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3.8 SEA TURTLES

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* (hard-shelled 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 (Natural Research Council 1990; Eckert 1995). As a result, all six species of sea turtles found in United States (U.S.) waters are currently listed as either threatened or endangered under the Endangered Species Act (ESA).

Sea turtles are highly adapted for life in the marine environment. Unlike terrestrial and freshwater turtles, sea turtles possess powerful, modified forelimbs (or flippers) that enable them to swim continuously for extended periods of time (Wyneken 1997). 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 the aforementioned suite of adaptations very important (Ernst et al. 1994; Meylan 1995).

Sea turtle traits and behaviors also help protect them from predation. Most sea turtle species have a tough outer shell and grow to a large size as adults; mature leatherback turtles (*Dermochelys coriacea*) can weigh up to 2,091 pounds (lb) (Eckert and Luginbuhl 1988). Sea turtles cannot withdraw their head or limbs into their shell, so growing to a large size as adults is important.

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 harmful mating encounters, 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). On occasion, sea turtles can unintentionally end up on land if they are dead, sick, injured, or cold-stunned. These events, also known as strandings, can be caused by either biotic (e.g., predation and disease) or abiotic (e.g., water temperature) factors.

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 tend to renest in close proximity during subsequent nesting attempts. The leatherback turtle is a notable divergence from this pattern. This species nests primarily on beaches with little reef or rock offshore. On these types of beaches 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 occur at sea off the coast of Southern California: loggerhead (*Caretta caretta*), eastern Pacific green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), and leatherback (*Dermochelys coriacea*). 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; López-Castro et al. 2000). Due to the primarily oceanic distributions of the leatherback, loggerhead, and olive ridley turtles off Southern California, the southwestern portion of the Southern California (SOCAL) Range Complex is designated as an area of primary occurrence for all sea turtle species (DoN 2005); although their presence within the SOCAL Range Complex is considered rare. There is also an area of primary occurrence in southern San Diego Bay due to the year-round prevalence of green turtles in those waters near the warm water outflow of a power plant. All are currently listed as either endangered or threatened under the ESA.

The distribution of sea turtles is strongly affected by seasonal changes in ocean temperature (Radovich 1961). In general, sightings increase during summer as warm water moves northward along the coast (Stinson 1984). Sightings may also be more numerous in warm years compared to cold years.

Sea turtles typically remain submerged for several minutes to several hours depending upon their activity state (Standora et al. 1984; 1994; Renaud and Carpenter 1994). Long periods of submergence hamper detection and confound census efforts.

Young loggerhead, green, and olive ridley turtles are believed to move offshore into open ocean convergence zones where abundant food attracts predators, including sea turtles (Carr 1987; NRC 1990; NMFS and USFWS 1998a; Gooding and Magnuson 1967). A survey of the eastern tropical Pacific found that sea turtles were present during 15 percent of observations in habitats of floating debris and material of biological origin (flotsam) (Pitman 1990; Arenas and Hall 1992).

Stinson (1984) reported that over 60 percent of eastern Pacific green and olive ridley turtles observed in California waters were in waters less than 165 feet (ft) (50 meters [m]) in depth. Green turtles were often observed along shore in areas of eelgrass. Loggerheads and leatherbacks were observed over a broader range of depths out to 3,300 ft (1,000 m). When sea turtles reach subadult size, they move to the shallow, nearshore benthic feeding grounds of adults (Carr 1987; NRC 1990; NMFS and USFWS 1998b). Aerial surveys off California, Oregon, and Washington have shown that most leatherbacks occur in slope waters and that few occur over the continental shelf (Eckert 1993). Tracking studies found that migrating leatherback turtles often travel parallel to deepwater contours ranging in depth from 650 to 11,500 ft (200 to 3,500 m) (Morreale et al. 1994).

3.8.1 Affected Environment

3.8.1.1 Existing Conditions

3.8.1.1.1 Sea Turtle Species

Green Turtle (Chelonia mydas)

The green turtle was listed under the ESA in July 1978, because of overexploitation for commercial and other purposes, the lack of adequate regulatory mechanisms and effective enforcement, evidence of declining numbers, and habitat loss and degradation (NMFS and USFWS 2007a). The breeding populations off Florida and the Pacific coast of Mexico are listed as endangered, whereas all others are classified as threatened. Climate change and fisheries bycatch may continue to affect nesting and foraging of this species (NMFS and USFWS 2007).

Green turtle hatchlings are 2 inches (in.) (50 millimeters [mm]) long, and weigh approximately one ounce (oz.) (28 grams [g]). Growth rates of juveniles, subadults, and adult green turtles measured at seven resident sites in the Hawaiian Archipelago revealed substantial variation; with annual growth rates ranging from highs of 1.8 in. to 2.5 in. (4.5 cm to 6.25 cm) at one location to lows of 0.1 in. to 0.6 in. (0.25 cm to 1.5 cm) at another location. These differences are probably a function of food availability and quality (Balazs 1980). It is estimated that green turtles reach sexual maturity sometime between 20 and 50 years of age. Adults can grow to more than 3 ft (0.91 m) long (straight carapace length [SCL]) and weigh 300 to 350 lb (136-159 kilograms [kg]).

The worldwide green sea turtle population is estimated at 88,520 nesting females (Spotila 2004). The worldwide population has declined 50 to 70 percent since 1900. In Michoacán, Mexico, the nesting colony declined from 25,000 in the 1970s to the current level of approximately 850 (Spotila 2004).

The green turtle is widely distributed in tropical and subtropical waters near continental coasts and around islands. Green turtles typically migrate along coastal routes from rookeries to feeding grounds, although some populations conduct transoceanic migrations (e.g., Ascension Island–Brazil). Hatchlings are epipelagic (surface dwelling in the open sea) for approximately 1 to 3 years. Hatchlings live in bays and along protected shorelines, and feed during the day on seagrass and algae (Bjorndal 1982). Juvenile and subadult green turtles may travel thousands of kilometers before they return to breeding and nesting grounds (Carr et al. 19787).

The green turtle is the only genus of sea turtle that is mostly herbivorous (Mortimer 1995). Throughout most of its range, the green turtle forages primarily on seagrass, and on algae when seagrass is absent (Carr 1952; Pritchard 1971; Balazs et al. 1995; Mortimer 1995). Occasionally, green turtles will consume macrozooplankton, including jellyfish, kelp, sponges (Carr 1952), and mangrove leaves (Pritchard 1971).

Green turtles typically make dives shallower than 30 m (Hochscheid et al., 1999; Hays et al., 2000), although they have been observed at depths of 73 to 110 m in the eastern Pacific Ocean (Berkson, 1967). The maximum dive time recorded for a juvenile green turtle around the Hawaiian Islands is 66 min, with routine dives ranging from 9 to 23 minutes (Brill et al. 1995).

Major nesting beaches for green turtles are found throughout the western and eastern Atlantic, Indian Ocean, and western Pacific (EuroTurtle 2001). However, there are no known nesting sites on the U.S. West Coast (NMFS and USFWS 1998b).

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. 1994). Green turtles are sighted year-round in the waters of Southern California, with the highest frequency of sightings occurring during the warm summer months of July to 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.

South of the United States, green turtles are widely distributed in the coastal waters of Mexico and Central America (e.g., Cliffton et al. 1982; Cornelius 1982). Along the coast of Mexico and Central America, the main aggregations of East Pacific green turtles occur in the breeding grounds of Michoacán, Mexico (August-January) and year-round in the 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 and USFWS 1998b). Bahía de Los Angeles in the Gulf of California is an important foraging area for green turtles (Seminoff et al. 2003).

According to tag-recovery data for the eastern Pacific Ocean, green turtle migrations occur between the northern and southern extremes of their range. Recoveries of nesting females tagged on the beaches of Michoacán have been documented from throughout Central America and also from Mexican waters, primarily from the Gulf of California and adjacent waters, and from the coast of Oaxaca. IATTC data suggest that green turtles are rare near the Mexican coast, and are only present during October through December (NMFS and USFWS 1998b).

Although the green turtle is the most common sea turtle off the coast of California, it would be rare in the Environmental Impact Statement (EIS) Study Area, if it occurred at all, because it occurs mainly in shallow waters where it can feed on seagrass and sea algae.

