, more northerly California Current and the southern, warm-water, California Counter Current influence the water of SCB. These two currents mix in the Santa Barbara Channel. The waters of the southern SCB are higher in temperature and salinity than those of the northern portion (Hickey 1993). These differing conditions, as well as upwelling of cooler, nutrient-rich waters, influence the unusually diverse marine biota within the SCB region (Murray and Littler 1981).

San Diego Bay is a naturally formed, crescent-shaped embayment. It is separated from the Pacific Ocean by the Silver Strand peninsula, a long, narrow sand spit, which extends from the City of Imperial Beach to North Island. From the mouth of Otay River to the tip of Point Loma, San Diego Bay is about 15 miles long.

3.10.1.1.3 Region of Influence

The only turtle found in San Diego Bay waters is the east Pacific green sea turtle (Macdonald et al. 1990). This species is found in warm waters throughout the world, where the turtles follow the 18°C isotherm temperatures in the ocean (Eckert 2002); San Diego Bay represents the one turtles' northernmost dwelling habitat. None of the four species of sea turtles reported along the west coast of the United States nest there. Nesting grounds are in Mexico, Central America, and various Pacific islands. Neither the loggerhead nor olive ridley sea turtle are expected to be present in San Diego Bay; but potentially, either species could occur offshore in extremely low numbers.

The marine region of Influence (ROI) can be partitioned into three zones: the bayside training zones within the San Diego Bay (sandy beaches, mudflats, and the nearshore environment); portions of the intertidal to nearshore (<0.5 nautical miles [nm]) ocean area off the southern beaches of Naval Air Station, North Island (NASNI); and the intertidal to nearshore (<3 nm) ocean area encompassing the training lanes at SSTC-N and SSTC-S, and ocean anchorages.

3.10.1.2 Threatened and Endangered Species

3.10.1.2.1 Loggerhead Sea Turtle

The loggerhead sea turtle is listed as threatened under the ESA, and the population appears to be declining. Loggerheads occur worldwide in tropical to temperate waters. Although they are rare in this area, they have been reported from Alaska to Chile, with thousands being seen off Baja California (Pitman 1990); they do not appear to nest in the eastern or central Pacific. Most loggerhead sightings were reported off Baja California, with the largest concentrations sited off the coast of Bahia Magdalena. Strandings and sightings along the west coast have been in southern California; although, a few sightings were reported off Washington (Hodge 1982). Due to their presence around the SCB, loggerheads could be expected to appear in the ROI.

Juvenile loggerheads have been reported year-round off southern California (Guess 1981a, b; Stinson 1984). These may represent the northern range limits of a much larger population of juveniles present off the west coast of Baja California (Pitman 1990). Both adults and juveniles are most often seen from July through September (Stinson 1984), although sightings are not common; in fact, adults are rarely seen. Sightings are more frequent during El Niño events, reflecting the preference that cheloniids have for warmer waters. During the period 1988 through 2008, six strandings of loggerhead turtles were reported in San Diego County, two were determined to be entrainment related, two marine debris related, and the remaining two were undetermined (NMFS 2009).

Loggerheads prey on benthic invertebrates; but fish and plants are also eaten. Juveniles off Baja California eat pelagic red crabs (*Pleuroncodes planipes*) (NMFS 1998e).

3.10.1.2.2 Olive Ridley Sea Turtle

The olive ridley sea turtle are globally listed as threatened under the ESA except for the Pacific coast of Mexico's breeding population, which is listed as endangered. The stock is declining, even though the olive ridley sea turtle is considered the most abundant sea turtle in the world. Clifton et al. (1982) estimated that the olive ridley Mexican breeding population off the Pacific coast of Mexico numbered over 10,000,000. Though the practice has been discontinued, in 1968 alone, over 1,000,000 olive ridleys were harvested in Mexico (Carr 1972).

The olive ridley sea turtle is found around the world in tropical to temperate waters. The usual range of the eastern Pacific olive ridley is from Baja California to Peru, within 1,200 nm of shore (NMFS 1998e). Stinson (1984) reported only ten sightings of this species north of Baja California (29º 45' N) and considered it rare off southern California. Juveniles have been reported offshore, while most sightings of adults and subadults are in water less than 165 feet deep off the coast. During the period 1988 through 2008, six strandings were reported in San Diego County, three were determined to be illness-related and the remaining three were undetermined (NMFS 2009). It would be rare, but possible to encounter olive ridley sea turtles in the ROI, and only in the warmest months.

Olive ridleys prey on benthic fish, mollusks, crustaceans, tunicates, and algae. Pelagic prey includes jellyfish, salps, and pelagic red crabs (NMFS 1998e).

3.10.1.2.3 Leatherback Turtle

The leatherback turtle was listed as endangered throughout its range in June 1970 (Federal Register Vol. 35 No. 106 pp 8491-8498). The leatherback is associated with continental shelf habitats and pelagic environments. It is uncommon in the insular Pacific, but individuals are sometimes encountered in deep water, near prominent archipelagoes (NMFS 1998d). To a large extent, the oceanic distribution of leatherbacks may reflect the distribution and abundance of macroplanktonic prey. (NMFS 1998d, NMFS

2007b). In response to a September 2007 petition to designated leatherback critical habitat off California and Oregon, NMFS determined the information presented in the petition warranted consideration of designation and will soon publish its proposed determination in the Federal Register.

The world leatherback turtle population is estimated at 35,860 females (Spotila 2004). Leatherbacks are seriously declining at all major Pacific basin rookeries. Nesting along the Pacific coast of Mexico declined at an annual rate of 22 percent over the last 12 years, and the Malaysian population represents one percent of the levels recorded in the 1950s (Dutton 2006).

The leatherback is the most widely distributed sea turtle, ranging far from its tropical and subtropical breeding grounds. It has the most extensive range of any adult, being found from 71ºN to 47ºS (Eckert, 1995). Leatherbacks are highly pelagic and approach coastal waters only during the reproductive season (EuroTurtle 2001). Postnesting adult leatherbacks appear to migrate along bathymetric contours from 650 to 11,500 ft (200 to 3,500 m) (Morreale et al. 1994), and most of the eastern Pacific nesting stocks migrate south (NMFS 2002).

The leatherback turtle is rare in the waters of southern California and sightings are infrequent within San Diego County or adjacent nearshore waters. During the period 1988 through 2008, nine strandings were reported in San Diego County, two were determined to be entrainment related, one fishery related and the remaining six were undetermined (NMFS 2009). It would be unlikely to encounter leatherback turtles, except in the offshore waters due to its preference for the pelagic habitat; and even then and encounter would likely only occur in July to September.

3.10.1.2.4 Pacific Green Sea Turtle

The green sea turtle is globally listed as threatened under the ESA, except for Florida's and the Pacific coast of Mexico's breeding population, which is listed as endangered. The worldwide population is estimated at 88,520 nesting females (Spotila 2004). Population estimates for the eastern Pacific region that includes the ROI are approximated because juvenile and male sea turtles do not come ashore, and are difficult to count. Population data are usually based on the numbers of adult females coming ashore to nest, but these numbers can be ambiguous: some females nest every two to three years, some may nest more than once on the same beach in a season, and some visit more than one nesting beach in a season. Researchers rely on the changing numbers of nesting females from year-to-year to determine population trends. Because broad year-to-year fluctuations in numbers of nesting females make short-term data misleading, surveys of a decade or less may be insufficient to determine a population trend (NMFS 2008).

Currently between 200 and 1,000 green sea turtles nest on beaches in the continental United States; no green sea turtles have been documented to nest on the west coast. Green sea turtles are capable of transoceanic migrations, but use coastal and open ocean waters within several hundred to one thousand kilometers of nesting grounds. In the eastern North Pacific, green turtles have been sighted from Baja California to southern Alaska, but most commonly occur from San Diego south (NMFS 2008).

Stinson (1984) reviewed sea turtle sighting records from northern Baja California to Alaska, and determined that the east Pacific green turtle was the most commonly observed hard-shelled sea turtle on the Pacific coast. Most of the sightings (62.0 percent) were reported from northern Baja California and southern California. The northernmost reported resident population occurs in San Diego Bay (Stinson 1984; Dutton and McDonald 1990a, 1990b, 1992; Dutton et al. 1987). Although green turtles are sighted throughout the year in the waters of southern California, the highest frequency of sightings occurred during the warm summer months of July through October (Stinson 1984). In waters south of Point Conception, Stinson (1984) found this seasonal sighting pattern to be independent of inter-year temperature fluctuations. North of Point Conception, more sightings occurred during warmer years. Green turtles appear to prefer waters that usually remain around 20°C in the coldest month. During warm spells, such as El Niño, green turtles may be found considerably north of their normal distribution. Stinson (1984) found green turtles to appear most frequently in U.S. coastal waters with temperatures exceeding 18°C. An east Pacific green turtle equipped with a satellite transmitter was tracked along the California coast and showed a distinct preference for waters with temperatures above 20°C (Eckert, unpublished data). The Green sea turtle is the most common sea turtle observed in the waters of Southern California but sightings remain rare within San Diego County or adjacent nearshore waters. During the period 1988 through 2008, 55 strandings were reported in San Diego County of which nine were determined to be related to boat collisions (NMFS 2009).

The two closest breeding populations to the ROI are located in Mexico: Isla Revillagigedos and Michoacan. Estimates from index calculations project there are 900 and 1400 individuals in each respective population. Green sea turtles are well documented at year-around feeding areas, such as those located on the west coast of Baja California, in the Gulf of California (Sea of Cortez), and along the coast of Oaxaca (NMFS 1998c). Green turtles primarily use three types of habitat: oceanic beaches (for nesting), convergence zones in the open-ocean, and benthic feeding grounds in coastal areas. Adult females migrate from foraging areas to mainland or island nesting beaches and may travel hundreds or thousands of kilometers each way. After emerging from the nest, hatchlings swim to offshore areas, where they live for several years, feeding close to the surface on a variety of pelagic plants and animals. Once the juveniles reach a certain age/size range, they leave the pelagic habitat and travel to nearshore foraging grounds. Once they move to these nearshore benthic habitats, adult green turtles are almost exclusively herbivores, feeding on sea grasses and algae (accessed online at: http://www.nmfs.noaa.gov/pr/species/ turtles/green.htm#habitat). The temperate waters off the Pacific coast of Mexico and California provide a wide variety of potential food sources, including several sea grasses and algae. Bahía de Los Angeles in the Gulf of California is an important foraging area for green turtles (Seminoff et al. 2003).

Green turtles dive shallower than 100 feet (Hochscheid et al. 1999, Hays et al. 2000); however, they have been observed at depths of 220 to 350 feet in the eastern Pacific Ocean (Berkson 1967). The maximum dive time recorded for a juvenile green turtle around the Hawaiian Islands is 66 minutes, with routine dives ranging from 9 to 23 minutes (Brill et al. 1995).

San Diego Bay

The only turtle found in ROI waters is the east Pacific green sea turtle (Macdonald et al. 1990), which is listed under ESA as endangered. This species is the same as the Atlantic green sea turtle; however, the Pacific stock has distinctive color morphology (Eckert 2002). Many scientists previously believed the green sea turtle was not a historical resident of San Diego Bay; now they have concluded that it may have naturally sought out San Diego Bay at least during the summer months (Macdonald et al. 1990; Eckert 2002 and Dutton 1998). In 1857, commercial activities brought sea turtles from Mexico and temporarily kept them in pens within San Diego Bay before being shipped north for sale in San Francisco (Stinson 1984). This practice continued for many decades; a photograph dated 1910 can be seen at the San Diego Maritime Museum showing stacks of sea turtles awaiting shipment piled up on a San Diego Bay wharf. Some of these turtles escaped and may have become inhabitants of San Diego Bay.

