
3.9 Marine Mammals

3.9 MARINE MAMMALS

3.9.1 Affected Environment

3.9.1.1 Definition

This section describes the marine mammal species expected to be present in the Silver Strand Training Complex (SSTC) area that potentially could be affected by the Proposed Action. The potential effects are analyzed, and a discussion is presented concerning current management and mitigation practices.

3.9.1.2 Regional Setting

Outside of the coastal zone of SSTC is part of the Pacific Ocean region referred to as the southern California Bight (SCB). The colder, more northerly California Current and the southern, warm-water California countercurrent (known as the Davidson Current, Figure 3.5-1) influences the ocean within the SCB. These two currents mix in the Santa Barbara Channel. The water within the southern portion of the SCB is warmer and more saline than the water within the northern area (Hickey 1993). These differing conditions, as well as upwelling of cooler, nutrient-rich waters, influence the diverse marine biota within and adjacent to the SCB region (Murray and Littler 1981). San Diego Bay is a naturally-formed, crescent-shaped embayment that is located along the southern end of the SCB (Largier 1995, DoN 2000); the San Diego Bay provides habitat for a number of oceanic and estuarine species as the ebb and flood of tides within the San Diego Bay circulate and mix ocean and bay waters, creating for distinct circulation zones within San Diego Bay (Largier et al. 1996, DoN 2000) (Section 3.5 Water Resources).

3.9.1.3 Region of Influence

The marine Region of Influence (ROI) can be partitioned into three zones:

- Bayside training zones within the San Diego Bay (sandy beaches, mudflats, and the nearshore environment);
- Ocean area training zones from intertidal to nearshore (<0.5 nautical mile [nm]) south of Naval Air Station North Island (NASNI); and
- Ocean area training zones from intertidal to nearshore (<3 nm) encompassing the training lanes at SSTC-North (SSTC-N), SSTC-South (SSTC-S), and ocean anchorages.

Marine mammals reasonably expected to use the ocean area <3 nm of SSTC for any portion of their life cycle are discussed in this section. Based on both anecdotal observations and several recent Navy funded surveys, there are limited to no marine mammal species present within the back portions of San Diego Bay south of the Coronado Bay Bridge (Merkel Inc. 2008).

3.9.1.4 Marine Mammals that May Inhabit or Regularly Transit the SSTC

Marine mammals addressed in this EIS include members of two orders:

1. Order Cetacea, which includes whales, dolphins, and porpoises
2. Order Carnivora, which includes true seals, sea lions, and fur seals

Cetaceans spend their lives entirely at sea. Carnivora, or pinnipeds, hunt and feed exclusively in the ocean, with certain species in southern California coming ashore to rest, molt, breed, and bear young.

Extensive natural history information for marine mammal species occurring within southern California waters has been summarized in previous works (Leatherwood et al. 1982, 1988; Reeves et al. 2002; DoN 2005c; Carretta et al. 2007; Department of the Navy [DoN] 2008). Approximately 41 marine mammal

species or stocks are known to occur within southern California waters based on National Marine Fisheries Service (NMFS) Stock Assessment Reports (Carretta et al. 2007, DoN 2008). Of these, only three year-round species and one migratory species are expected to be found within the SSTC marine ROI. These include the California sea lion (*Zalophus californianus*), Pacific harbor seal (*Phoca vitulina richardii*), bottlenose dolphin (*Tursiops truncatus*), and gray whale (*Eschrichtius robustus*). Densities from Southern California (SOCAL) Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement with the exception of bottlenose dolphin which was from NCCOS (2005). While the density estimated for gray whales more than likely over-estimates potential density off SSTC, NMFS Southwest Fisheries Science Center recommends using this density because it the best currently available information. Table 3.9-1 summarizes the population status and abundance of each of these species.

The United States stock of California sea lion and the California stock of Pacific harbor seal can be commonly found at haul-out sites on the mainland, on buoys and docks within California harbors including northern San Diego Bay, and the Channel Islands. Breeding sites for California sea lions are exclusively on the islands off the coast of California for California sea lions. Harbor seals have island and some mainland breeding sites. For both California sea lions and harbor seals, there are no haul-out sites, or rookeries within or adjacent to the SSTC. The California Coastal stock of the Pacific bottlenose dolphin is a toothed whale (odontocete) that regularly inhabits the nearshore waters of southern California. This species regularly moves along the California coast and may transit the SSTC area since they remain close to shore (within 0.5 nm). This particular stock has limited site fidelity and can be distributed anywhere between Monterey to northern Baja Mexico depending on localized prey abundance. The Eastern Pacific stock of gray whale occurs off southern California during their annual migration between summer feeding areas in the Bering and southern Chukchi seas and winter calving areas in Baja California and mainland Mexico. While gray whales may occasionally be found within 1 nm (1.8 kilometer [km]) of shore during their migration periods, they are found further offshore than the nearshore waters at SSTC (NMFS, J. Barlow 2007). As such, gray whales would be infrequent transients through or seaward of the outer section of the SSTC.