Leatherback Turtle (*Dermochelys coriacea*)

The leatherback turtle was listed as endangered throughout its range in June 1970 (Federal Register Vol. 35 No. 106 pp 8491-8498). Critical habitat has not been identified for this species in the Pacific, largely because nesting areas are not known and important foraging areas have not been identified (NMFS and USFWS 2007b).

Leatherback hatchlings are approximately 2 to 3 in. (50-77 cm) in length and weigh approximately 1.4 to 1.8 oz (40-50 g). The incremental growth observed in two recaptured juvenile leatherbacks after 1 and 1.5 months foraging in Delaware Bay was 0.7 and 1.2 in. (1.9 and 3.0 cm) in length and 3.3 and 6.0 lb (1.5 and 2.7 kg) in weight, respectively. This equates to an average growth rate of approximately 0.8 in (2.0 cm) SCL and 3.3 lb (1.5 kg) per month during the summer (Eggers et al. 2001). The adult leatherback is the largest turtle in the world. Mature males and females can be as long as 6.5 ft (2 m) and weigh almost 2,100 lb (900 kg).

The world leatherback turtle population is currently 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 1 percent of the levels recorded in the 1950s (NMFS 2006). Sarti Martinez et al. (2007) reported a decline of tens of thousands of nests in the 1980's to only 120 nests at four study beaches in 2004.

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). Hatchling leatherbacks are pelagic, but nothing is known about their distribution for the first 4 years (Musick and Limpus 1997). 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 2002a).

Leatherbacks feed mainly on jellyfish, tunicates, and other epipelagic soft-bodied invertebrates (Hartog and van Nierop 1984; Davenport and Balazs 1991). There is evidence that leatherbacks are associated with oceanic front systems, such as shelf breaks and the edges of oceanic gyre systems where their prey is concentrated (Lira et al. 1996).

This species is one of the deepest divers in the ocean, with dives deeper than 3,280 ft (1,000 m) (Eckert et al. 1988). The leatherback dives continually and spends short periods of time on the surface between dives (Eckert et al. 1986; Southwood et al. 1998). Typical dive durations averaged 6.9 to 14.5 minutes per dive, with a maximum of 42 minutes (Eckert et al. 1996). During migrations or long-distance movements, leatherbacks maximize swimming efficiency by traveling within 5 m of the surface (Eckert 2002).

After analyzing some 363 records of sea turtles sighted along the Pacific coast of North America, Stinson (1984) concluded that the leatherback was the most common sea turtle in U.S. waters north of Mexico. Sightings and incidental capture data indicate that leatherbacks are found in Alaska as far north as 60°N, 145°W, and as far west as the Aleutian Islands, and documented encounters extend southward through the waters of British Columbia, Washington and Oregon, and California (NMFS and USFWS 1998a).

Leatherbacks occur north of central California during the summer and fall, when sea surface temperatures are highest (Dohl et al. 1983; Brueggeman 1991). There is some evidence that they follow the 61 degree Fahrenheit (ºF) (16 degree Celsius [ºC]) isotherm into Monterey Bay, and the length of their stay apparently depends on prey availability (Starbird et al. 1993). Some aerial surveys of California, Oregon, and Washington waters suggest that most leatherbacks occur in continental slope waters and fewer occur over the continental shelf. There were 96 sightings of leatherbacks within 27 nautical miles (nm) (50 kilometers [km]) of Monterey Bay from 1986 to 1991, mostly by recreational boaters (Starbird et al. 1993). Fishermen "regularly" catch leatherbacks in drift/gill nets off Monterey Bay (NMFS and USFWS 1998a).

The leatherback turtle is rare in the waters in and near San Clemente Island (SCI). It likely would be encountered only in the offshore waters of the SOCAL OPAREAs because of its preference for the pelagic habitat, and likely only in July to September.

Loggerhead Turtle (*Caretta caretta*)

The loggerhead turtle was listed under the ESA as threatened throughout its range in July 1978, primarily because of direct take, incidental capture in various fisheries, and the alteration and destruction of its habitat including nesting beaches (NMFS 2002c; NMFS and USFWS 2007c).

At emergence, hatchlings average 1.8 in. (45 mm) in length and weigh approximately 0.04 lb (20 g). They reach sexual maturity at about 35 years of age. Mean SCL of adults in the southeastern U.S. is approximately 36 in. (92 cm); corresponding weight is about 250 lb (113 kg).

The global population of loggerhead turtles is estimated at 43,320 to 44,560 nesting females (Spotila 2004). In the Pacific, loggerheads nest mostly in Japan and Australia, and populations nesting there declined markedly between the 1970s and 1990s (NMFS 2002c). The Pacific population of nesting females is estimated at 1,200 (Spotila 2004).

The loggerhead is a widely distributed species, occurring in coastal tropical and subtropical waters around the world. Loggerhead turtles undertake long migrations that take them far from their breeding grounds. They prefer to feed in coastal bays and estuaries, and in the shallow waters along continental shelves. Adult loggerheads feed on a variety of benthic fauna like conchs, crabs, shrimp, sea urchins, sponges, and fish. During migration through the open sea, they eat jellyfish, pteropods, floating mollusks, floating egg clusters, flying fish, and squid.

On average, loggerhead turtles spend over 90 percent of their time underwater (Byles 1988; Renaud and Carpenter 1994). In the North Pacific Ocean, two loggerheads tagged with satellite-linked depth recorders spent about 40 percent of their time in the top meter and virtually all their time shallower than 328 ft (100 m); 70 percent of the dives were no deeper than 16 ft (5 m) (Polovina et al. 2003). Off Japan, virtually all the dives of two loggerheads between nesting were shallower than 98 ft (30 m) (Sakamoto et al., 1993). Routine dives can last 4 to 172 minutes (Byles 1988; Sakamoto et al. 1990; Renaud and Carpenter 1994). Small juvenile loggerheads live at or near the surface; for the 6 to 12 years spent at sea as juveniles, they spend 75 percent of their time in the top 16 ft (5 m) of water (Spotila 2004). Juveniles spend more time on the surface in deep, offshore areas than in shallow, nearshore waters (Lutcavage and Lutz 1997).

There are no reported loggerhead nesting sites in the eastern or central Pacific (NMFS 2002c). Most of the loggerheads in the eastern Pacific are believed to originate from beaches in Japan, where the nesting season is late May to August (NMFS and USFWS 1998c). The size structure of loggerheads in coastal and nearshore waters of the eastern and western Pacific suggest that Pacific loggerheads have a pelagic stage similar to that in the Atlantic (NMFS 2002c); loggerheads spend the first 6 to 12 years of their lives at sea (Spotila, 2004). Large aggregations (thousands) of mainly juveniles and subadult loggerheads are found off the southwestern coast of Baja California (Nichols et al. 2000), in a band starting about 16 nm (30 km) offshore and extending out at least another 16 nm (30 km) with maximum abundance at Bahia Magdalena (NMFS and USFWS 1998c). Bartlett (1989 in NMFS and USFWS 1998c) reported the range of sizes to be 8- to 32-in (20- to 80-cm) shell length (mean = 24 in [60 cm]); no hatchlings or mature adults were present. Concentrations ranged from 0.3 to 1.5 turtles per square nautical mile (nm^2) (1.0 to 5.0 per square kilometer [km²]) at peak sightings in good weather. Some loggerheads also enter the Gulf of California; Seminoff et al. (2003) recorded them at Bahía de Los Angeles and the Infiernillo Channel, but the low capture per unit effort suggested that the Gulf of California may not provide critical habitat for loggerhead turtles in the eastern Pacific.

Most records of loggerheads off the U.S. West coast are from Southern California (Stinson, 1984; Guess 1981a, 1981b), but there are a few sightings from Washington (Hodge 1982) and Alaska (Bane 1992). Most of the sightings in northern U.S. waters are of juveniles; of 43 records summarized by Stinson (1984), only a few may have been adults or near adults, e.g., in the Channel Islands and in Encinitas, California. Sightings are typically confined to the summer months in the eastern Pacific, peaking in July to September off Southern California and southwestern Baja California (Stinson 1984; NMFS and USFWS 1998c).