In the 1920s, San Diego Gas and Electric built a power plant on Broadway in downtown San Diego; and then added its Silvergate plant on the eastern shore of San Diego Bay in 1941 (Smith and Graham 1976). In 1951, as a product of the power plants' water cooling systems, discharged effluents were recorded up to 8°C warmer than the intake temperature (Terzich 1965). In 1960, San Diego Gas and Electric began operating a new, larger power plant in South San Diego Bay, expanding into additional units over the next several years. The addition of these plants, and the accompanying warm water discharges, unintentionally altered the San Diego Bay abiotic conditions to provide attractive year-around habitat for the warm water-seeking sea turtle.

The first report of sea turtles in this power plant's warm water discharge channel was made in 1968 as part of a study of the ecological effects of the discharge (Ford 1970). Water temperatures at the surface ranged from 35°C at the outfall to 28°C at the end of the 6,000 foot channel, compared to 28°C in central San Diego Bay (Ford et al. 1970).

Green turtles foraging in San Diego Bay and along the Pacific coast of Baja California originate primarily from rookeries of the Islas Revillagigedos (Dutton 2003). Both adults and juveniles have been sighted, with individuals seen throughout the summer and winter at the San Diego Gas and Electric channel, South San Diego Bay, and around Coronado Bridge, near a thick stand of eelgrass (Ford and Chambers 1973, Stinson 1984, Macdonald et al. 1990, Dutton and McDonald1992). Even in temperatures as cold as 14°C, turtles are actively swimming in San Diego Bay. They do not breed or nest in San Diego Bay, as they need undisturbed beaches for nesting (Macdonald et al. 1990)—those found along the coast of Mexico. Tagged individuals are known to return to San Diego Bay in subsequent years for unknown reasons (Stinson 1984). Residency time in San Diego Bay is unknown; turtles within the local population were satellite tagged and tracked back to Mexico breeding beaches; significant immigration and emigration is thought to occur. Based on the number of juveniles recently observed, there is some recruitment into the population (Dutton and McDonald1992), and according to Dutton (2003) the recruitment source is Isla Revillagigedos. Warm water El Niño events could stimulate an increase in migrations.

The resident population of east Pacific green sea turtles in San Diego Bay is approximately 30 to 60 individuals, increasing to nearly 100 during peak migratory time periods (DoN 2008); however, there is limited information about their movements or behavior. It is unknown how often they leave San Diego Bay or where they reside when they are outside the South San Diego Bay Power Plant channel. Female east Pacific green sea turtles are believed to migrate from San Diego Bay to nesting grounds in Mexico prior to nesting season; the remaining male adults and subadults continue to be present within San Diego Bay. Eelgrass beds, as well as associated algae and invertebrates known to be food for turtles, are extensive in the South and South Central San Diego Bay. Recent information on turtle foraging (Seminoff 2006) has broadened the general understanding of targeted food items as well as expanded the idea that adult green sea turtles are more omnivorous than previously thought. Resident turtles within the ROI may be utilizing invertebrates within deeper areas of San Diego Bay, in conjunction with eelgrass and algae as food sources.

Potential habitat for Pacific green sea turtles within San Diego Bay, and adjacent sandy beaches near Silver Strand and Imperial Beach—including the ROI—may be utilized during foraging, but are not considered suitable for nesting. Foraging by Pacific green sea turtles is concentrated to eelgrass beds and to lesser extent invertebrate communities in South and South Central bay, considering the concentration of the majority of habitat within those areas (see Figure 3.7-2). Potential foraging areas outside the bay associated with kelp beds or eelgrass are primarily located adjacent to the mouth of San Diego Bay (Zuniga Jetty) and north towards Point Loma. Silver Strand and Imperial Beach to the south contain ephemeral low density macroalgae communities, but are exposed to the dominant western wave action and long shore sand transport. Because very little is known about foraging patterns of resident Pacific green sea turtles within San Diego Bay, and the majority of sightings have been concentrated in the South Bay power plant channel, inferences about movement patterns remain conjecture.

An ongoing Navy/Port/National Oceanic and Atmospheric Administration (NOAA)-NMFS tracking effort is underway to determine the level of movement of the east Pacific green sea turtle within San Diego Bay. Approximately 18 turtles in San Diego Bay are tagged with devices that can be read by listening stations (hydrophones) in the water. The hydrophones are located in a two-stranded arc stretching from the southeast corner of SSTC-N to the north side of Delta South, surrounding the Enhancement Island. This double line functions as a gate. If a tagged turtle enters this area, a signature will be left on the hydrophones it passes—documenting where it entered the area and where it exited. This presence/absence determination will help guide planning for Navy actions and construction, as well as guide remediation studies. NOAA's objectives in the effort are to determine spatial and temporal population distributions, preferred habitat, and ingress and egress into San Diego Bay.

Ecological Role

Sea turtles are primarily herbivore grazers of marine algae and grasses. Previous studies concluded that during the day, San Diego Bay turtles reside in the deeper portion of the South San Diego Bay Power Plant warm water discharge channel, and at night feed on eelgrass beds in South San Diego Bay, such as Coronado Cays (Stinson 1984). Stomach content analysis revealed that the turtles eat red alga, eelgrass, and sea lettuce (*Ulva* sp.) within South San Diego Bay (Dutton and McDonald1992). Recent studies investigating daily movements and activity ranges of green turtles at Bahia de Los Angeles, a neritic foraging area, documented dispersal of turtles while resident at coastal foraging areas (Seminoff and Jones 2006). Data suggested that green turtles traversed large distances over limited temporal durations visiting multiple habitats. Contrary to previously perceived movement patterns, Seminoff and Jones (2006) found that in general, green turtles at Bahia de los Angeles moved throughout the diel cycle with greater distances covered during diurnal versus nocturnal periods.

While young turtles are carnivorous from hatchling until juvenile size and gradually becoming herbivorous, they have also been described as opportunistic feeders, eating jellyfish, ctenophores, bivalves, or gastropods if readily available (Eckert 2002). The warmer environment of the discharge channel appears to have stimulated growth rates in the turtles that are twice that of non-San Diego Bay turtles, possibly by increasing their digestive efficiency (Dutton and McDonald 1992). San Diego Bay is unique in the eastern Pacific as having the only thermal gradient where turtles can select their optimum space (Eckert 2002). The main, warm water effluent of the power plant has allowed the green sea turtle to remain in San Diego Bay during the normally cooler winter months. When temperatures rise in the channel, turtles disperse throughout San Diego Bay. When temperatures exceeded 29 to 32°C, which is approaching their lethal limit (Dutton 1992, 1993), no turtles were observed in the channel. Their crucial habitat zones in other parts of San Diego Bay in the warmer months are not known. Recent sightings in Seal Beach during winter in an embayed settling pond raised the question of the green turtles foraging and resident extent with respect to southern California (Schallmann 2009). In review, very little information is available on green sea turtles residing in San Diego Bay and to what extent they forage or transit within San Diego Bay.

The turtle has no natural predators in San Diego Bay. Mortalities tend to be caused by various natural and human induced causes including collisions with boats or ships (NMFS 2009). Unlike the Hawaiian stock, where tumors on green turtles are now epidemic in polluted waters, the San Diego Bay population has shown only a few individuals to have fibropapilloma tumors, which usually begin in the eye area (McDonald and Dutton 1990; Dutton 1998).

3.10.1.3 Regulatory Framework

Sea turtles present at SSTC are listed under ESA. Under ESA, Federal agencies are required to consult with NMFS on proposed Federal actions that "may affect" listed species or critical habitat. If a proposed Federal action may affect a listed species or designated critical habitat, formal consultation is required except when the Services concur that the proposed action "is not likely to adversely affect" listed species or designated critical habitat. [50 CFR 402.02, 50 CFR 402.13]. The Navy, based on the assessment provided below, believes that the proposed action on SSTC may affect but is not likely to adversely affect the federally listed turtle species found within SSTC. In accordance with ESA requirements, the Navy has completed informal consultation under Section 7 of the ESA with NMFS. NMFS has concurred that that with implementation of mitigation measures, the Proposed Action may affect, not likely to adversely affect, ESA-listed species and has signed a letter of concurrence on 19 November, 2010.

3.10.1.4 Current Mitigation Measures

Current procedures for monitoring sea turtles before and after underwater detonations are designed to prevent harm to these animals. There are numerous mitigation measures for very shallow water (VSW) underwater detonations on SSTC oceanside (0-24 feet):

1. Easily visible anchored floats will be positioned on a 1,200 foot or 400 yard radius of a roughly semi-circular zone (the shoreward half being bounded by shoreline and immediate off-shore water) around the detonation location for small explosive exercises at the SSTC. These mark the outer limits of the mitigation zone.
2. For each VSW underwater detonation event, a safety-boat with a minimum of one observer is launched 30 or more minutes prior to detonation and moves through the area around the detonation site. The task of the safety observer is to exclude humans from coming into the area and to augment a shore observer's visual search of the mitigation zone for sea turtles. The safety-boat observer is in constant radio communication with the exercise coordinator and shore observer discussed below.
3. A shore-based observer will also be deployed for VSW detonations in addition to boat based observers. The shore observer will indicate that the area is clear of marine mammals after 10 or more minutes of continuous observation with no sea turtles having been seen in the mitigation zone (1,200 feet or 400 yards) or moving toward it.
4. At least 10 minutes prior to the planned initiation of the detonation event-sequence, the shore observer, on an elevated on-shore position, begins a continuous visual search with binoculars of the mitigation zone. At this time, the safety-boat observer informs the shore observer if any sea turtle has been seen in the zone and, together, both search the surface within and beyond the mitigation zone for sea turtles.
5. The observers (boat and shore based) will indicate that the area is not clear any time a sea turtle is sited in the mitigation zone or moving toward it and, subsequently, indicate that the area is clear of sea turtles when the animal is out and moving away and no other sea turtles have been sited.
6. Initiation of the detonation sequence will only began on final receipt of an indication from the shore observer that the area is clear of sea turtles and will be postponed on receipt of an indication from that any observer that the area is not clear of sea turtles.
7. Following the detonation, visual monitoring of the mitigation zone continues for 30 minutes for the appearance of any sea turtle in the zone. Any sea turtles appearing in the area will be observed for signs of possible injury.
8. Any sea turtle observed after an underwater detonation training event either injured or exhibiting signs of distress will be reported to Navy environmental representatives from the regional Navy shore commander (Commander, Navy Region Southwest) and U.S. Pacific Fleet, Environmental Office, San Diego Detachment. The Navy will report these events to the Stranding Coordinator of NMFS' Southwest Regional Office using Marine Mammal Stranding communication trees and contact procedures established for the Southern California Range Complex. These voice or email reports will contain the date and time of the sighting, location (or if precise latitude and longitude is not currently available, then the approximate location in reference to an established SSTC beach feature), species description (if known), and indication of the animal's status.

There are similar mitigation measures for shallow water underwater detonations on SSTC oceanside (24-72 feet):

1. A mitigation zone of 1,500 feet or 500 yards will be established around each underwater detonation point. This mitigation zone is based on the maximum range to onset-TTS (either 23 psi or 182 dB).
2. A minimum of two boats, including but not limited to small zodiacs and 11-meter Rigid Hulled Inflatable Boats (RHIB) will be deployed. One boat will act as an observer platform, while the other boat is typically the diver support boat.
3. Two observers with binoculars on one small craft/boat will survey the detonation area and the mitigation zone for sea turtles from at least 30 minutes prior to commencement of the scheduled explosive event and until at least 30 minutes after detonation.
4. In addition to the dedicated observers, all divers and boat operators engaged in detonation events can potentially monitor the area immediately surrounding the point of detonation for sea turtles.
5. If a sea turtle is sighted within the 1,500 foot or 500 yard mitigation zone or moving towards it, underwater detonation events will be suspended until the sea turtle has voluntarily left the area and the area is clear of sea turtles for at least 30 minutes.
6. Immediately following the detonation, visual monitoring for sea turtles within the mitigation zone will continue for 30 minutes. Any sea turtle observed after an underwater detonation training event either injured or exhibiting signs of distress will be reported to Navy environmental representatives from the regional Navy shore commander (Commander, Navy Region Southwest) and U.S. Pacific Fleet, Environmental Office, San Diego Detachment. The Navy will report these events to the Stranding Coordinator of NMFS' Southwest Regional Office using Marine Mammal Stranding communication trees and contact procedures established for the Southern California Range Complex. These voice or email reports will contain the date and time of the sighting, location (or if precise latitude and longitude is not currently available, then the approximate location in reference to an established SSTC beach feature), species description (if known), and indication of the animal's status.