None of the four marine mammal species that inhabit or regularly transit the SSTC are listed as threatened or endangered under the Endangered Species Act (ESA). All marine mammals are protected under the Marine Mammal Protection Act (MMPA) of 1972, amended in 1994. The MMPA is administered by NMFS. The MMPA prohibits any person subject to the Act from taking a marine mammal within U.S. waters or on the high seas, without authorization from NMFS.

For three species (bottlenose dolphins, California sea lion, and harbor seals), the marine waters within the SSTC only constitute a small portion of their total range. California sea lions and harbor seal abundance—as reflected by number of pinnipeds seen hauled out on northern San Diego Bay docks and buoys (Merkel Inc. 2008)—may be seasonally higher at certain times of the year due to local movement between offshore rookeries and the mainland. The gray whale only transits the nearshore waters west of SSTC during annual migrations between northern feeding grounds and breeding lagoons in Mexico. There are no pinniped haul-out sites within the SSTC; therefore, dependent pups would not be expected in the ROI. The nearest documented harbor seal beach haul-out site is located at the Children's Pool in La Jolla, California—14 miles northwest of the SSTC area (Lowry and Carretta 2003). California sea lions enter San Diego Bay to forage on scraps near commercial bait barges and haul-out on jetties or buoys. Harbor seals can occasionally be seen hauled out on buoys within San Diego Bay, but no regular haul-out sites are located near the ROI. Sick or injured marine mammals can strand on California beaches, with pinnipeds being the most common marine mammal to strand on California beaches (NMFS 2000). Strandings of marine mammals usually consist of a single animal but occasionally groups of several of odontocetes, or toothed whales, will strand. The causes of strandings include starvation (particularly in young animals), seizures due to natural (e.g., domoic acid) or anthropogenic toxins, diseases (e.g., morbillivirus, leptospirosis) and predation. Within California, domoic acid toxicity is a significant source

of mortality and strandings for pinnipeds and dolphins (Lefebvre et al. 1999, Scholin et al. 1999, Zagzebski et al. 2002, Goldstein et al. 2008, Bejarano et al. 2008, Goldstein et al. 2009).

Table 3.9-1: Summary of Cetacean and Pinniped Species That May Inhabit, Regularly Transit, Or Seasonally Migrate Past the SSTC

Common Name Species Name Stock	Stock Abundance ¹ (Coefficient of Variation)	Annual Population Trend	Occurrence	Warm Season (May-Oct) Presence and Density ² (individuals/km ²)	Cold Season (Nov-Apr) Presence and Density (individuals/km ²)
Mysticetes Gray whale <i>Eschrichtius robustus</i> Eastern North	19,126 (0.07) Migratory	Increasing >3.2%	Transient, seasonal migrations	NO 0	YES 0.014
Odontocetes Bottlenose dolphin <i>Tursiops truncatus</i> California coastal stock	323 (0.13)	Stable	Limited, small population within one km of shore	YES 0.202	YES 0.202
Pinnipeds Harbor seal <i>Phoca vitulina richardii</i> California stock	All California 34,233 SOCAL ⁴ estimated abundance 5,271	Slight growth; Stabilizing	Common; Channel Islands haul-outs including SCI; mainland California haul- outs north of Pt Mugu	YES 0.06	YES 0.19
California sea lion <i>Zalophus californianus</i> U.S. stock	238,000 ³	Increasing 6.1%; possibly stabilizing	Most common pinniped, Channel Islands breeding sites in the summer	YES 0.01	YES 0.02

¹ All abundance estimates from NMFS Stock Assessment Reports (Carretta et al 2010, Allen and Angliss 2010) and reflect estimation of abundance for the entire stock.