Olive Ridley Turtle (*Lepidochelys olivacea*)

The olive ridley turtle was listed under the ESA as endangered for the Pacific Mexican nesting population and threatened for all other populations in July 1978. The endangered classification was based on the extensive overharvesting of olive ridleys in Mexico, which caused a severe population decline (NMFS and USFWS 2007d).

Hatchlings emerge weighing less than 1 oz. (<28 g) and measuring about 1.5 in. (3.8 cm). Adult turtles are relatively small, weighing on average around 100 lb (45 kg). Olive ridleys reach sexual maturity in 15 years. The size and morphology of the olive ridley varies from region to region. Nesting females vary in size between 22 and 31 in. (56-79 cm) SCL with the largest animals being observed on the Pacific coast of Mexico.

The olive ridley is the most abundant sea turtle in the world. The worldwide population of olive ridley turtles is estimated at ~2 million nesting females (Spotila 2004). Worldwide, olive ridleys are in serious decline (Spotila 2004), but most nesting populations along the Pacific coast of Mexico and Costa Rica appear to be stable or increasing, after an initial large decline because of harvesting of adults (NMFS 2002d).

The olive ridley has a large range in tropical and subtropical regions in the Pacific, Indian, and South Atlantic oceans, and is generally found between 40ºN and 40ºS. Most olive ridley turtles lead a primarily pelagic existence. The Pacific population migrates throughout the Pacific, from their nesting grounds in Mexico and Central America to the North Pacific (NMFS, 2002d). The postnesting migration routes of olive ridleys tracked via satellite from Costa Rica traversed thousands of kilometers of deep oceanic waters ranging from Mexico to Peru, and more than 1,864 mi (3,000 km) out into the central Pacific (Plotkin et al., 1994). The olive ridley is the most abundant sea turtle in the open ocean waters of the eastern tropical Pacific Ocean (Pitman 1990).

Olive ridley turtles are primarily carnivorous and opportunistic. They consume snails, clams, sessile and pelagic tunicates, bottom fish, fish eggs, crabs, oysters, sea urchins, shrimp, pelagic jellyfish, and pelagic red crab (Fritts 1981; Marquez 1990; Mortimer 1995). Olive ridley turtles can dive and feed at considerable depths (260–1,000 ft [80–300 m]) (Eckert 1995), although only about 10 percent of their time is spent at depths greater than 328 ft (100 m) (Eckert et al. 1986; Polovina et al. 2003). In the eastern tropical Pacific Ocean, at least 25 percent of their total dive time is spent in the permanent thermocline, located at 66 to 328 ft (20–100 m) (Parker et al. 2003). Olive ridleys spend considerable time at the surface basking, presumably in an effort to speed their metabolism and digestion after a deep dive (Spotila 2004). In the open ocean of the eastern Pacific, olive ridley turtles are often seen near flotsam, possibly feeding on associated fish and invertebrates (Pitman 1992). In the North Pacific Ocean, two olive ridleys tagged with satellite-linked depth recorders spent about 20 percent of their time in the top meter and about 10 percent of their time deeper than 328 ft (100 m); 70 percent of the dives were no deeper than 16 ft (5 m) (Polovina et al. 2003).

Females and males begin to aggregate in “reproductive patches” near their nesting beaches 2 months before the nesting season, and most mating is generally assumed to occur near the nesting beaches (NMFS 2002d). Most olive ridleys nest synchronously in huge colonies called “arribadas,” with several thousand females nesting at the same time; others nest alone, out of sequence with the arribada (Kalb and Owens 1994). The arribadas usually last from three to seven nights (April 1994). Most females lay two clutches of eggs with an inter-nesting period of 1 to 2 months (Plotkin et al. 1994). Radio-tracking studies showed that females that nested in arribadas remain within 3 mi (5 km) of the beach most of the time during the inter-nesting period (Kalb and Owens 1994). Solitary nesting also occurs, but numbers are much lower than in arribadas, and there are other differences in behavior.

Although most mating is generally assumed to occur near nesting beaches, Pitman (1990) observed olive ridleys mating at sea, as far as 1850 km from the nearest mainland, during every month of the year except March and December. However, there was a sharp peak in offshore mating activity during August and September, corresponding with peak breeding activity in mainland populations. Turtles observed during National Marine Fisheries Service (NMFS)/Southwest Fisheries Science Center (SWFSC) dolphin surveys during July to December 1998 and 1999 were captured; 50 of 324 were involved in mating (Kopitsky et al. 2002). Aggregations of turtles, sometimes >100 individuals, have been observed as far offshore as 120°W, ~1,620 nm (3,000 km) from shore (Arenas and Hall 1991).

In the eastern Pacific, the largest nesting concentrations occur in southern Mexico and northern Costa Rica, with stragglers nesting as far north as southern Baja California (Fritts et al. 1982) and as far south as Peru (Brown and Brown 1982). Of the 160,000 olive ridleys nesting annually in Mexico, only three are in northern Baja and 71 are in southern Baja with the rest nesting on mainland areas (NMFS and USFWS 1998d). Olive ridleys nest throughout the year in the eastern Pacific with peak months, including major arribadas, occurring from September through December (NMFS and USFWS 1998d). There is no known nesting on the U.S. West Coast.

Outside of the breeding season, the turtles disperse, but little is known of their behavior. Neither males nor females migrate to one specific foraging area, but exhibit a nomadic movement pattern and occupy a series of feeding areas in the oceanic waters (Plotkin et al., 1994). Sightings of large aggregations of ridleys at sea (e.g., Oliver 1946) have led to unconfirmed speculation that turtles travel in large flotillas between nesting beaches and feeding areas (Márquez 1990). Arenas and Hall (1991) reported aggregations of over 100 animals as far offshore as 120ºW.

Tagged turtles nesting in Costa Rica were recovered as far south as Peru, as far north as Oaxaca, Mexico, and offshore to a distance of 1,080 nm (2,000 km) (Cornelius and Robinson 1986 in NMFS and USFWS, 1998d). Data collected during tuna fishing cruises from Baja California to Ecuador and from the coast to almost 150ºW indicated that the two most important areas in the Pacific for the olive ridley are the central American coast and the nursery/feeding area off Colombia and Ecuador, where both adults (mostly females) and juveniles are often seen (NMFS and USFWS 1998d).

At-sea occurrences in the U.S. and waters under U.S. jurisdiction are limited to the west coast of the continental U.S. (Stinson 1984) and Hawaii. Many published records located north of Southern California are of dead, stranded turtles. Known records from Alaska (n=3) were all dead stranded turtles (Hodge and Wing 2000), and an olive ridley stranded on the ocean side of Point Reyes Peninsula was also dead (Evens 1993). However, there are also a number of California sightings of live olive ridleys. Hubbs (1977) reported a pair mating off the La Jolla coast, and an adult was hooked by a fisherman in Los Angeles Harbor in 1983 (NMFS and USFWS 1998d). In October 2001, a live adult male was found entangled in fishing line ~0.5 nm (1 km) west of Muir Point off Marin County, and in November 2002 an olive ridley was observed swimming up to and hauling out on Shell Beach in Tomales Bay State Park (Steiner and Walder 2005).

3.8.1.1.2 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). 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 distal end of 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 sounds of waves breaking on a beach.

The role of underwater low-frequency hearing in sea turtles is unclear. It has been suggested that 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 loggerhead sea turtles is 100 to 800 Hz, with an upper limit of about 2,000 Hz (Lenhardt 1994). In general the effective range of hearing for green and loggerhead sea turtles is 100 to 500 Hz (Ridgway et al. 1969; Moein 1994; Moein et al. 1994; Bartol and Ketten 2003). Hearing below 80 Hz 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, and concluded that they have a useful hearing span of perhaps 60 to 1,000 Hz, but hear best from about 200 hertz (Hz) 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. At 70 Hz, it was about 70 dB in air. Bartol et al. (1999) reported that juvenile loggerhead sea turtles (*Caretta caretta*) hear sounds between 250 and 1,000 Hz.