The conditions of the oceanside training areas at SSTC (Boat Lanes 1-14) and the existing mitigations in effect are expected to provide for reliable and effective mitigation of harm to infrequent and transitory sea turtles from underwater detonations. The physical topography of the VSW zone, low numbers of protected species in VSW, and training routines at SSTC allow for exceptionally reliable and effective mitigation procedures. Unlike typical circular pressure wave propagation, pressure-wave propagation in VSW (and thus mitigation zones), is restricted to a relatively small area and volume due to the nearby shoreline and shallow depth. The shoreline limits the zone to a rough semi-circle extending seaward about the point of detonation - i.e., the site has a field-of-search with a visual angle from the shore of less than 180 degrees. The beach slopes up from the waterline with an elevated on-shore position that provides a stable – i.e., unmoving - elevated height-of-eye for complete binocular-aided observation of the detonation area and sea-surface beyond 1,300 ft seaward of the detonation locations. Visual observation from the shore is combined with the observations of a safety boat operator moving through and beyond the mitigation area.

The following mitigation measures for the Elevated Causeway System (ELCAS) and pile driving activities incorporated the existing range procedures at SSTC and were consistent with existing training objectives and activities as well as established human safety procedures. In case of unanticipated conflict, human safety considerations take precedence and such conflicts are always used to make incremental improvements in the procedures used in subsequent activities. The Navy implements four mitigation measures for ELCAS activities performed at SSTC:

1. Buffer; Navy will monitor a 150 foot buffer zone surrounding temporary pile driving and removal activities for the presence of sea turtles before, during, and after pile removal activities. If sea turtles are found in the area, pile removal activities will be halted until the sea turtles have voluntarily left the ZOI. The buffer zone is based off of ZOIs calculated for marine mammals and is expected to be larger than that required for sea turtles.
2. Monitoring: Monitoring for sea turtles will take place concurrent with pile removal activities and 30 minutes prior to pile removal commencement. A trained observer will be placed on shore, on the ELCAS, or in a boat at the best vantage point(s) practicable to monitor for sea turtles and will implement shut–down/delay procedures when applicable by calling for shut–down to the hammer operator.
3. Soft Start: Providing additional protection for sea turtles, ELCAS pile driving includes a soft start as part of normal construction procedures. The pile driver increases impact strength as resistance goes up. At first, the pile driver piston drops a few inches. As resistance goes up, the pile driver piston will drop from a higher distance thus providing more impact due to gravity. This will allow sea turtles in the project area to vacate or begin vacating the area minimizing potential harassment. The ELCAS soft start is not the traditional soft-start used in bigger civilian construction projects, and doesn't include a waiting period (an initial set of several strikes from the impact hammer at 40-60 percent energy levels, followed by a one minute waiting period, then two subsequent 3 strike sets), but does provide additional time for sea turtles to vacate the area. Including waiting periods as part of training would be inconsistent with Navy training objectives that requires the ELCAS to be constructed as quickly as possible in real world conditions to ensure rapid supply of equipment and materials to shore in a hostile territory during wartime, or during humanitarian assistance operations.
4. Any sea turtle under observed after an underwater detonation or ELCAS training event either injured or exhibiting signs of distress will be reported to Navy environmental representatives from the regional Navy shore commander (Commander, Navy Region Southwest) and U.S. Pacific Fleet, Environmental Office, San Diego Detachment. The Navy will report these events to the Stranding Coordinator of NMFS' Southwest Regional Office using Marine Mammal Stranding communication trees and contact procedures established for the Southern California Range Complex. These voice or email reports will contain the date and time of the sighting, location (or if precise latitude and longitude is not currently available, then the approximate location in reference to an established SSTC beach feature), species description (if known), and indication of the animal's status.

The above mitigation measures were developed primarily for marine mammal species based on their detectability and potential for hearing impairment or injury from underwater detonations and are applied at SSTC for sea turtle species as well. These mitigation zones are expected to be greater than the zones in which sea turtles are believed to be physically affected.

3.10.2 Environmental Consequences

This section presents the analysis of potential impacts to sea turtles as a result of implementation of the project alternatives, including the No Action Alternative. The analysis of effects on turtles concerns direct physical injury—the potential for death, injury, and disturbance. Potential effects to sea turtles from training events are consistent for all sea turtle species. However, of the four species of sea turtle that could potentially be located within the ROI, only the green sea turtle is documented to be present in the ROI. As training activities are of short duration and dispersed throughout the ROI, the probability of encounter with sea turtle species that are considered rare in the ROI would be extremely low. Therefore, the green sea turtle is the only species addressed in this analysis.

Activities analyzed in this section for all alternatives are Activities 1-30, 32-35, 37-42, 44-46, 49-53, 57, and 77-78, N1-N9, Tables 2-1 and 2-2. Marine vessels provide support to a host of activities and are subsequently analyzed for effect; however, portions of training activities in which interactions between personnel/craft and turtles are anticipated to be rare, such as swimming, Self-Contained Underwater breathing Apparatus (SCUBA) diving, or activities that utilize only non-motorized Combat Raiding Rubber Craft (CRRCs) (Activities 54, 55, 56, 60, 64, 67, 69, 70, 71, and 73, Table 2-1), are excluded from individual activity analysis as potential impacts from interactions would be minimal to non-existent. Training activities that occur exclusively on the land portion of SSTC (Activities 17, 19, 31, 36, 43, 47, 48, 58, 59, 61, 62, 63, 66, 65, 68, 72, 73, 74, 75, 76, and N10, Tables 2-1 and 2-2) that are not anticipated to interact with the marine environment are excluded from this analysis as they are not expected to impact turtles that may be present adjacent to the SSTC beach or bayside training areas.

3.10.2.1 Approach to Analysis

In order to assess the overall impact of training events on turtle resources in the ROI, the training activities were divided into constituent actions that have the potential to impact the environment. Training activities were grouped into categories to assess potential effects for similar activities, including Aircraft Activities, Marine Vessel Activities, Underwater Detonations, and Amphibious and Beach Activities. These activities occur in a defined manner and space; therefore the effect of these activities on the environment can be assessed. For this analysis, activities are described in the following sections to define the potential effects the activities may have on turtles within the ROI. Information about the location and footprint of these activities was obtained through interviews with Navy training professionals.

Activities may negatively impact sea turtles through generation of noise and/or pressure waves and by causing habitat degradation or loss. Effects on sea turtles vary based on the type, magnitude, duration, and distance from the disturbance, as well as the natural history and unique behavior of each species of turtle.

The following human actions have been documented to affect sea turtles, and may occur in the ROI (NMFS 1998): ship or boat strikes, artificial lighting, beach cleaning, beach erosion, beach replenishment, coastal construction, and increased human presence. Of these, boat propellers and collisions are documented to have killed or harmed turtles in both San Diego and Mission Bay (McDonald and Dutton 1992). Primarily, many of these human actions are adverse only at nesting beaches, which are not present in the ROI; thus, most of the actions in the ROI do not directly kill or harm turtles, but instead degrade habitat or alter behavior. Foraging behavior within the ROI consists of bottom feeding of eelgrass, algae, and attached invertebrates. There is a low probability of turtle's ingesting byproducts from human actions, as most such occurrences are related to sea turtles ingesting plastic bags that are mistaken for jellyfish: jellyfish are most abundant in pelagic waters and would not be expected to be present or targeted by turtles within the ROI.

A general understanding of sea turtle hearing and possible effects to sea turtles is presented below in Sections 3.10.2.1.1 through 3.10.2.1.5 as a basis for which to apply the effects of Navy training activities; however, the data obtained on effects of sound and shock waves on turtles is limited, and most information regarding effects is based on marine mammal studies. A determination of possible harmful effects to sea turtles are significantly limited to the range of data available for any particular type of sound source. Additionally, available data focused on turtle disturbances related to effects on behavioral changes or foraging patterns from marine vessels, aircraft, or underwater detonations are limited or absent. Given the sources of shock waves, sound, and disturbance associated with the activities contained in Chapter 2, effects to turtles are grouped by activity.

3.10.2.1.1 Sea Turtle Hearing

Sea turtles do not have an auditory meatus or pinna that channels sound to the middle ear; nor do they have a specialized tympanum (eardrum), like mammals do. Instead, they have a cutaneous layer and underlying subcutaneous fatty layer that function as a tympanic membrane. The subcutaneous fatty layer receives and transmits sound to the extracolumella—a cartilaginous disk—located at the entrance to the columella, a long, thin, bone that extends from the middle ear cavity to the entrance of the inner ear or otic cavity (Ridgway et al. 1969). Sound arriving at the inner ear via the columella is transduced by the bones of the middle ear. Sound also arrives by bone conduction through the skull. Sea turtle auditory sensitivity is not well studied; though, a few preliminary investigations suggest that it 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 a cue to identify their natal beaches (Lenhardt et al. 1983). The range of maximum sensitivity for sea turtles is 100 to 800 hertz (Hz), with an upper limit of about 2,000 Hz (Lenhardt 1994). The effective range of hearing for green and loggerhead sea turtles is 100 to 500 Hz (Ridgway et al. 1969, Moein et al. 1994, Ketten and Bartol 2006). Below 80 Hz sea turtle hearing is less sensitive, but still potentially usable to the animal (Lenhardt 1994). Ridgway et al. (1969) used aerial and mechanical stimulation to measure the cochlea in three specimens of green turtle; he concluded that they have a useful hearing span of perhaps 60 to 1,000 Hz, but hear best from about 200 up to 700 Hz—with their sensitivity falling off considerably below 200 Hz. The maximum sensitivity for one animal was at 300 Hz, and for another was at 400 Hz. At the 400 Hz frequency, the turtle's hearing threshold was about 64 decibels (dB) in air (approximately 126 dB in water). At 70 Hz, it was about 70 dB in air (approximately 132 dB in water). Bartol et al. (1999) reported juvenile loggerhead sea turtles could hear sounds between 250 and 1,000 Hz. Lenhardt et al. (1983) applied audio frequency vibrations at 250 and 500 Hz to the heads of loggerheads and ridleys submerged in salt water to observe their behavior, measure the attenuation of the vibrations, and assess any neural-evoked response. These stimuli were chosen as representative of the lowest sensitivity area of marine turtle hearing (Wever 1978). At the maximum upper limit of the vibratory delivery system, the turtles exhibited abrupt movements, slight retraction of the head, and extension of the limbs in the process of swimming. Lenhardt et al. (1983) concluded that bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving surfaces. Finally, sensitivity within the optimal hearing range is apparently low—as threshold detection levels in water are high at 160 to 200 dB referenced to 1 micropascal meter (dB re 1 µPa-m) (Lenhardt 1994).

3.10.2.1.2 Effects of Shock Waves

Several factors determine a turtle’s susceptibility to injury and death from shock wave effects. Most blast injuries in turtles and other marine animals involve damage to air- or gas containing organs or damage to the membranes associated with auditory acquisition. Specific studies investigating potential effects to turtles from shock waves are limited and, in most cases, estimated based on marine mammal criteria and relative differences in hearing thresholds between the two groups.