Lenhardt et al. (1983) applied audio frequency vibrations at 250 Hz and 500 Hz to the heads of loggerheads and Kemp’s ridleys submerged in salt water to observe their behavior, measure the attenuation of the vibrations, and assess any neural-evoked response. These stimuli (250 Hz, 500 Hz) 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 even within the optimal hearing range is apparently low as threshold detection levels in water are relatively high at 160 to 200 dB re 1 micro-Pascal (µPa) (Lenhardt 1994).

3.8.1.2 Current Mitigation Measures

The comprehensive suite of protective measures and Standard Operating Procedures (SOPs) implemented by the Navy to reduce impacts to marine mammals also serves to mitigate potential impacts on sea turtles. In particular, personnel and watchstander training, establishment of turtle-free exclusion zones for underwater detonations of explosives, and pre- and postexercise surveys, all serve to reduce or eliminate potential impacts of Navy activities on sea turtles that may be present in the vicinity. Applicable mitigation measures, as described in detail in Chapter 5, are summarized here.

3.8.1.2.1 Personnel Training—Watchstanders and Lookouts

The use of shipboard lookouts is a critical component of all Navy protective measures. Navy shipboard lookouts (also referred to as "watchstanders") are highly qualified and experienced observers of the marine environment. Their duties require that they report all objects sighted in the water to the Officer of the Deck (OOD) (e.g., trash, a periscope, marine mammals, sea turtles) and all disturbances (e.g., surface disturbance, discoloration) that may be indicative of a threat to the vessel and its crew. There are personnel serving as lookouts on station at all times (day and night) when a ship or surfaced submarine is moving through the water.

3.8.1.2.2 Operating Procedures and Collision Avoidance

- Prior to major exercises, a Letter of Instruction, Mitigation Measures Message, or Environmental Annex to the Operational Order will be issued to further disseminate the personnel training requirement and general marine species protective measures.
- Commanding Officers (COs) will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.
- Where feasible and consistent with mission and safety, vessels will avoid closing to within 200 yards (yd.) (183 m) of sea turtles.
- Floating weeds and kelp, algal mats, clusters of seabirds, and jellyfish are good indicators of sea turtles and marine mammals. Therefore, increased vigilance in watching for sea turtles and marine mammals will be taken where these are present.

3.8.1.2.3 Measures for Specific Training Events

Surface-to-Surface Gunnery (5-inch, 76-millimeter (mm), 20-mm, 25-mm and 30-mm explosive rounds)

- Lookouts will visually survey for floating weeds and kelp, and algal mats which may be inhabited by immature sea turtles in the target area. Intended impact shall not be within 600 yd. (585 m) of known or observed floating weeds and kelp, and algal mats.
- A 600-yd. (550 m) radius buffer zone will be established around the intended target.
- From the intended firing position, lookouts will survey the buffer zone for sea turtles prior to commencement and during the exercise as long as practicable.

Surface-to-Surface Gunnery (nonexplosive rounds)

- Lookouts will visually survey for floating weeds and kelp, and algal mats which may be inhabited by immature sea turtles in the target area. Intended impact will not be within 200 yd. (183 m) of known or observed floating weeds and kelp, and algal mats.
- A 200-yd. (183-m) radius buffer zone will be established around the intended target.
- From the intended firing position, lookouts will survey the buffer zone for sea turtles prior to commencement and during the exercise as long as practicable.
- When manned, target towing vessels will maintain a lookout. If a sea turtle is sighted in the vicinity of the exercise, the tow vessel will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.
- The exercise will be conducted only when the buffer zone is visible and sea turtles are not detected within the target area and the buffer zone.

Surface-to-Air Gunnery (explosive and nonexplosive rounds)

- Vessels will orient the geometry of gunnery exercises in order to prevent debris from falling in the area of sighted sea turtles, algal mats, and floating kelp.
- Vessels will expedite the recovery of any parachute-deploying aerial targets to reduce the potential for entanglement of sea turtles.
- Target towing aircraft shall maintain a lookout. If a sea turtle is sighted in the vicinity of the exercise, the lookout on the aircraft towing the target will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.

Air-to-Surface Gunnery (explosive and nonexplosive rounds)

- If surface vessels are involved, lookouts will visually survey for floating kelp, which may be inhabited by immature sea turtles, in the target area. Impact should not occur within 200 yd. (183 m) of known or observed floating weeds and kelp or algal mats.
- A 200-yd. (183-m) radius buffer zone will be established around the intended target.
- If surface vessels are involved, lookout(s) will visually survey the buffer zone for sea turtles prior to and during the exercise.
- Aerial surveillance of the buffer zone for sea turtles will be conducted prior to commencement of the exercise. Aerial surveillance altitude of 500 to 1,500 ft (152-456 m) is optimum. Aircraft crew/pilot will maintain visual watch during exercises. Release of ordnance through cloud cover is prohibited: aircraft must be able to actually see ordnance impact areas.
- The exercise will be conducted only if sea turtles are not visible within the buffer zone.

Small Arms Training (grenades, explosive and nonexplosive rounds)

- Lookouts will visually survey for floating weeds or kelp, algal mats, marine mammals, and sea turtles. Weapons will not be fired in the direction of known or observed floating weeds or kelp, algal mats, and sea turtles.

Air-to-Surface At-Sea Bombing Exercises (explosive bombs and cluster munitions, rockets)

- If surface vessels are involved, lookouts will survey for floating kelp, which may be inhabited by immature sea turtles. Ordnance shall not be targeted to impact within 1,000 yd. (914 m) of known or observed floating kelp, sea turtles, or marine mammals.
- A buffer zone of 1,000-yd. (914-m) radius will be established around the intended target.
- Aircraft will visually survey the target and buffer zone for sea turtles prior to and during the exercise. The survey of the impact area will be made by flying at 1,500 feet or lower, if safe to do so, and at the slowest safe speed. Release of ordnance through cloud cover is prohibited: aircraft must be able to actually see ordnance impact areas. Survey aircraft should employ most effective search tactics and capabilities.
- The exercises will be conducted only if sea turtles are not visible within the buffer zone.

Air-to-Surface At-Sea Bombing Exercises (nonexplosive bombs and cluster munitions, rockets)

- If surface vessels are involved, lookouts will survey for floating kelp, which may be inhabited by immature sea turtles, and for sea turtles and marine mammals. Ordnance shall not be targeted to impact within 1,000 yd. (914 m) of known or observed floating kelp, sea turtles, or marine mammals.
- A 1,000-yd. (914-m) radius buffer zone will be established around the intended target.
- Aircraft will visually survey the target and buffer zone for sea turtles prior to and during the exercise. The survey of the impact area will be made by flying at 1,500 ft (152 m) or lower, if safe to do so, and at the slowest safe speed. Release of ordnance through cloud cover is prohibited: aircraft must be able to actually see ordnance impact areas. Survey aircraft should employ most effective search tactics and capabilities.
- The exercise will be conducted only if sea turtles are not visible within the buffer zone.

Air-to-Surface Missile Exercises (explosive and nonexplosive)

- Ordnance shall not be targeted to impact within 1,800 yd. (1646 m) of known or observed floating kelp, which may be inhabited by immature sea turtles.
- Aircraft will visually survey the target area for sea turtles. Visual inspection of the target area will be made by flying at 1,500 feet (457 m) or lower, if safe to do so, and at slowest safe speed. Firing or range clearance aircraft must be able to actually see ordnance impact areas. Explosive ordnance shall not be targeted to impact within 1,800 yd. (1,646 m) of sighted marine mammals and sea turtles.

Underwater Detonations (up to 20-lb charges)

To ensure protection of sea turtles during underwater detonation training, the operating area must be determined to be clear of sea turtles prior to detonation.

Exclusion Zones

All Mine Warfare and Mine Countermeasures Operations involving the use of explosive charges must include exclusion zones for sea turtles to prevent physical and/or acoustic effects to those species. These exclusion zones shall extend in a 700-yd. arc radius around the detonation site.

Preexercise Surveys

For Demolition and Ship Mine Countermeasures Operations, the preexercise survey shall be conducted within 30 minutes prior to the commencement of the scheduled explosive event. The survey may be conducted from the surface, by divers, and/or from the air, and personnel shall be alert to the presence of any sea turtle. Should such an animal be present within the survey area, the exercise shall be paused until the animal voluntarily leaves the area. The Navy will suspend detonation exercises and ensure the area is clear for a full 30 minutes prior to detonation. Personnel will record any sea turtle observations during the exercise as well as measures taken if species are detected within the exclusion zone.

Postexercise Surveys

Surveys within the same radius shall also be conducted within 30 minutes after the completion of the explosive event. Any marine mammal or sea turtle appearing in the area will be observed for signs of possible injury. Possibly injured marine mammals or turtles are reported to the Commander, Naval Region Southwest Environmental Director and the San Diego Detachment office of Commander, Pacific Fleet.

Mining Operations

Mining Operations involve aerial drops of inert training shapes on target points. Aircrews are scored for their ability to accurately hit the target points. Although this operation does not involve live ordnance, sea turtles have the potential to be injured if they are in the immediate vicinity of a target points; therefore, the safety zone shall be clear of sea turtles around the target location. To the maximum extent feasible, the Navy shall retrieve inert mine shapes dropped during Mining Operations.

Sinking Exercise

The selection of sites suitable for Sinking Exercises (SINKEX) involves a balance of operational suitability, requirements established under the Marine Protection, Research and Sanctuaries Act (MPRSA) permit granted to the Navy (40 Code of Federal Regulations (C.F.R.) Section (§) 229.2), and the identification of areas with a low likelihood of encountering ESA-listed species, including sea turtles. The MPRSA permit requires vessels to be sunk in waters which are at least 9,000 ft (2,743 m) deep and at least 50 nm from land.

The Navy has developed range clearance procedures to maximize the probability of sighting any sea turtles or other protected species in the vicinity of an exercise (see Chapter 5).

San Clemente Island Very Shallow Water Underwater Detonations Mitigation Measures

- For each exercise, the safety-boat with an 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 augment a shore observer’s visual search of the mitigation zone for marine mammals and turtles. The safety-boat observer is in constant radio communication with the exercise coordinator and shore observer.
- 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 marine mammal or turtle has been seen in the zone and, together, both search the surface within and beyond the mitigation zone for marine mammals and turtles.
- The shore observer will indicate that the area is clear of animals after 10 or more minutes of continuous observation with no marine mammals or turtles having been seen in the mitigation zone or moving toward it.
- The observer will indicate that the area is not clear of animals any time a marine mammal or turtle is sited in the mitigation zone or moving toward it and, subsequently, indicate that the area is clear of animals when the animal is out and moving away and no others have been sighted.
- Initiation of the detonation sequence will only begin on receipt of an indication from the shore observer that the area is clear of animals and will be postponed on receipt of an indication from that observer that the area is not clear of animals.
- Following the detonation, visual monitoring of the mitigation zone continues for 30 minutes for the appearance of any marine mammal or turtle in the zone. Any marine mammal or sea turtle appearing in the area will be observed for signs of possible injury. Possibly injured marine mammals or turtles are reported to the Commander, Naval Region Southwest Environmental Director and the San Diego Detachment office of Commander, Pacific Fleet.

Mine Countermeasures Activities Outside of Very Shallow Depth

- **Exclusion Zones**

  All mine warfare and mine countermeasure activities involving the use of explosive charges must include exclusion zones for marine mammals and sea turtles to prevent physical and/or acoustic effects to those species. These exclusion zones shall extend in a 700 yd. radius around the detonation site.

- **Preexercise Surveys**

  For demolition and Ship Mine Countermeasure (SMCM) activities, preexercise surveys shall be conducted within 30 minutes prior to the commencement of the scheduled explosive event. The survey may be conducted from the surface, by divers, and/or from the air, and personnel shall be alert to the presence of any sea turtle. Should such an animal be present within the survey area, the exercise shall be paused until the animal voluntarily leaves the area.

- **Postexercise Surveys**

  Surveys within the same radius shall also be conducted within 30 minutes after the completion of the explosive event. Any marine mammal or sea turtle appearing in the area will be observed for signs of possible injury.

- **Reporting**

  Any evidence of a sea turtle that may have been injured or killed by the action shall be reported immediately to Commander, Pacific Fleet and Commander, Navy Region Southwest, Environmental Director.

Mining Operations

Mining Operations involve aerial drops of inert training shapes on floating targets. Aircrews are scored for their ability to accurately hit the target. This operation does not involve live ordnance. The probability is remote that a marine species would be in the exact spot in the ocean where an inert object is dropped. However, as a conservative measure, initial target points are briefly surveyed from the aircraft prior to inert ordnance drops, to ensure the intended drop area is clear of marine mammals and sea turtles. To the maximum extent feasible, the Navy shall retrieve inert mine shapes dropped during Mining Operations.

3.8.2 Environmental Consequences

3.8.2.1 Approach to Analysis

3.8.2.1.1 Sonar

Mid-Frequency Active Sonar

Estimating the impacts on sea turtles from mid-frequency active (MFA) sonar events is primarily based on the hearing sensitivities of each species. While there is no established criteria for harm or harassment under the ESA, the potential for physiological effects from MFA sonar such as temporary or permanent threshold shifts exists, and can be used as a criterion for evaluating MFA sonar effects. Similarly, behavioral responses to acoustic sources can be used to evaluate species responsiveness to acoustic sources. Extrapolation from human and marine mammal data to turtles is inappropriate given the morphological differences between the auditory systems of mammals and turtles. However, the measured hearing threshold for green turtles (Ridgway et al. 1969; and by extrapolation, at least the olive ridley and loggerhead) is only slightly lower than the maximum MFA sonar levels to which these three species could be exposed and this hearing sensitivity data can be utilized to analyze potential effects. Sea turtles hear in the range of 30 to 2,000 Hz with best sensitivity between 200 to 800 Hz (Ridgway et al. 1969; Lenhardt 1994). As such, noise sources within the frequency range of MFA sonar activities will be compared with the hearing sensitivity of sea turtles to evaluate potential effects.

High-Frequency Active Sonar

Estimation of the effects of high-frequency active sonar on sea turtles is conducted in the same manner as the evaluation of MFA sonar sources. As previously mentioned, sea turtles hear in the range of 30 to 2,000 Hz with best sensitivity between 200 to 800 Hz (Ridgway et al. 1969; Lenhardt 1994), which is well below the range of high-frequency (>10 kilohertz [kHz]) sound sources that may be used in the SOCAL Range Complex. It is not believed that a temporary or permanent threshold shift would occur from an acoustic source with such a frequency disparity from the acoustic sensitivity range in any species. Given the lack of audiometric information in leatherback turtles, the potential for temporary threshold shifts must be classified as unknown but would likely follow those of other sea turtles. Therefore, no threshold shifts in green, olive ridley, loggerhead turtles, or leatherback turtles are expected, and a detailed analysis of high-frequency active sonar sources is not carried forward in this analysis.

3.8.2.1.2 Underwater Detonation

Criteria and thresholds for estimating the impacts on sea turtles from a single underwater detonation event were determined from information on cetaceans used for the environmental assessments for the two Navy ship-shock trials: the *Seawolf* Final EIS (DoN 1998) and the *Churchill* Final EIS (DoN 2001a). During the analysis of the effects of explosions on marine mammals and sea turtles conducted by the Navy for the *Churchill* EIS, analysts compared the injury levels reported by the best of these experiments to the injury levels that would be predicted using the modified Goertner method and found them to be similar (DoN 2001a; Goertner 1982). The criteria and thresholds for injury and harassment are summarized in Table 3.8-1.