Viada et al. (2008) presented a summary of the limited field observations and experiments of explosive impacts on sea turtles. In several instances, turtle injuries and mortalities—and in some cases, strandings—have been noted following underwater detonations. In one case where turtles were recovered after an openwater detonation, both charge weight (1,200 pound) and the approximate distances (500 to 2,000 feet) of the turtles from the detonation were known (O'Keefe and Young, 1984). Only one field experiment has been conducted in which sea turtles were exposed at known distances from a structure removal detonation; however, that study did not include concurrent pressure measurements to estimate the magnitude and duration of the shock wave received by caged turtles (Klima et al. 1988). In this study, four Kemp's ridley and four loggerhead turtles were placed in cages at four distances (750 feet, 1,200 feet, 1,800 feet and 3,000 feet) from an offshore platform scheduled for removal using explosive charges. Cages were suspended at a depth of 15 feet over a seafloor of 30 feet depth prior to the *simultaneous* detonation of four, 50.75-pound charges of nitromethane, placed inside the platform's support pilings at a depth of 16 feet below the seafloor surface. Sea turtles exposed at 750 and 1,200 feet as well as one loggerhead exposed at 3,000 feet, were rendered unconscious. The Kemp's ridley turtle exposed at 750 feet also sustained slight physical injury, showing an eversion of cloacal lining through its vent. Remaining Kemp's ridley turtles at more distant ranges were apparently unharmed. Unfortunately, this study did not include concurrent pressure measurements to estimate the magnitude and duration of the shock wave received by the caged turtles.

Two immature green turtles were killed when 20 pounds of plastic explosives (C-4) were detonated in open water in the eastern Gulf of Mexico—at distances of 100 to 150 feet from the charge—by a U.S. Navy Ordnance Disposal Team. Overall water depth, charge depth, and turtles' depth were not reported. Turtles' body masses were not provided; however, it is assumed they were small, considering the turtles were reported as immature. In an open water environment, 20 pounds of C-4 explosive would be expected to generate nominal peak pressures of 347 and 244 pounds per square inch (psi) at ranges of 100 and 150 feet, respectively. Current SSTC mitigation measures require a 1,200 foot radius area surrounding detonation locations that are in 0 to 24 feet of water and a 1,500-foot radius area surrounding detonation locations that are in 24 to 72 feet of water; at these distances from a 20-pound explosive source, the estimated received levels at these ranges would be less than approximately 15 psi.

While there have been several reports of turtle impacts and injury following structure removal detonations, there has been no mechanistic model developed to estimate impacts on sea turtles. Rather, it is assumed that models developed for other vertebrates are reasonable approximations. O'Keeffe and Young (1984) developed an equation for a turtle safety range—the distance beyond which turtles would not likely be killed or seriously injured—based on field observations of three turtles following an open-water detonation. The equation is based on cube-root scaling of the charge weight and the distance at which one turtle was not affected. Young (1991) provided a more conservative version of the same equation but states that it is based on the criteria for platform removal established by the NMFS (i.e. it was not independently derived from observations or experimental data). The Navy (2001) also modeled effect ranges using the turtle death/injury observations from O'Keeffe and Young (1984), and a lung injury model developed by Goertner (1982) for small mammals. Results suggest that lung injury predictions for sea turtles are not inconsistent with predictions for small mammals.

To assess the ZOI and potential effects of underwater explosions on green sea turtles at SSTC, separate criteria are used for mortality, injurious physiological effects, and TTS. As a conservative metric, SSTC criteria are based on the numeric criteria for underwater explosive events derived for marine mammals and approved by NMFS in recent NMFS rule making (NMFS 2009a, 2009b) for underwater detonations. The criteria and thresholds for injury and harassment are summarized in Table 3.10-1.

Mortality from the onset of severe lung injury is based on a Goertner modified positive impulse index of 30.5 psi-ms (Goertner 1982). Slight Injury is designated as the point of slight lung injury based on a Goertner modified positive impulse index of 13 psi-millisecond (psi-ms) and tympanic membrane rupture which corresponds to 50 percent rate of rupture at 205 dB re 1 squared micropascal-second ($\mu Pa^2 \bullet s$) maximum sound exposure level (SEL) level in any 1/3-octave band at frequencies >100 Hz. Physiological disruption is designated as sound exposure to 182 dB re1μPa^2-sec greatest SEL in any 1/3-octave band over all exposures, and also 23 pounds per square inch (psi) peak pressure for any single exposure.

Table 3.10-1: Summary of Criteria and Acoustic Thresholds for Underwater Detonation Impacts to Sea Turtles

Underwater Explosive Criteria		
Criterion	**Criterion Definition**	**Threshold**
Mortality	Onset of severe lung injury (1% probability of mortality)	31 psi-ms (positive impulse)
Level A Harassment (Injury)	Onset of lung injury	13.0 psi-ms (positive impulse)
	50% of population would experience ear drum rupture	205 dB re 1μPa^2-sec (full spectrum energy)
Level B Behavioral Harassment	TTS (dual criteria)	23 psi (peak pressure; explosives <2,000 lbs), or
		182 dB re1μPa^2-sec (peak 1/3 octave band)
	(sequential detonations only)	177 dB re 1μPa^2-sec

Impulse levels generated from training activities that could potentially adversely affect sea turtles are either confined to waters less than 72 ft depth within ocean training lanes (detonations) or occur infrequently (pile driving, 4 times/yr) and, in conjunction with established mitigation measures are unlikely to injure sea turtles. Impulse levels from underwater detonations and pile driving activities would likely reach levels sufficient to modify turtle behavior within the immediate area and would qualify as Level B harassment. Given the nonlinear degradation of impulse waves through seawater and the variability of bottom substrate and depth at different detonation sites, it is difficult to estimate the distance of no effect for all the possible ranges of detonation.

3.10.2.1.3 Acoustic Effects of Underwater Sound

Little is documented or understood about the hearing ability of any sea turtle species or their dependency on sound, passive or active, for survival cues. A complication is that sea turtles occupy a wide range of habitats, and each life stage of sea turtles has exceptional differences in gross morphometry of auditory structures and in the physical parameters of their habitat (Ketten et al. 2003). Recent hearing studies investigating auditory brainstem responses, in conjunction with analyzing variation in auditory anatomy, reported smaller juvenile green sea turtles responded to sounds between 100 to 800 Hz (most sensitive hearing range from 600 to 700 Hz); the larger sub-adult green sea turtles had a more constricted range of hearing, from 100 to 500 Hz—similar to the larger loggerhead sea turtles.

There are two types of sound sources that are of major concern to turtles with respect to activities conducted under the Proposed Action: (1) strong underwater shock pulses that can cause physical damage to auditory structures; and, (2) underwater sounds that could cause disturbance or injury. Both types of sound can cause injury or result in distribution and/or behavioral changes. Sound attributed to aircraft over-flight does not propagate sufficient underwater shock waves (associated with explosions) to elicit lethal or sublethal effects to turtles. Predicted sound levels resulting from HC-130 aircraft flying at 1,000 feet and 250 feet were 110 and 121 dB re 1 μPa, respectively, directly under the flight path at a depth of one foot (maximum 1/3-octave level frequencies 20 Hz to 5 kilohertz [kHz]) (US Air Force 1999). Additional noise modeling indicates that the predicted sound level at a depth of one foot resulting from the overflight of an HH-60 helicopter at 100 feet would be approximately 100 to 118 dB re 1 µPa (frequencies of 20 Hz and 5 kHz). At these lower frequencies, it is anticipated that the threshold of sea turtle hearing is in excess of 126 dB re 1 µPa. As this hearing threshold is above the anticipated sound produced by aircraft overflights, this EIS will not address the acoustic effects of aircraft on sea turtles.

A hovercraft, or Landing Craft Air Cushion (LCAC) unit, is a large craft that uses fans to hover above the water. Its footprint includes its physical structure plus 50 feet surrounding it, because of the strong wind produced by the fans. An LCAC approaches the beach and comes ashore up near the crest of the beach. Hovercraft were recorded in the frequency ranges of 80 to 630 Hz with source level of up to approximately 110 dB re 1 µPa and 50-2000 Hz with a source level up to 121 re 1 µPa (Richardson et al. 1995). Recordings of a Griffon 2000TD hovercraft passing a hydrophone at full power in Prudhoe Bay, Alaska indicated broadband (10 to 10,000 Hz) levels reaching 133 dB re 1 µPa (Blackwell and Greene 2005), with most spectral energy centered around 87 Hz. Therefore, turtles can likely sense hovercraft at the low end of their hearing range and may modify their movements or behavior according to the perceived sound.

A study analyzing small boat noise levels at a reference distance of one meter from the sound source indicated that boat noise at high engine speeds is wide-band and of high intensity. The same study using an underwater hydrophone array in Puget Sound, Washington, found that source-level noise produced by small boats varies from 141 dB to 161 dB re 1 µPa and the broadest frequency range observed was between 0.86 kHz to 8.0 kHz (Galli et al. 2008). Whether turtles modify their behavior or habituate to disturbance associated with vessel noise is unknown. It is likely that turtles are affected to some extent by vessel noise, given the frequency bandwidths presented by Galli et al. (2008) that overlap the auditory detection capabilities of sea turtles.

3.10.2.1.4 Disturbance – Behavioral Responses to Acoustic Energy

Given the sound levels and frequency bandwidths that are capable of being detected by green sea turtles, it is likely turtles make behavioral adjustments to differing noise levels and frequencies. Research regarding behavioral modification due to sound is limited and the majority of investigations regarding hearing in sea turtles have been focused on the frequency hearing range of individual species. The opportunity for an animal to respond appropriately to an approaching source of danger is constrained by how soon the animal can detect the danger. Contemporary knowledge of the sensory biology of marine turtles (Moein Bartol & Musick 2003) indicates that sound and light offer potential cues for detecting an approaching vessel. The ability of marine turtles to hear underwater sound has been confirmed by measuring their auditory brainstem responses (Ketten & Bartol 2006) and by observations of their behavioral responses to sound (Moein 1994, Lenhardt 1994). The low frequency range of turtle hearing (Ridgeway et al. 1969, O'Hara & Wilcox 1990, Lenhardt 1994, and Ketten & Bartol 2006) lies well within the broad frequency spectrum of noise produced by vessels (Richardson et al. 1995). Yet despite turtles' known auditory capacity, several factors mitigate against their reliance on sound cues.

The direction of an underwater sound source is difficult to identify because of complex propagation characteristics of sound underwater (Richardson et al. 1995). In addition, marine areas heavily used by humans, such as San Diego Bay, are subject to noise from numerous vessels, as well as other anthropogenic sources above and below the surface, which would tend to mask individual sounds. Hazel (2007) inferred that sound would have minimal utility for submerged turtles in identifying a mobile threat; the study suspected that turtles would tend to habituate to vessel sounds as background noise. However, if turtles relied primarily on sound cues, higher response rates would be predicted for faster approaches—louder engine noise at higher speed—the converse of Hazel (2007) results.

Turtle sightings within San Diego Bay are extremely rare and are most common within the south San Diego Bay, where they have been documented to reside and forage, according to McDonald and Dutton

(1992). Tagging studies by NMFS documented that turtles within San Diego Bay move within a much larger area than previously thought, including transiting high vessel traffic areas such as the turning basin within north central San Diego Bay. With the increased vessel traffic within San Diego Bay over the last 30 years, and the consistent population of turtles known to reside in San Diego Bay, the frequency of vessel strikes would be higher; however, turtles actively avoid vessels or noise attributed to such vessels by swimming towards the surface—their standard fleeing response.

Disturbance includes a variety of effects, including subtle changes in behavior, more conspicuous changes in activities, and displacement. Lenhardt (1994) and Hazel (2007) stated that marine turtles resting on the bottom swim to the surface as the standard responses to noise from vessels and sound impulse within their hearing range. Based on NMFS (2001) and National Research Council (NRC 2005) studies, the assumption is that simple exposure to sound, or brief reactions that do not disrupt behavioral patterns in a potentially adverse manner—a manner that might have deleterious effects to the well-being of individual turtles or their populations—do not constitute adverse effect.

Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors. If a turtle does react briefly to a sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be adverse to the individual, let alone the stock or the species as a whole. However, if a sound source displaces turtles from an important feeding or breeding area for a prolonged period, impacts on the animals could be sufficient to warrant effect.

To what extent turtles utilize hearing to locate prey, navigate, or avoid interactions is subjective; however, with consideration of the infrequency in which turtles are sighted within San Diego Bay, and the location they choose to reside, it seems turtles actively avoid disturbances related to human activities or have habituated to existing noise conditions to a degree that they remain resting below the sea surface; thus reducing their potential interaction with surface activities. As turtles are not documented to use hearing to locate prey or navigate, it is unlikely that masking from background noise attributed to urbanization or vessel traffic has adverse effects on turtle behavior or foraging.

Given the many uncertainties in predicting the quantity and types of impacts of noise on turtles, it is common practice to estimate how many turtles are present within a particular distance of training activities, or exposed to a particular level of sound. The green sea turtle population in San Diego Bay is estimated at between 30 and 100 individuals depending on the time of year. Green turtles would be expected to interface with training activities infrequently, taking into account the resident turtles' affinity for warm water concentrated in south San Diego Bay during the winter months (Macdonald et al. 1990; Eckert 2002 and Dutton 1998) and assuming a direct migration path from offshore areas to south central San Diego Bay during summer months. Large motorized vessels transiting primarily offshore areas or navigational channels within San Diego Bay are unlikely to collide with turtles, since vessel movements are at moderate speed and maintain a consistent heading. Small motorized vessels have a greater potential for interacting with turtles due to their speed and erratic navigation patterns. Effects from vessel movements are difficult to quantify, given the variation in reported strandings/deaths attributed to vessel strikes (McDonald and Dutton 1992, NMFS 2009). Based on the total area of San Diego Bay (15,694 acres) and the limited amount of area the oceanside training areas encompass (6,492 acres), relative to the adjacent nearshore environment, the possibility of training activities affecting green sea turtles is low. Bayside training areas account for a total of 1,883.5 acres or 12 percent of the total area available for turtles in San Diego Bay. Assuming that resident turtles remain in south San Diego Bay when resting and are randomly distributed throughout San Diego Bay when foraging 12 percent of the population, between 3.6 and 12.0 turtles, could be present within all bayside training areas during foraging times.

Given that the majority of green sea turtles forage within shallow, subtidal areas where their primary food sources occur; and given that a routine dive ranges from 9 to 23 minutes (Brill et al. 1995), turtles spend a very small time (approximately 6 minutes of every hour based on minimum dive times) at the surface—where they are most likely to be affected by motorized vessels. Furthermore, given the fact that turtle foraging has been shown to be biased toward evening hours, an even smaller percentage of turtles have potential to interact with daytime vessel activities. Marine vessel activities are concentrated outside primary turtle foraging habitat (shallow water less than 12 feet below Mean Lower Low Water [MLLW]), based the proportion of habitat (< -12 feet MLLW) within each bayside training area (see Figure 3.7-3). Marine vessel activities originate from established berthing locations and transit areas of moderately deep and deep subtidal < -12 feet MLLW) to prescribed locations. Therefore, it is unlikely that Navy vessel traffic alone would cause disturbance (e.g., strikes, noise, etc) sufficient to determine a measurable effect to green sea turtles.

3.10.2.1.5 Habitat Modification

Pacific green sea turtles are not documented to require any defined habitat within San Diego Bay or the ROI to maintain their existence or residency. Recent studies investigating movement and foraging patterns indicate that a much greater portion of San Diego Bay may be used by resident turtles than previously thought. The turtle's current and historic use of south San Diego Bay channels is correlated to temperature, considering the shallow depths, solar heating, and lack of circulation that occurs within that area. Effects to San Diego Bay substrate or eelgrass (to what extent turtles within San Diego Bay utilize eelgrass as a primary source of food is subject to debate) from training activities have a low probability of adversely impacting turtles within the ROI.

3.10.2.2 No Action Alternative

This section focuses on groups of activities that have potential to result in an impact to turtles. The No Action Alternative would maintain the current level and types of training that occur in the ROI. Current mitigation measures (Section 3.10.1.4) would remain unchanged. Similar types of activities are grouped together to facilitate effects analysis. Types of activities that could affect turtles include marine vessel activities, underwater detonations, and amphibious activities. In addition, beach and inland activities have been determined to have no effect on turtles in areas within the SSTC study area, as turtles are not documented to haul or nest within the ROI beaches or upland areas.

3.10.2.2.1 Marine Vessel Activities

Marine vessel use in the ROI consists of self-propelled boats, propeller surface craft, and water-jet driven craft. Self-propelled craft are used for trainees to navigate in San Diego Bay and ocean water, as well as transportation to shore for raids. Under the No Action Alternative, marine vessels both mechanically driven and self-propelled are used in 41 of the 78 training activities listed in Table 2-1 and detailed in Appendix B.

Propeller surface craft are used in the ROI for a variety of purposes. These craft can be used in entirely water based activities where trainees practice navigation, mock boat attacks, and boarding drills; also, they can be used for transportation of people or equipment to shore for raids, to ensure safety of swimmers during physical fitness training, and to transport marine mammals for training. Under the No Action Alternative, training activities involve propeller and jet-driven surface craft of various size and speed. Activities occur in both San Diego Bay and oceanside training lanes, and to varying degrees craft land on beaches in both areas.

Impacts to turtles from marine vessels, both propeller-driven and jet-driven operating within the ROI include physical injury, sound, and disturbance. Since Ford (1970) documented the presence of turtles within San Diego Bay, little mortality has been attributed to vessel strikes (McDonald and Dutton 1992).

Consistent reporting of vessel strikes on turtles within San Diego Bay is lacking and vessel strike data within San Diego County indicates that nine vessel strikes have occurred between 1986 and 2008 (NMFS 2009). A portion of the most recently documented mortalities associated with vessel strikes may have occurred outside San Diego County since dominant winds tend to focus drifting debris towards San Diego Bay and the ROI. Marine vessel traffic within the ROI is concentrated near navigational channels and berthing areas, primarily occurring during daylight hours. The location and movement patterns of resident San Diego Bay green sea turtles are not well understood, which makes impacts related to marine vessel strikes difficult to quantify. The majority of marine activities occur in the offshore training lanes, and small boat training events within the ROI are a small proportion of the total activities within SSTC. Vessels taking part in activities within San Diego Bay transit through a small portion of documented turtle resting and foraging locations in the South and South Central portions of San Diego Bay. Any effects to turtles within the ROI from marine vessels remains a low probability; considering the temporal variability of both training events and turtles residing or feeding within training activity areas.

Marine vessel training activities include minimal anchoring or landing, except in defined locations or emergency situations. Eelgrass habitats are located throughout San Diego Bay, but are most heavily concentrated within the south and south central portions of San Diego Bay (Figure 3.7-2) Vessel training events are primarily within channel areas, or at slow speeds near bayside training beaches. Training events avoid eelgrass habitats because these areas can fowl running gear (propellers and jets) and affect maneuvering. Any damage to eelgrass habitats from small mechanically driven vessel activities would be temporal and localized, and would not affect entire eelgrass beds or regions. Thus, turtle habitat loss or degradation attributed to marine vessel activities would not be expected.

Impacts on turtles from noise, physical interaction, disturbance, or habitat modification, attributed to marine vessels operating within the ROI, is not anticipated to be adverse with respect to activities that involve the use of self-propelled or small, mechanically driven craft (Activities 1, 5 - 16, 18, 20 - 26, 28, 32 - 35, 37 - 39, 57, 77, 78, Table 2-1). Small, mechanically driven vessels do not emit noise levels documented to reach impacts criteria. Behavior modifications of turtles interacting with small marine vessels, both mechanically driven and self-propelled, would be infrequent considering the low population density of turtles, the documented movements within the training areas compared to the regional setting, and the temporal and spatial variability of both turtles and the individual activities. Impacts to turtles related to reduced foraging success, disturbance, or habitat modification attributed to self-propelled or small mechanically driven vessel activities, are not likely to occur based on the impacts criteria previously presented, and the short duration and spatial extent of activities within habitat documented to support turtles. Landings of small craft and personnel within bayside training areas containing eelgrass habitats may have localized and temporary impacts to resident turtles, as a result of disturbance and habitat modification. Impacts to turtles from vessel strikes, both lethal and sublethal, could potentially occur; however, impacts remain a low probability, considering previous strike data and the concentrated location of both turtles and training activities in separate areas.

Impacts on turtles from noise, physical interaction, disturbance, or habitat modification attributed to activities involving large mechanically driven vessels operating within the ROI is not anticipated to be adverse (Activities 1, 13, 20, 22, 24, 25, 27, 38, 39, 40, 41, 44, 45, 46, 49, 51, 52, 53, Table 2-1). Behavior modifications of turtles interacting with large mechanically driven vessels would be infrequent considering the low population density of turtles, the slow and deliberate nature of the vessels, and an absence of documented vessel strikes during the past decade. Reduced foraging success or behavior modification attributed to large, mechanically driven vessel activities is only likely to occur for migrating or actively moving turtles; they would not adversely affect turtles based on the findings previously presented. Landings of large vessels within bayside training areas containing eelgrass habitat may have localized and temporary impacts to resident turtles from disturbance and habitat modification because of propeller or jet scouring. The short duration and spatial extent of activities in conjunction with the small resident population of turtles greatly reduces the probability of large mechanically driven vessels interfacing with turtles. Based on the low density and high mobility of turtles, the probability of lethal and sub-lethal impacts attributed to turtle/vessel collisions is low. Given the noise and movements created from marine vessel activities, behavioral modifications sufficient to illicit measurable effect are unlikely. In accordance with ESA, marine vessel activities under the No Action Alternative may affect ESA-listed turtles.

3.10.2.2.2 Underwater Detonations

Underwater detonations that take place under the No Action Alternative are detailed in Section 3.8.2.2.3 (Table 3.8-11). All detonations take place in the oceanside training lanes, designated Boat Lanes 1-14 in the table, from 0 to 72 feet of water depth depending on the activity.

Biological information describing the threshold and degree of impact to sea turtles from pressure waves and sound are not available. As such, NMFS uses marine mammal criteria. Detailed information on the thresholds for lethal and sub-lethal effect from pressure waves and sound generated from underwater detonations are described in depth in Section 3.9.2.3 and are applied to the impact analysis presented in this section. The thresholds are used to establish ZOI for injury and mortality for underwater detonations at SSTC. Table 3.10-2 provides a summary of ZOI distances for sea turtles based for each underwater detonation activity.

The frequency of turtles transiting the ROI within the nearshore coastal habitat used for underwater detonations is not currently known. Information on the number of turtles that annually migrate into San Diego Bay, the path they transit, or the frequencies at which they use nearshore waters of the ROI, are unknown, but expected to be low. Multiple scenarios can be inferred; however, without site-specific data on turtle spatial and temporal movement, probability estimates of turtles transiting the ocean portions of the ROI remains debatable.

Empirical testing performed by the NSWC/Anteon Corp., Inc. (2005) reported that underwater detonations at SSTC-N oceanside boat lanes would propagate sound, pressure, and energies differently in very shallow water (zero to 24 feet of water depth) than shallow water (24 to 72 feet of water depth). Details about this empirical testing and its results can be found in Section 3.9.2.4.2. The testing found that ZOIs for underwater detonations conducted in VSW for physiological disruption (temporary threshold shift [TTS]) for exercises with charge-weights of 20 pounds or less of C4 on the bottom is 1,200 ft.

Impacts to turtle behavior or foraging habitat from underwater detonations are not expected. There is a lack of suitable foraging habitat within SSTC-N and SSTC-S boat lanes, and a low probability of turtles transiting or residing within the activity area. Further, the Navy will implement mitigation measures (described in section 3.10.1.4), which include the use of two trained observers with binoculars and small craft surveying detonation areas and the buffer zone for at least 30 minutes prior to and after detonations. These mitigation measures would further reduce the probability of turtle impacts. In accordance with ESA, marine vessel activities under the No Action Alternative may affect ESA-listed turtles.