Table 3.8-1: Summary of Criteria and Acoustic Thresholds for Underwater Detonation Impacts to Marine Mammals and Sea Turtles

Harassment Level	Criterion	Threshold
Mortality	Onset of Severe Lung Injury	Goertner Modified Positive Impulse Indexed to 31 psi-ms
Level A Harassment Injury	Tympanic membrane rupture Onset of slight lung injury	50% rate of rupture; 205 dB re 1 µPa^2-s (Energy Flux Density) Goertner Modified Positive Impulse Indexed to 13 psi-ms
Level B Harassment Noninjury	Onset Temporary Threshold Shift (TTS)	182 dB re 1 µPa^2-s Energy Flux Density level in any 1/3-octave band at frequencies above 100 Hz for sea turtles
Noninjury	Onset Temporary Threshold Shift (Dual Criteria)	23 psi peak pressure level (for small explosives)
Noninjury	Sub-TTS Behavioral Disturbance	177 dB re:1µPa^2-s (Energy Flux Density) for multiple successive explosions

psi-ms = pounds per square inch-milliseconds, µPa^2-s = squared micropascal-second

There are two criteria for noninjurious harassment including temporary threshold shifts (TTS), which is a temporary, recoverable, loss of hearing sensitivity (NMFS 2001; DoN 2001a) and a sub-TTS behavioral disturbance for multiple successive explosions. The criterion for TTS is 182 dB re 1 squared micropascal-second (µPa^2-s) Energy Flux Density Level (EL) level in any 1/3-octave band at frequencies >100 Hz for sea turtles. There is a second criterion for estimating TTS threshold: 12 pounds per square inch (psi) peak pressure. Navy policy is to use the 23-psi criterion for explosive charges less than 2,000 lb and the 12-psi criterion for explosive charges larger than 2,000 lb. It was introduced to provide a safety zone for TTS when the explosive or the animal approaches the sea surface (for which case the explosive energy is reduced but the peak pressure is not). The second threshold, termed "sub-TTS," applies to multiple explosions in succession. The sub-TTS threshold is used to account for behavioral disturbance significant enough to be judged as harassment, but occurring at lower sound energy levels than those that may cause TTS. The criteria for sub-TTS behavioral disturbance is 177 dB re:1 μPa^2-s (Energy Flux Density).

Two criteria are used for injury: onset of slight lung hemorrhage and 50 percent eardrum rupture (tympanic membrane [TM] rupture). These criteria are considered indicative of the onset of injury. The threshold for onset of slight lung injury is calculated for a small animal (a dolphin calf weighing 27 lb), and is given in terms of the "Goertner modified positive impulse," indexed to 13 psi-millisecond (ms) (DoN 2001a). In the absence of analogous data in chelonids, the criteria developed for marine mammals are also applied to sea turtles. This threshold is conservative since the positive impulse needed to cause injury is proportional to animal mass, and therefore, larger animals require a higher impulse to cause the onset of injury. The threshold for TM rupture corresponds to a 50-percent rate of rupture (i.e., 50 percent of animals exposed to the level are expected to suffer TM rupture); this is stated in terms of an EL value of 205 dB re 1 μPa^2-s. The criterion reflects the fact that TM rupture is not necessarily a serious or life-threatening injury, but is a useful index of possible injury that is well correlated with measures of permanent hearing impairment (e.g., Ketten 1998 indicates a 30-percent incidence of permanent threshold shift [PTS] at the same threshold).

The criterion for mortality for marine mammals used in the *Churchill* Final EIS is "onset of severe lung injury." This is conservative in that it corresponds to a 1-percent chance of mortal injury, and yet any animal experiencing onset severe lung injury is counted as a lethal exposure. The threshold is stated in terms of the Goertner (1982) modified positive impulse with value "indexed to 31 psi-ms." Since the Goertner approach depends on propagation, source/animal depths, and animal mass in a complex way, the actual impulse value corresponding to the 31-psi-ms index is a complicated calculation. Again, to be conservative, the *Churchill* analysis used the mass of a calf dolphin (at 26.9 lb), so that the threshold index is 30.5 psi-ms.

There is a lead time for setup and clearance of the impact area before any event using explosives takes place (may be 30 minutes to several hours). There will, therefore, be a long period of area monitoring before any detonation or live-fire event begins. Ordnance cannot be released until the target area is determined clear. Operations are immediately halted if marine mammals or sea turtles are observed within the target area. Operations are delayed until the animal clears the target area. All of these factors, along with the low density of sea turtles in the SOCAL Range Complex, serve to avoid the risk of harming sea turtles.

3.8.2.2 No Action Alternative

3.8.2.2.1 Mid-Frequency Active Sonar

Four species of sea turtles could potentially occur in the action area, all of which are protected under the ESA: leatherback, loggerhead, green turtle, and olive ridley turtles. There are no density estimates for sea turtles in the action area, and there are no established criteria for harm or harassment from sonar sources.

Studies indicate that the auditory capabilities of sea turtles are centered in the low-frequency range (<1,000 Hz). Ridgway et al. (1969) found that green turtles exhibit maximum hearing sensitivity between 200 and 700 Hz, and speculated that the turtles had a useful hearing span of 60 to 1,000 Hz. (However, there was some response to strong vibrational signals at frequencies down to the lowest one tested—30 Hz.). Bartol et al. (1999) tested the response of juvenile loggerhead turtles to brief, low-frequency broadband clicks, and brief tone bursts at four frequencies from 250 to 1,000 Hz. They demonstrated that loggerheads hear well between 250 and 1,000 Hz; within that frequency range, the turtles were most sensitive at 250 Hz. A recent study on the effects of airguns on sea turtle behavior also suggests that sea turtles are most likely to respond to low-frequency sounds (McCauley et al. 2000). Green and loggerhead sea turtles will avoid airgun arrays at 2 km and at 1 km, with received levels of 166 dB re 1 µPa and 175 dB re 1 µPa, respectively (McCauley et al. 2000). The sea turtles' response was consistent: above a level of about 166 dB re 1 µPa, the turtles noticeably increased their swimming activity. Above 175 dB re 1 µPa, their behavior became more erratic, possibly indicating that the turtles were agitated (McCauley et al. 2000).

The MFA sonar that has the lowest operating frequency operates at a center frequency of 3.5 kHz. Sea turtles hear in the range of 30 Hz to 2 kHz with best sensitivity between 200 to 800 Hz (Ridgway et al. 1969; Lenhardt 1994), which is well below the center operating frequency of the sonar. Hearing sensitivity even within this optimal hearing range is apparently low as threshold detection levels in water are relatively high at 160 to 200 dB re 1 µPa (Lenhardt 1994), which is only slightly lower than the operating levels of the sonar. It is not believed that a TTS would occur at such a small margin over threshold in any species. Therefore, no threshold shifts in green, olive ridley, or loggerhead turtles are expected. Given the lack of audiometric information, the potential for TTS among leatherback turtles must be classified as unknown but would likely follow those of other sea turtles.

Even if sea turtles were able to sense the sonar output, it is unlikely that any physiological stress leading to endocrine and corticosteroid imbalances over the long term (allostatic loading) would result (McEwen and Lashley 2002). An example of plasma hormone responses to stress was described by Jessop et al. (2002) for breeding adult male green turtles. Using capture/restraint as a stressor, they found a smaller corticosterone response and significant decreases in plasma androgen for breeding migrant males as compared to nonbreeding males. These responses were highly correlated with the relatively poorer body condition and body length of the migrant breeders as compared to the nonmigrant and premigrant males. While this study illustrates the complex relationship between stress/physiological state and plasma hormone responses, these kinds of effects are unlikely for sea turtles from MFA sonar within the SOCAL Range Complex.

Any potential role of long-range acoustical perception in sea turtles has not been studied and is unclear at this time. The concept of sound masking is difficult, if not impossible, to apply to sea turtles. Although low-frequency hearing has not been studied in many sea turtle species, most of those that have been tested exhibit low audiometric and behavioral sensitivity to low-frequency sound. It appears that if there were the potential for the mid frequency sonar to increase masking effects for any sea turtle species, it would be expected to be minimal. In addition, there will be no significant harm to sea turtles from active sonar activities.

Although there may be many hours of active Anti-Submarine Warfare (ASW) sonar events, the actual "pings" of the sonar signal may only occur several times a minute, as it is necessary for the ASW operators to listen for the return echo of the sonar ping before another ping is transmitted. Thus, acoustic sources used during ASW exercises in the action area are unlikely to affect sea turtles, most notably when directly compared to the hearing abilities of these species.

3.8.2.2.2 Underwater Detonations

There are no sea turtle nesting sites on the islands in the SOCAL Range Complex. There are no density estimates for sea turtles in the action area although it is known that densities are low. There are no established criteria for harm or harassment. Leatherback and olive ridley turtles likely would not occur in or near Northwest Harbor or Horse Beach Cove, because they are pelagic species.

Very little is known about the effects of underwater detonations on sea turtles (review by Viada et al. 2008). Most information comes from studies of the use of explosives to remove offshore oil rigs in the Gulf of Mexico (Klima et al. 1988; Gitschlag and Herczeg 1994) and one study by the US Navy (O'Keefe and Young 1984). Results vary depending on the size and type explosive used and the water depth. Klima et al. (1994) reported that sea turtles ranging in size from 1.3 to 15.0 lbs (0.59 to 6.8 kg) were uninjured when 138 to 322 ft (42 to 98 m) with detonations of 203 lbs (92 kg). Okeefe and Young (1984) reported that sea turtles beyond 2000 ft (680 m) were uninjured with an underwater detonation of 1,200 lbs (544 kg).

Analysis of data on the propagation effects of underwater detonations in very shallow water (VSW) indicates that such detonations would not have adversely affect the annual recruitment or survival of any sea turtle species and stocks.

Naval Special Warfare (NSW) in-water demolitions training and Extended Echo Ranging (EER)/Improved Extended Echo Ranging (IEER) sonobuoy detonations are unlikely to encounter sea turtles, due to the relatively small number of such exercises, and the mitigation measures described in Section 3.8.1.2.

3.8.2.2.3 Ship Collisions

Collisions between vessels and sea turtles are possible, but are unlikely. The Navy's standard operating procedures include a number of measures that will prevent a collision between a naval vessel and a sea turtle (see Section 3.8.1.2). Thus, the combination of the low initial probability of collision with a sea turtle and the active attempts to avoid such an event reduces the likelihood of a ship colliding with a sea turtle to an extremely low level.

3.8.2.2.4 Encounters with Military Debris

The Navy endeavors to recover expended training materials. Notwithstanding, it is not possible to recover all training debris, and some may be encountered by sea turtles in the waters of the SOCAL Range Complex. Debris related to military activities that is not recovered generally sinks; the amount that might remain on or near the sea surface is low, and the density of such debris in the SOCAL Range Complex would be very low. Types of training debris that might be encountered include parachutes of various types (e.g., those employed by personnel or on targets, flares, or sonobuoys); torpedo guidance wires, torpedo "flex hoses"; cable assemblies used to facilitate target recovery; sonobuoys; and Expendable Mobile ASW Training Targets (EMATT).

Range debris is highly unlikely to affect sea turtles in the SOCAL Range Complex (see DoN 1996). The following discussion addresses categories of debris.

<u>Torpedo Guidance Wires</u>. Torpedoes are equipped with a single-strand guidance wire, which is laid behind the torpedo as it moves through the water. At the end of a training torpedo run, the wire is released from the firing vessel and the torpedo to enable torpedo recovery. The wire sinks rapidly and settles on the ocean floor. Guidance wires are expended with each exercise torpedo launched. DoN (1996) analyzed the potential entanglement effects of torpedo control wires on sea turtles. The Navy analysis concluded that the potential for entanglement effects will be low for the following reasons:

- The guidance wire is a very fine, thin-gauge copper-cadmium core with a polyolefin coating. The tensile breaking strength of the wire is a maximum of 42 lb (19 kg) and can be broken by hand. With the exception of a chance encounter with the guidance wire while it was sinking to the sea floor (at an estimate rate of 0.5 ft [0.2 m] per second), a marine animal would be vulnerable to entanglement only if its diving and feeding patterns place it in contact with the bottom.

- The torpedo control wire is held stationary in the water column by drag forces as it is pulled from the torpedo in a relatively straight line until its length becomes sufficient for it to form a chain-like droop. When the wire is cut or broken, it is relatively straight and the physical characteristics of the wire prevent it from tangling, unlike the monofilament fishing lines and polypropylene ropes identified in the entanglement literatures.

While it is possible that a sea turtle would encounter a torpedo guidance wire as it sinks to the ocean floor, the likelihood of such an event is considered remote, as is the likelihood of entanglement after the wire has descended to and rests upon the ocean floor.

Parachutes. Aircraft-launched sonobuoys, flares, torpedoes, and EMATTs deploy nylon parachutes of varying sizes. At water impact, the parachute assembly is expended and sinks, as all of the material is negatively buoyant. Some components are metallic and will sink rapidly. Entanglement and the eventual drowning of a sea turtle in a parachute assembly would be unlikely, since such an event would require the parachute to land directly on an animal, or the animal would have to swim into it before it sinks. The expended material will accumulate on the ocean floor and will be covered by sediments over time, remaining on the ocean floor and reducing the potential for entanglement. If bottom currents are present, the canopy may billow (bulge) and pose an entanglement threat to sea turtles with bottom-feeding habits; however, the probability of a sea turtle encountering a submerged parachute assembly and the potential for accidental entanglement in the canopy or suspension lines is considered to be low.

Torpedo Flex Hoses. Improved flex hoses or strong flex hoses will be expended during torpedo exercises. Department of the Navy (DoN) (1996) analyzed the potential for the flex hoses to affect sea turtles. This analysis concluded that the potential entanglement effects to sea turtles will be insignificant for reasons similar to those stated for the potential entanglement effects of control wires:

- Due to weight, flex hoses will rapidly sink to the bottom upon release. With the exception of a chance encounter with the flex hose while it was sinking to the sea floor, a sea turtle would be vulnerable to entanglement only if its diving and feeding patterns placed it in contact with the bottom.
- Due to its stiffness, the 250-ft-long flex hose will not form loops that could entangle sea turtle.

EMATT. EMATTs are approximately 5 by 36 in. (12 by 91 centimeters [cm]) and weigh approximately 21 lb. EMATTs are much smaller than sonobuoys and Acoustic Device Countermeasures (ADCs). EMATTs, their batteries, parachutes, and other components will scuttle and sink to the ocean floor and will be covered by sediments over time. In addition, the small amount of expended material will be spread over a relatively large area. Due to the small size and low density of the materials, these components are not expected to float at the water surface or remain suspended within the water column. Over time, the amount of materials will accumulate on the ocean floor, but due to ocean currents, the materials will not likely settle in the same vicinity. There will be no significant impact to sea turtles from expended EMATTs or their components.

Falling Debris. There is an extremely low probability of injury to a sea turtle from falling debris such as munitions constituents, inert ordnance, expendable bathythermographs, acoustic device countermeasure, or targets. The low density of sea turtles in the SOCAL Range Complex would make it unlikely that falling debris would strike sea turtles.

The potential for impacts to sea turtles from sound or other energy released due to contact of debris with the water is considered remote.

3.8.2.2.5 Other Effects

Indirect effects on listed species could occur because of effects of the Proposed Action on their prey species. Leatherback turtles feed on jellyfish and other soft-bodied invertebrates, loggerhead turtles feed on benthic invertebrates (e.g., crabs, shrimp, and sea urchins), and green turtles feed on plant material. According to the National Research Council of the National Academies (NRC, 2003 Department Fisheries and Oceans 2004), there is very little information available regarding the hearing capability of marine invertebrates. No effects to marine invertebrates are anticipated from active sonar since acoustic transmissions are brief in nature and invertebrates are unlikely to hear it. Underwater detonations may cause some affects to invertebrates or algae but only in a small area.

3.8.2.3 Alternative 1

3.8.2.3.1 Mid-Frequency Active Sonar

The increased operations under Alternative 1 will result in an increase in the number of hours of training using MFA sonar sources. It is unlikely that sea turtles can detect sounds in the frequency range of this sonar and therefore increased MFA sonar training is unlikely to affect sea turtles.

3.8.2.3.2 Underwater Detonations

The increased operations under Alternative 1 would result in an increase in the number of underwater detonations during SINKEX, Air-to-Surface Missile Exercises (A-S MISSILEX), Surface-to-Surface Missile Exercises (S-S MISSILEX), Bombing Exercises (BOMBEX), and Surface-to-Surface Gunnery Exercises (S-S GUNEX). Although the number of underwater detonations would increase, due to the clearance requirements for underwater detonations and live-fire events, sea turtles would not be within the area and therefore impacts are not anticipated.