Table 3.10-2: Maximum Zones of Influence for No Action Alternative

Underwater Detonation Operation	Charge Weight Used[1]	Season	Injury		Mortality
			Onset of slight lung injury (13.0 psi-msec)[3]	50% TM rupture (205 dB re 1µPa²-sec) [3]	Onset of extensive lung injury (30.5 psi-msec) [3]
Mine Countermeasures	20	Warm	360	80	80
		Cold	160	80	80
Floating Mine	≤ 5	Warm	20	80	20
		Cold	20	80	20
Unmanned Underwater Vehicle Activities	20	Warm	360	80	80
		Cold	150	80	80
Marine Mammal Systems Activities[2]	13	Warm	130	70	80
		Cold	140	70	80
Marine Mammal Systems Activities	13	Warm	130	60	80
		Cold	140	70	80
Very Shallow Water Mine Countermeasures	0.1 - 20	Warm	360	80	80
		Cold	150	80	80
Dive Platoon[2] (mid-depth)	3.5	Warm	70	130	40
		Cold	70	130	40
Dive Platoon[2] (bottom)	3.5	Warm	80	90	50
		Cold	90	90	50
Mine Neutralization [2]	3.5	Warm	80	90	50
		Cold	90	90	50

[1] Charge weights are listed in pounds
[2] Sequential Detonations
[3] Distances are listed in yards

3.10.2.2.3 Amphibious and Beach Activities

Training activities in this section include amphibious vehicles, ELCAS, and fluid transfer systems. Training activities include the use of training areas within both San Diego Bay and the nearshore environment. Potential impacts from included activities range from vehicle transit within ROI waters, noise, and habitat modification, are similar to those described in Section 3.10.2.2.1, Marine Vessel Activities.

Amphibious Activities

Amphibious vehicles and vessels are used during various training activities land on beaches and San Diego Bay shorelines that turtles may utilize during foraging. The modification of that shoreline depends on the size of the amphibious vehicle, the frequency of the landings within the area, and whether the propulsion system creates scouring during the landing activity. Amphibious activities analyzed in this section focuses on the interaction the vehicle has with the landing area and to a lesser extent the waters adjacent to the landing areas such as Craft Landing Zone (CLZ), Lighter, Amphibious, Resupply, Cargo-5 ton (LARC V), and Barge Ferry Causeway/ Coxswain Training (Activities 27 and 53, Table 2-1) as well as more intense activities associated with construction of an ELCAS.

To prepare for a LCAC ingress/egress activity, CLZ teams survey and mark beaches. The CLZ team then safely guides LCACs to the designated shore landing areas. Increased turbidity and scouring from landing activities within SSTC Boat Lanes 1-14 would not likely be sufficient to result in adverse impacts to turtles. Any impact to turtle behavior or foraging would be temporary and localized, considering the energetics of the surf zone, the extent of similar adjacent habitat, and low frequency (once per year over a 6 day period) of the activity. In San Diego Bay, increased turbidity and scouring from landing or anchoring activities such as Barge Ferry Causeway/Coxswain Training may have localized impacts to eelgrass habitats, but would not likely be sufficient to result in adverse impacts to turtles. Any impact to turtle behavior or foraging would be temporary and localized, given the extent of similar adjacent habitat and low frequency (four per year for one day) of the activity.

Causeway Pier Insertion and Retraction and ELCAS activities involve the insertion of a causeway (a temporary floating pier) onto the beach. Causeways either remain floating offshore or are elevated onto pilings driven into the sediment. Causeway activities occur primarily on SSTC-N oceanside boat training areas 1-10, but also periodically in the bayside Bravo training area. Under the No Action Alternative, these activities occur three and nine times respectively and are separate training events.

Pile driving will be conducted during installation of the ELCAS, which is constructed to provide a quick and temporary pier structure for offloading Navy vessels. Under the No Action Alternative, ELCAS activities occur twice a year and occur either bayside at Bravo Beach, or oceanside at SSTC-North. Pile installation occurs over a period of 10 days. Approximately 101 piles are driven in a typical ELCAS training event, with around 250 to 300 impacts per pile, and each pile taking on average 10 minutes to install. Pile driving is done 24 hours-per-day; floodlights are used at night, which would illuminate the surrounding area. At the end of the training, a vibratory extractor attached to the pile head will be used to remove piles. Removal takes approximately 15 minutes per pile over a period of around 3 days. As discussed in Section 3.10.1.4, pile driving includes a semi-soft start. The pile driver increases impact strength as resistance goes up. At first, the pile driver piston drops a few inches. As resistance goes up, the pile driver piston will drop from a higher distance providing more impact due to gravity.

Shock pulses from pile driving have the potential to affect turtles—if they are in the immediate area. Depending on the level of the sound and shockwaves produced by pile driving activities and the proximity turtles transit to the activities, various lethal and sublethal impacts may occur. Shockwaves and peak pressures generated from ELCAS pile driving activities could reach between 188 and 208 dB re 1 μPa^2-s. There is no established criterion for injury or mortality from pile driving activities associated with sea turtles; however, marine mammal criteria may conservatively address sea turtles like they do for underwater detonation activities. Section 3.9.2.3 details the buffer zones used to mitigate the impacts of ELCAS pile driving activities on sea turtles.

Given the complexity and magnitude of associated logistical aspects of ELCAS and the soft start of the pile driving activities, if turtles are present within the activity area, they will likely leave prior to full-impact pile driving activity. Additionally, mitigation measures in place (Section 3.10.1.4) would allow for the detection of sea turtles in the immediate vicinity prior to initiating pile driving activities and it would offset potential exposure to turtles within the activity footprint.

Given the infrequency of these activities, and the duration between driving piles within a high-energy surf zone, impacts to turtles within the offshore boat lanes are expected to be temporary and localized. Impacts to turtles, with regard to habitat modification within Bravo, can be more precisely defined based on loss or modification of eelgrass habitat described in Section 3.7. Only a small percentage of all piles being driven would occur within eelgrass habitat and eelgrass. Bravo lane eelgrass habitat represents only 17.5 acres (using 2004 coverages listed in Table 3.7-3). Furthermore, ELCAS training activities take place within a defined training lane within Bravo, 1.13 acres, and potential loss of eelgrass habitats will be mitigated for as discussed in Section 3.7. In summary, ELCAS activities are performed infrequently, and in most cases within an already physically challenging surf zone habitat, or designated location within the Bravo training lane. Impacts to turtles would be concentrated in proximity to pile driving activities and most notably within eelgrass habitat. Given the extent of adjacent habitat and population of turtles known to exist in adjacent habitat, effects to turtles from ELCAS activities are expected to be temporary and localized. Based on the limited occurrence and constrained nature of amphibious activities within turtle foraging areas, and the low density of turtles, the probability of impacts to turtles is low. In accordance with the ESA, amphibious activities in the No Action Alternative may affect ESA-listed turtles.

Beach Activities

Beach activities covered in this section involve activities that transfer fuel (simulated) or water from vessels on the water to beaches within training areas. The focus of the analysis for the applicable activities is concentrated on the type of medium being transferred and the nearshore waters or intertidal areas that may be affected by equipment movement or positioning. Impacts from marine vessel movements or landings are address in Section 3.10.2.2.1. Fluid transfer training events involve two activities (1) the simulation of fueling transfers utilizing seawater and (2) the intake of seawater for desalination and the discharge of hypersaline brine back into San Diego Bay.

Fluid transfer activities consist of transferring salt water to simulate fuel transfer, under the activities Offshore Petroleum Discharge System (OPDS) and Amphibious Bulk Liquid Transfer System (ABLTS), and bringing saltwater ashore for desalinization, under the activity ROWPU. For both activities, water is pumped to a beach interface unit and returned to the ocean with a hose. Simulated fueling transfer during OPDS poses minimal risk to turtles due to its localized nature and infrequent use. During ROWPU training, salt water is brought ashore and desalinized. Hypersaline water is then stored in a bladder and transported offsite for sewerage or mixed with potable water and discharged back into the sea at nearly the same salinity as the source ocean water. Discharge of treated water is not likely to affect turtles, considering the diluted nature of the discharge, the dissolution from the receiving water, and physical mixing that occurs within the surf zone and nearshore waters where activities occur. Any physical impacts to turtles would be temporary and localized as training activities occur infrequently. Impacts from fluid transfer activities including, habitat modification, and entrainment in the OPDS/ABLTS systems, and effects to turbidity would not be expected to have lethal or sublethal impacts to turtles due to the small area impacted and low likelihood of sea turtle presence. In summary, no long term adverse impacts would occur from fluid transfer activities and any impact to turtles would be unlikely. In accordance with the ESA, beach activities in the No Action Alternative may affect ESA-listed turtles.

3.10.2.3 Alternative 1 (Preferred Alternative)

Alternative 1 increases the current level and types of training that occur in the ROI. Current mitigation measures would remain unchanged (Section 3.10.1.4). This section focuses on groups of activities that have potential to result in an impact to specified turtle species. As discussed previously, similar types of activities are grouped together to facilitate impacts analysis.

3.10.2.3.1 Air Activities

As presented in Chapter 2 (see Tables 2-1 and 2-2) and detailed in Appendix B, helicopter activities over San Diego Bay and ocean waters within the ROI would more than double under Alternative 1 in comparison to the No Action Alternative. Given that impacts to turtle species from air activities are not expected from noise and sea surface disturbance, the increase in Air Activities would not measurably change the potential impact to green sea turtles or their populations.

One new air activity utilizing helicopters would use a Light Detection and Ranging (LIDAR) blue-green laser to detect, classify, and localized floating and near-surface mines in shallow water (Activity N5, see Table 2-2) and would be added under Alternative 1. Brudenall (2008) reports that the leatherback sea turtle shows ocular features that are characteristic of Chelonians with similarities to aquatic mammals. The calculated optical sensitivity suggests that compared to pelagic fish, for instance, the leatherback sea turtle eye is not particularly well adapted for vision in dim light even though this species is known to venture into deep, dark waters, and might feed at night. Further, Zorn et al. (1998) concluded oceanographic LIDARs that meet current human laser safety standards will have no harmful impacts on the eyes of cetaceans or pinnipeds, and sea turtles, because the human eye is more sensitive to laser radiation than either the cetacean eye or the pinniped eye. As LIDAR activities are dispersed across the oceanside boat lanes of the ROI, where the expected density of green sea turtles is extremely low, the use of LIDAR would pose a minimal risk to sea turtles. In accordance with ESA, air activities under Alternative 1 may affect ESA-listed turtles.

3.10.2.3.2 Marine Vessel Activities

Marine vessels, propeller and water-jet driven, would increase in use and scope under Alternative 1 compared to the No Action Alternative as presented in Chapter 2 (Tables 2-1 and 2-2) and detailed in Appendix B. Any increases in marine vessel use in both oceanside and bayside training areas would result in a commensurate increase the probability of impact on turtles from disturbance and physical injury, though the anticipated level of impact from these activities is expected to remain low. The greatest increases to marine vessel activities would be attributed to new activities: Shock Wave Action Generator (SWAG, N1), Surf Zone Test Detachment (N2) as well as increases to existing activities, Seal Delivery System/Advanced SEAL Delivery System (SDV/ASDS) Cert training, and Barge Ferry/Causeway Coxswain training.