3.8.2.3.3 Nonacoustic Impacts

Nonacoustic impacts on sea turtles under Alternative 1 would be substantially the same as impacts identified under the No Action Alternative. Under Alternative 1, increased operations would not increase the risk of collisions between Navy ships and sea turtles, given the extensive mitigation measures in effect to avoid such an event. Based on these SOPs, collisions with sea turtles are not expected under Alternative 1. With regard to potential encounters between sea turtles and unrecovered military debris expended on the SOCAL Range Complex: debris related to military activities that is not recovered generally sinks; the amount that might remain on or near the sea surface is low, and the density of such debris in the SOCAL Range Complex would be very low under Alternative 1 as under the No Action Alternative. Impacts to sea turtles from expended debris are unlikely.

3.8.2.4 Alternative 2

3.8.2.4.1 Mid-Frequency Active Sonar

The increased operations under Alternative 2 will result in an increase in the number of hours of ASW training. It is unlikely that sea turtles can detect MFA sonar; therefore increased ASW training with sonar is unlikely to affect sea turtles.

3.8.2.4.2 Underwater Detonations

The increased operations under Alternative 2 would result in an increase in the number of underwater detonations during SINKEX, A-S MISSILEX, S-S MISSILEX, BOMBEX, and S-S GUNEX. Although the number of underwater detonations would increase, due to the clearance requirements for underwater detonations and live-fire events, sea turtles would not be within the area and therefore impacts are not anticipated.

The increased operations under Alternative 2 would result in an increase in IEER sonobuoy detonations but the numbers would be very small because of their distribution, the relatively small number of exercises, and the mitigation measures described in Section 3.8.1.2. Annual rates of adult survival likely would not be reduced, and recruitment would not be affected. IEER sonobuoy detonations will not have considerable effects on sea turtle species.

3.8.2.4.3 Nonacoustic Impacts

Nonacoustic impacts on sea turtles under Alternative 2 would be substantially the same as impacts identified under the No Action Alternative. Under Alternative 2, increased operations would not increase the risk of collisions between Navy ships and sea turtles, given the extensive mitigation measures in effect to avoid such an event. Based on these SOPs, collisions with sea turtles are not expected under Alternative 2. With regard to potential encounters between sea turtles and unrecovered military debris expended on the SOCAL Range Complex: debris related to military activities that is not recovered generally sinks; the amount that might remain on or near the sea surface is low, and the density of such debris in the SOCAL Range Complex would be very low under Alternative 2 as under the No Action Alternative. Impacts to sea turtles from expended debris are unlikely.

3.8.2.4.4 Shallow Water Training Range Installation

Once underway during hydrophone array installation for the Shallow Water Training Range (SWTR), the larger project vessels would move very slowly during cable installment activities (0 to 2 knots [0 to 3.7 km per hour]), and would not pose a collision threat to sea turtles that may be present in the vicinity. Entanglement of marine species is not likely because of the rigidity of the cable that is designed to lay extended on the sea floor and would not coil easily. Anchor and cable lines would be taut, posing no risk of entanglement or interaction with sea turtles that may be swimming in the area. Once installed on the seabed, the new cable and communications instruments would be equivalent to other hard structures on the seabed, again posing no risk of adverse effect on sea turtles. There are no documented incidents of sea turtle entanglement in a submarine cable during the past 50 years (Norman and Lopez 2002). The project vessels would abide by all appropriate naval regulations regarding marine species sighting and reporting.

3.8.2.5 Threatened and Endangered Species

As listed in Section 3.8.1.1.1, there are four species of sea turtles that occur off the coast of California (loggerhead [*Caretta caretta*], eastern Pacific green [*Chelonia agassizi*], olive ridley [*Lepidochelys olivacea*], and leatherback [*Dermochelys coriacea*]); all are currently listed as either endangered or threatened under the ESA. None of the four species is known to nest on Southern California beaches. Regular 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; López-Castro et al. 2000). Due to the primarily oceanic distributions of the leatherback, loggerhead, and olive ridley turtles off Southern California, the southwestern portion of the SOCAL Range Complex is designated as an area of primary occurrence for all sea turtle species (DoN 2005); however, their presence within the SOCAL Range Complex is considered rare. There is also an area of primary occurrence in southern San Diego Bay, adjacent to the SOCAL Range Complex, due to the year-round prevalence of green turtles in those waters near the warm water outflow of a power plant.

The spatial and temporal variability of both the occurrence of these four species of sea turtles and the operations within the SOCAL Range Complex combine to produce low probability that a direct or indirect effect would occur in relation to these species. It is nevertheless possible, if unlikely, that Navy activities in the SOCAL Range Complex may affect listed loggerhead, green, olive ridley, or leatherback sea turtles.

3.8.3 Mitigation Measures

3.8.3.1 ASW Operations

Mitigation measures for marine mammals (Section 3.9.10) provide similar mitigative effects for sea turtles. These mitigations include general maritime measures of lookout training and collision avoidance. Also, exercise specific measures are used for active sonar training, and activities involving explosive and nonexplosive ordnance.

3.8.3.2 Mine Countermeasures Activities Outside of Very Shallow Depth

3.8.3.2.1 Exclusion Zones

All mine warfare and mine countermeasure activities involving the use of explosive charges must include exclusion zones for marine mammals and sea turtles to prevent physical and/or acoustic effects to those species. These exclusion zones shall extend in a 700 yd. radius around the detonation site.

3.8.3.2.2 Preexercise Surveys

For demolition and Ship Mine Countermeasure (SMCM) activities, preexercise surveys shall be conducted within 30 minutes prior to the commencement of the scheduled explosive event. The survey may be conducted from the surface, by divers, and/or from the air, and personnel shall be alert to the presence of any sea turtle. Should such an animal be present within the survey area, the exercise shall be paused until the animal voluntarily leaves the area.

3.8.3.2.3 Postexercise Surveys

Surveys within the same radius shall also be conducted within 30 minutes after the completion of the explosive event. Any marine mammal or sea turtle appearing in the area will be observed for signs of possible injury.

3.8.3.2.4 Reporting

Any evidence of a sea turtle that may have been injured or killed by the action shall be reported immediately to Commander, Pacific Fleet and Commander, Navy Region Southwest, Environmental Director.

3.8.4 Unavoidable Adverse Environmental Effects

Due to the rarity of sea turtles in the SOCAL Range Complex and the mitigation measures in place, unavoidable environmental effects to sea turtles are not expected.

3.8.5 Summary of Effects by Alternative

Table 3.8-2 summarizes the water quality effects of the No Action Alternative, Alternative 1, and Alternative 2. For purposes of analyzing such effects under both National Environmental Policy Act (NEPA) and Executive Order (EO) 12114, the table allocates effects on a jurisdictional basis (i.e., under NEPA for actions or effects within U.S. Territory, and under EO 12114 for actions or effects outside U.S. Territory).

Table 3.8-2. Summary of Effects by Alternative

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Active sonar will have limited effect on sea turtles due to hearing capabilities. • Underwater detonations associated with the SOCAL OPAREAs activities could affect sea turtles but it is unlikely due to their rarity in the SOCAL OPAREAs and implementation of mitigation measures. • Ship collisions are unlikely due to the rarity of sea turtles in the SOCAL OPAREAs and implementation of mitigation measures. • Other sources of impacts, such as entanglement or falling debris, are unlikely to affect sea turtles because of the sparse distribution of sea turtles.	• Effects are expected to be the same as U.S. Territorial Waters.
Alternative 1	• Effects generally are the same as described for the No Action Alternative.	• Effects generally are the same as described for the No Action Alternative.
Alternative 2 (Preferred Alternative)	• Effects generally are the same as described for the No Action Alternative. • SWTR cable placement and Shallow Water Minefield mooring highly unlikely to affect sea turtles due to the slow speed of cable-laying ships and the rigidity of the cable.	• Effects generally are the same as described for the No Action Alternative.
Mitigation	• Mitigation measures are in place for active sonar, general maritime procedures, and underwater detonation.	• Mitigation measures are in place for active sonar, general maritime procedures, and underwater detonation.