New activities under Alternative 1 will take place within all boat training lanes and bayside training areas. Large and small mechanically driven vessels are used to support diving activities within boat lanes and bayside training locations. Sound levels from transiting vessels may illicit behavior modification of turtles based on documented sound levels and developed impact criteria (see Table 3.10-1). Vessel strikes and behavior modifications related to vessel movement or towed systems may occur; however, impacts would be more likely to occur in San Diego Bay training areas than ocean boat lanes, though vessel training events in San Diego Bay are primarily within channel areas or at slow speeds near bayside training beaches. This is based on the proximity of bayside training areas to known turtle resting and foraging areas and the low probability of activities in ocean boat lanes interacting with migrating turtles. Impacts would be infrequent based on the current documented vessel strike frequency data as well as the concentration of marine vessel and towed systems in oceanside beach lanes where sea turtle occurrence is low. As such, impacts to sea turtles would be similar to those presented under the No Action Alternative. Based on the low density and high mobility of turtles relative to the increase in marine vessel activities proposed in Alternative 1, the probability of lethal and sub lethal impacts attributed to turtle/vessel collisions is low. Given the increased noise and movements created from marine vessel activities proposed in Alternative 1, behavioral modifications sufficient to illicit measurable effect are unlikely. In accordance with ESA, marine vessel activities under Alternative 1 may affect ESA-listed turtles.

3.10.2.3.3 Underwater Detonations

All underwater detonation training activities occur on the ocean side of SSTC within the designated boat lanes, with the exception of small charge weight (0.033 lb) SWAG within the open waters of south San Diego Bay. In general, 78% of the annual SSTC underwater detonations include underwater charges less than 10 lbs. NEW. As presented and described in Section 3.8.2.3.3 (Table 3.8-11), underwater detonations would increase measurably in frequency from 103 activities under the No Action Alternative to 311 activities under Alternative 1 and in magnitude from 20 pounds for the No Action Alternative to 29 pounds for Alternative 1 and 2. The increase in the weight of the underwater detonation charges to 29 pounds NEW would not increase the potential area of effect (harassment or injury) from beyond 360 yards (1,080 ft) from a single detonation based on Goertner's modified impulse pressure at the surface of 13 psi-ms for slight lung injury SLI (Table 3.10-3). Because the distance of potential impact was unchanged and the number of activities increases under Alternatives 1 and 2, underwater detonations would not be expected to result in lethal or sublethal effects to green sea turtles based on current impacts criteria previously outlined in Section 3.10.2.1.2 and the use of existing mitigation measures (Section 3.10.1.4). Increases to the size and frequency of detonations may have adverse impacts on turtles.

Under Alternative 1, five additional activities would be conducted: SWAG and Unmanned Underwater Vehicle (UUV) Neutralization, Airborne Mine Neutralization System (AMNS), Demolition Requalification and Training/Underwater Detonations, and Naval Special Warfare (NSW) Underwater Demolition Training (Activities N1, N3, N7, N9, and N11, respectively, Table 2-2) and the footprint of activities would be expanded to include SWAG detonations of up to 15 grams NEW within San Diego Bay.

SWAG (Activity N1, Table 2-2) is a new activity under Alternative 1 that would take place within all boat training lanes and Echo bayside training area. SWAG is a tool used to disarm enemy limpet mines, which have been attached to the hull of a ship. The SWAG is composed of a cylindrical steel tube, three inches long and one inch wide, containing approximately 15 grams NEW of explosives which has a minimal zone of influence (ZOI) (Table 3.10-3). For SWAG training, a metal sheet containing an inert limpet mine is lowered from the side of a small vessel. Divers go below and place a single SWAG on the mine mid-water column at water depths of 10 to 20 feet. The presence of SCUBA divers elicits a fleeing response in sea turtles (Bowen 2007). Given the size of the charge utilized in this activity, current and proposed mitigation measures, and the substantial time required to setup the activity, adverse impacts to turtles from the SWAG activity are unlikely.

UUV Neutralization (Activity N3, Table 2-2) is a new activity under Alternative 1 that would take place within SSTC Boat Lanes 1-14. Training activities consist of placing sequential charges, consisting of a Seafox (3.3 pounds) or Archerfish (3.57 pounds) charge placed from depths of ten feet to the bottom in water depths less than 72 feet. Given the size of the charge utilized in this activity, current mitigation measures, and the substantial time required to setup the activity, impacts to turtles would be similar to those described in 3.10.2.2.2 and are unlikely.

AMNS (Activity N7, Table 2-2) is a new activity under Alternative 1 that would take place within SSTC Boat Lanes 1-14. Training consists of deployment of AMNS underwater vehicle that searches for, locates, and destroys mines. The vehicle is self-propelled and unmanned. Ten of the 48 annual activities culminate in the AMNS being remotely detonated when it encounters a simulated (inert) mine shape. The charge contained within the AMNS underwater vehicle is 3.52 pounds NEW. Helicopter crews continuously scan the water surface of the activity area for obstructions that could affect towing activities. As such, this continuous scan serves as an effective pre-detonation monitoring for any sea turtle that may be near the activity area. Given this operating procedure, the size of the charge utilized in this activity, the location of the activity in where sea turtle density is anticipated to be extremely low, and the substantial time required to setup the activity, impacts to turtles would be similar to those described in 3.10.2.2.2 and are unlikely.

Table 3.10-3: Maximum Zones of Influence Under Alternative 1 and 2

Underwater Detonation Operation	Charge Weight Used[1]	Season	Injury		Mortality
			Onset of slight lung injury (13.0 psi-msec)[2]	50% TM rupture (205 dB re $1\mu Pa^2$-sec)[2]	Onset of extensive lung injury (30.5 psi-msec)[2]
Mine Countermeasures	20	Warm	360	80	80
		Cold	160	80	80
Floating Mine	5	Warm	20	80	20
		Cold	20	80	20
SWAG	0.033	Warm	0	0	0
		Cold	0	0	0
Unmanned Underwater Vehicle Activities	15	Warm	360	80	80
		Cold	150	80	80
Marine Mammal Systems Activities (sequential)	29	Warm	360	140	90
		Cold	170	140	90
Marine Mammal Systems Activities	29	Warm	360	100	90
		Cold	170	100	90
Dive Platoon (sequential)	3.5	Warm	80	90	50
		Cold	90	90	50
Qual/Cert (sequential)	13.75	Warm	140	100	80
		Cold	140	100	80
Qual/Cert	25.5	Warm	300	90	90
		Cold	170	90	90
Mine Neutral (sequential)	3.5	Warm	80	90	50
		Cold	90	90	50
UUV Neutral (sequential)	3.57	Warm	80	60	50
		Cold	90	60	50
AMNS	3.5	Warm	80	40	40
		Cold	80	40	40

[1] Charge weights are listed in pounds
[2] Maximum ZOIs are listed in yards
Most training events are a single detonation per event. However, several training activities involve sequential charges during the same training event. Unless otherwise specified, all sequential charges are conducted either less than 10-seconds apart or greater than 30-minute apart.

Demolition Requalification and Training/Underwater Detonations (Activity N9, Table 2-2) is a new activity under Alternative 1 that would take place within all boat training lanes. Training consists of requalifying or training teams in underwater detonations by conducting detonations on metal plates near the shore. Additionally, at depths of 10 to 72 feet, two sequential 12.5 to 13.75-pound charges are placed on the bottom or a single 25.5-pound charge is place from a depth of 20 feet to the bottom. Given the size of the charge, the location of the activity, current mitigation measures, and the substantial time required to setup the activity, impacts to turtles would be similar to those described in 3.10.2.2.2 and are unlikely.

NSW Underwater Demolition Training (Activity N11, Table 2-2) is a new activity under Alternative 1 would be conducted within all training lanes. Up to 40 persons participate in the activity, which involves small groups swimming to shore from four inflatable boats located approximately 1,000 yards offshore; boats may be beached on shore. A single charge of less than 10 pounds of C-4 explosives (if detonated on the bottom) or less than five pounds(if within five feet of the surface) is command detonated near the shoreline in water less than 24 feet deep. Impacts to turtles from underwater detonations within waters of the ROI are based on modeling and tests (DoN 2001a: Goertner, 1982). The radius of lethal and sublethal effect to turtles from impulse waves is solely based on peak pressure presented in Table 3.10-1 and the maximum size of the detonation known to take place for each activity. Given that nearly all SSTC underwater detonations occur in nearshore Boat Lanes 1-14, over mostly sand bottom not documented to support foraging or transient turtles, that the density of sea turtles in the training area is low, and use of mitigation measures to minimize the potential for impacts to turtles (Section 3.10.3), the probability of impacts to sea turtles is low. If impacts to turtles do occur, they would likely be behavioral and considered localized and temporary. In accordance with ESA, underwater detonation activities under Alternative 1 may affect ESA-listed turtles.

3.10.2.3.4 Amphibious and Beach Activities

Amphibious Activities

As described in Section 3.10.2.2.3, ELCAS activities are not expected to have adverse impacts to turtles, given the complexity and magnitude of associated logistical aspects of ELCAS. The majority of turtles within the activity area are likely to be displaced prior to pile driving activity due to setup activities, or displaced during the soft start process of pile driving. Shock waves and peak pressures generated from ELCAS pile driving activities would be expected to produce shock waves sufficient to reach impacts criteria for the onset of slight lung injury; however, the small ZOI combined with existing mitigation measures for turtles (Section 3.10.1.4) are likely to reduce the potential for impact. Impacts from ELCAS activities including sound, shock waves, habitat modification, and increased turbidity could have impacts to turtles foraging in adjacent eelgrass areas, though these impacts would be temporary and localized. Suspended material from pile driving within the oceanside training areas would not substantially modify the surf zone or nearshore clarity to a degree expected to affect turtles behavior or foraging. In contrast, increased turbidity and the potential redistribution of sediment from pile driving may have adverse impacts to eelgrass habitat from smothering that could have secondary effects to turtle foraging. Based on the limited occurrence and constrained nature of amphibious activities within turtle foraging areas and the low density of turtles, the probability of impacts to turtles is low. In accordance with the ESA, amphibious activities in Alternative 1 may affect ESA-listed turtles.

Beach Activities

Increases in beach activities not discharging by-products or interfacing with the nearshore or San Diego Bay waters have no potential to affect turtles and are not analyzed in this section. Beach activities that may affect the nearshore environment are discussed in this section. Fluid transfer training events involve two activities (1) the simulation of fueling transfers utilizing seawater and (2) the intake of seawater for desalination and the discharge of hypersaline brine back into San Diego Bay. Fluid transfer activities consist of transferring salt water to simulate fuel transfer, under the activity OPDS, ABLTS, and bringing saltwater ashore for desalinization, under the activity ROWPU. Under Alternative 1 the total number of annual activities would increase from four to five.

As described in Section 3.10.2.2.3, fluid transfer training events are expected to have a minimal effect on turtles, and the incremental change in the number of activities would not change those predictions. Surface coverage by conduit is not sufficient to affect behavior of turtles. Bottom substrate disturbance or modification within the surf zone, or intertidal areas attributed to equipment or sand movement would occur within an already physically disturbed zone. Modification of habitat within the San Diego Bay would be proportional to the amount of lost eelgrass habitats. Any impact to turtles within the boat lanes would be below measurable thresholds, and would only be expected in the San Diego Bay if eelgrass habitats were modified or destroyed to a sufficient level to reduce foraging success.

3.10.2.4 Alternative 2

Implementation of Alternative 2 would increase the overall training to the same level as Alternative 1. Implementation of Alternative 2 would also include the introduction of new types of training; conducting existing routine training at additional locations within SSTC established training areas, and increasing access to, and availability of, existing beach and inland training areas. The only difference between Alternative 1 and 2 is that all SSTC-N beach training areas would be available for use, regardless of time of year. Therefore, impacts associated with Alternative 2 would be the same as those described above for Alternative 1. Under Alternative 2, the proposed change to access and availability to existing beach and inland training areas would not result in a change in impacts to sea turtles over Alternative 1. Under Alternative 2, training activities would result in similar effects to sea turtles as previously described under Alternative 1.

3.10.3 Proposed Mitigation Measures

Given implementation of the current mitigation measures for SSTC activities (described in detail in Section 3.10.1.4), there would be minimal impacts to sea turtles under any of the alternative activities considered in this EIS.

Mitigation procedures for oceanside underwater detonations would remain the same as described in Section 3.10.1.4. In addition, the Navy would implement mitigation measures for underwater detonations involving SWAG, which are proposed in Alternative 1 and 2, but are not currently conducted:

1. A buffer zone of 60 yards (180 feet) will be established around each SWAG detonation point.
2. Observer(s) with binoculars and small craft will survey the detonation area and the buffer zone for sea turtles from at least 10 minutes prior to commencement of the scheduled explosive event until at least 10 minutes after detonation. Observers will pay extra attention within the buffer zone to large amounts of floating kelp strands and other marine debris (if any), since these may provide shelter and food for sea turtles.
3. Divers placing charges on mines and dive support vessels will check the area immediately around the mine location for sea turtles.
4. If a sea turtle is sighted within the buffer zone or moving towards it, exercises will be suspended until the animal has voluntarily left the area and the area is clear of sea turtles for at least 10 minutes.
5. Immediately following SWAG detonation, visual monitoring for sea turtles within the buffer zone will continue for 10 minutes. Any animals appearing following a detonation will be observed for

signs of injury. Injured sea turtles will be reported to the Commander Navy Region Southwest (CNRSW) Environmental Director, the Pacific Fleet (PACFLT) Environmental Office, and National Marine Fisheries Service (NMFS) Southwest Regional Office. An existing Standing Communication Tree for the Southern California Range Complex has been formally approved by NMFS and the Navy. Using this protocol, the Navy will report all sea turtle strandings observed by Navy personnel immediately to NMFS or as soon as clearance procedures allow, to the practical extent possible.

As a result of the informal green sea turtle consultation with NMFS, the Navy will implement an additional mitigation measure:

1. If there are sea turtles known to be equipped with sonic tags in the area of and during pile driving operations, Navy will collaborate with NMFS to analyze movements of these turtles in the immediate area during pile driving. Following any monitoring of sound attenuation associated with pile driving, the Navy will share the results with NMFS and provide recalculations of buffer zones as they are available.

Current mitigation measures implemented during ELCAS pile driving are described in detail in Section 3.10.1.4 and would continue.

3.10.4 Unavoidable Adverse Environmental Effects

There are no unavoidable adverse environmental effects to sea turtles as a result of implementation of any alternatives.

3.10.5 Summary of Effects

Table 3.10-4 presents a summary of effects and mitigation measures for the No Action Alternative, Alternative 1, and Alternative 2. All alternatives avoid effects on turtles and their preferred habitats. The Navy, based on the assessment provided above, believes that the proposed action on SSTC may affect but is not likely to adversely affect the federally listed turtle species found within SSTC. In accordance with ESA requirements, the Navy has completed informal consultation under Section 7 of the ESA with NMFS. NMFS has concurred that with implementation of mitigation measures, the Proposed Action may affect, but is not likely to adversely affect, ESA-listed species and has signed a letter of concurrence on 19 November, 2010. A full description of the informal green sea turtle consultation process is provided in Chapter 6 and Appendix G provides a list of the SSTC informal consultation documentation. Agency correspondence and supporting documentation can be found on the SSTC EIS website at www.silverstrandtrainingcomplexeis.com.

Table 3.10-4: Summary of Effects

Alternative	Effects
No Action Alternative	• Underwater detonations, vessel strikes, and noise associated with marine vessels and pile driving are unlikely to adversely impact sea turtles due to their rarity in the SSTC, the concentration of activities in ocean boat lanes, and implementation of mitigation measures. • Training activities under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed turtles.
Alternative 1	• Training tempo would increase; however, impacts are expected to be substantially the same as the No Action Alternative. • Training activities under Alternative 1 may affect, but is not likely to adversely affect, ESA-listed turtles.
Alternative 2	• Training tempo would increase; however, impacts are expected to be substantially the same as the No Action Alternative. • Training activities under Alternative 2 may affect, but is not likely to adversely affect, ESA-listed turtles.
Mitigation Measures	Mitigation measures for very shallow water (VSW) underwater detonations on SSTC oceanside (0-24 feet): • Easily visible anchored floats will be positioned on a 1,200 foot or 400 yard radius of a roughly semi-circular zone (the shoreward half being bounded by shoreline and immediate off-shore water) around the detonation location for small explosive exercises at the SSTC. These mark the outer limits of the mitigation zone. • For each VSW underwater detonation event, a safety-boat with a minimum of one observer is launched 30 or more minutes prior to detonation and moves through the area around the detonation site. The task of the safety observer is to exclude humans from coming into the area and to augment a shore observer's visual search of the mitigation zone for sea turtles. The safety-boat observer is in constant radio communication with the exercise coordinator and shore observer discussed below. • A shore-based observer will also be deployed for VSW detonations in addition to boat based observers. The shore observer will indicate that the area is clear of sea turtles after 10 or more minutes of continuous observation with no sea turtles having been seen in the mitigation zone (1,200 feet or 400 yards) or moving toward it. • At least 10 minutes prior to the planned initiation of the detonation event-sequence, the shore observer, on an elevated on-shore position, begins a continuous visual search with binoculars of the mitigation zone. At this time, the safety-boat observer informs the shore observer if any sea turtle has been seen in the zone and, together, both search the surface within and beyond the mitigation zone for sea turtles. • The observers (boat and shore based) will indicate that the area is not clear any time a sea turtle is sighted in the mitigation zone or moving toward it and, subsequently, indicate that the area is clear of sea turtles when the animal is out and moving away and no other sea turtles have been sited. • Initiation of the detonation sequence will only began on final receipt of an indication from the shore observer that the area is clear of sea turtles and will be postponed on receipt of an indication from that any observer that the area is not clear of sea turtles. • Following the detonation, visual monitoring of the mitigation zone continues for 30 minutes for the appearance of any sea turtle in the zone. Any sea turtle appearing in the area will be observed for signs of possible injury.

Table 3.10-4: Summary of Effects (Continued)

Alternative	Effects
Mitigation (Continued)	• Any sea turtle observed after a VSW underwater detonation either injured or exhibiting signs of distress will be reported to Navy environmental representatives from the regional Navy shore commander (Commander, Navy Region Southwest) and U.S. Pacific Fleet, Environmental Office, San Diego Detachment. The Navy will report these events to the Stranding Coordinator of NMFS' Southwest Regional Office using Marine Mammal Stranding communication trees and contact procedures established for the Southern California Range Complex. These voice or email reports will contain the date and time of the sighting, location (or if precise latitude and longitude is not currently available, then the approximate location in reference to an established SSTC beach feature), species description (if known), and indication of the animal's status. Mitigation measures for shallow water underwater detonations on SSTC oceanside (24-72 feet): • A mitigation zone of 1,500 feet or 500 yards will be established around each underwater detonation point. • A minimum of two boats, including but not limited to small zodiacs and 11-meter Rigid Hulled Inflatable Boats (RHIB) will be deployed. One boat will act as an observer platform, while the other boat is typically the diver support boat. • Two observers with binoculars on one small craft\boat will survey the detonation area and the mitigation zone for sea turtles from at least 30 minutes prior to commencement of the scheduled explosive event and until at least 30 minutes after detonation. • In addition to the dedicated observers, all divers and boat operators engaged in detonation events can potentially monitor the area immediately surrounding the point of detonation for sea turtles. • If a sea turtle is sighted within the 1,500 foot or 500 yard mitigation zone or moving towards it, underwater detonation events will be suspended until the sea turtle has voluntarily left the area and the area is clear of sea turtles for at least 30 minutes. • Immediately following the detonation, visual monitoring for sea turtles within the mitigation zone will continue for 30 minutes. Any sea turtles observed after an underwater detonation either injured or exhibiting signs of distress will be reported to Navy environmental representatives from the regional Navy shore commander (Commander, Navy Region Southwest) and U.S. Pacific Fleet, Environmental Office, San Diego Detachment. The Navy will report these events to the Stranding Coordinator of NMFS' Southwest Regional Office stranding coordinator using Marine Mammal Stranding communication trees and contact procedures established for the Southern California Range Complex. These voice or email reports will contain the date and time of the sighting, location (or if precise latitude and longitude is not currently available, then the approximate location in reference to an established SSTC beach feature), species description (if known), and indication of the animal's status.

Table 3.10-4: Summary of Effects (Continued)

Alternative	Effects
Mitigation (Continued)	Mitigation for ELCAS/Pile Driving Activities on SSTC oceanside: • A mitigation zone will be established at 150 feet or 50 yards from ELCAS pile driving and pile removal events. This mitigation zone is based on the predicted range to Level A harassment (180 dB RMS) for cetaceans, and is being applied conservatively to sea turtles. • Monitoring will be conducted within the 150 foot or 50 yard mitigation zone surrounding ELCAS pile driving and removal events for the presence of sea turtles before, during, and after pile driving and removal events • If sea turtles are found within the 150 foot or 50 yard mitigation zone, pile removal events will be halted until the sea turtles have voluntarily left the mitigation zone. • Monitoring for sea turtles will take place concurrent with pile removal events and 30 minutes prior to pile driving and removal commencement. A minimum of one trained observer will be placed on shore, on the ELCAS, or in a boat at the best vantage point(s) practicable to monitor for sea turtles. • Monitoring observer(s) will implement shut–down/delay procedures when applicable by calling for shut–down to the hammer operator when sea turtles are sighted within the mitigation zone. • Soft Start - Providing additional protection for sea turtles, ELCAS pile driving includes a soft start as part of normal construction procedures. The pile driver increases impact strength as resistance goes up. At first, the pile driver piston drops a few inches. As resistance goes up, the pile driver piston will drop from a higher distance thus providing more impact due to gravity. This will allow sea turtles in the project area to vacate or begin vacating the area minimizing potential harassment. The ELCAS soft start is not the traditional soft-start used in bigger civilian construction projects, and doesn't include a waiting period (an initial set of several strikes from the impact hammer at 40-60 percent energy levels, followed by a one minute waiting period, then two subsequent 3 strike sets), but does provide additional time for sea turtles to vacate the area. Including waiting periods as part of training would be inconsistent with Navy training objectives that requires the ELCAS to be constructed as quickly as possible in real world conditions to ensure rapid supply of equipment and materials to shore in a hostile territory during wartime, or during humanitarian assistance operations. For underwater detonations on SSTC oceanside under Alternative 1 and 2: • The buffer for very shallow water detonations (0 to 24 feet of water) and for shallow water detonations (in 24 to 72 feet of water) will be the same as described for the No Action Alternative. For SWAG charges laid bayside on SSTC under Alternative 1 and 2: • A buffer zone of 180 feet will be established around each SWAG detonation point.

Table 3.10-4: Summary of Effects (Continued)

Alternative	Effects
Mitigation (Continued)	• Observer(s) with binoculars and small craft will survey the detonation area and the buffer zone for sea turtles from at least 10 minutes prior to commencement of the scheduled explosive event until at least 10 minutes after detonation. Observers will pay extra attention within the buffer zone to large amounts of floating kelp strands and other marine debris (if any), since these may provide shelter and food for sea turtles. • Divers placing charges on mines and dive support vessels will check the area immediately around the mine location for sea turtles. • If a sea turtle is sighted within the buffer zone or moving towards it, exercises will be suspended until the animal has voluntarily left the area and the area is clear of sea turtles for at least 10 minutes. • Immediately following the detonation, visual monitoring for sea turtles within the buffer zone will continue for 10 minutes. Any animals appearing will be observed for signs of injury. Injured sea turtles will be reported to the CNRSW Environmental Director, the PACFLT Environmental Office, and NMFS regional stranding coordinator. As a result of the informal green sea turtle consultation with NMFS, the Navy will implement an additional mitigation measure: • If there are sea turtles known to be equipped with sonic tags in the area of and during pile driving operations, Navy will collaborate with NMFS to analyze movements of these turtles in the immediate area during pile driving. Following any monitoring of sound attenuation associated with pile driving, the Navy will share the results with NMFS and provide recalculations of buffer zones as they are available.