² Densities used for pinnipeds were obtained from Carretta et al. (2000) using the offshore warm and cold season pinniped densities. This publication represents one of the few NMFS at-sea pinniped surveys within Southern California. It is anticipated that while reflective of the more populous offshore numbers of pinnipeds, these values will likely be over predictive of actual at-sea pinniped density within the much smaller spatial extent of the coastal SSTC area (shore to 4000 yards from shore). Densities for the coastal stock of bottlenose dolphins was obtained from the NCCOS 2005 which presents NMFS data for various coastal segments along the California coast, including one adjacent to the SSTC. Densities for gray whales was modified from Carretta et al. (2000) by scientists at the NMFS' Southwest Fisheries Science Center to reflect the limited nature of transitory gray whale presence within the very nearshore habitat of the SSTC. Gray whales migrate through Southern California twice a year. Individual marine mammals likely only present on the order of minutes to hours in transit past SSTC (3 nm/hr travel rate).

³ All pupping occurs in Southern California.

⁴ Derived by NMFS from the aerial counts of all age classes within Southern California only.

Five species are considered rare or infrequent visitors within the SSTC ROI (DoN 2005c, Barlow and Forney 2007, Carretta et al. 2007). Guadalupe fur seals (*Arctocephalus townsendi*) breed on Guadalupe Island in Baja California, Mexico and migrate north to forage. Northern elephant seals (*Mirounga angustirostris*) breed on islands in Baja California, Mexico and the SCB including San Clemente Island off the coast of San Diego (Lowry 2002) and migrate north to forage (Le Boeuf et al. 1993). Northern fur seals (*Callorhinus ursinus*) breed on San Miguel Island which is the southern extent of their range

(Carretta et al. 2007). Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) and common dolphins (*Delphinus* spp.) have occasionally been seen during marine mammal surveys west of Point Loma (Merkel Inc. 2008). Though these animals have been noted in the waters outside of the coastal zone and outside of the SSTC ROI, their occurrence is considered rare and these species are not addressed further in this Environmental Impact Statement (EIS).

More detailed information on the four marine mammal species expected to occur within the ROI (gray whale, bottlenose dolphin, harbor seal, and California sea lion) is provided in Sections 3.9.1.5 and 3.9.1.6.

3.9.1.5 Cetaceans

3.9.1.5.1 Mysticetes (Baleen whales)

Gray Whale

Stock – Eastern North Pacific

Population Status – In 1994, due to steady increases in population abundance, the Eastern North Pacific stock of gray whales was removed from the Federal List of Endangered and Threatened Wildlife and Plants, as it was no longer considered endangered or threatened under the ESA (Angliss and Outlaw 2008). The Eastern North Pacific stock of gray whale is not considered a strategic stock under the MMPA.

Even though the stock is within Optimal Sustainable Population (OSP), which is the population size which falls within a range from the population level of a given species or stock which is the largest supportable within the ecosystem to the population level that results in maximum net productivity, abundance will rise and fall as the population adjusts to natural and man-caused factors affecting the carrying capacity of the environment (Rugh et al. 2005). In fact, it is expected that a population close to or at the carrying capacity of the environment will be more susceptible to fluctuations in the environment (Moore et al. 2001). Systematic counts of gray whales migrating south along the central California coast have been conducted by shore-based observers at Granite Canyon most years since 1967. The population size of the Eastern North Pacific gray whale stock has been increasing over the past several decades at a rate approximately between 2.5 to 3.3 percent per year since 1967. NMFS' population estimate is 19,126 individuals as reported in Angliss and Outlaw (2008), and the minimum population estimate as 17,752.

Distribution – The Eastern North Pacific population is found from the upper Gulf of California (Tershy and Breese 1991), south to the tip of Baja California, and up the Pacific coast of North America to the Chukchi and Beaufort seas. There is a pronounced seasonal north-south migration. The eastern North Pacific population summers in the shallow waters of the northern Bering Sea, the Chukchi Sea, and the western Beaufort Sea (Rice and Wolman 1971). The northern Gulf of Alaska (near Kodiak Island) is also considered a feeding area; some gray whales occur there year-round (Moore et al. 2007). Some individuals spend the summer feeding along the Pacific coast from southeastern Alaska to central California (Sumich 1984, Calambokidis et al. 1987, 2002). Photo-identification studies indicate that gray whales move widely along the Pacific coast and are often not sighted in the same area each year (Calambokidis et al. 2002). In October and November, the whales begin to migrate southeast through Unimak Pass and follow the shoreline south to breeding grounds on the west coast of Baja California and the southeastern Gulf of California (Braham 1984, Rugh 1984). The average gray whale migrates 4,050 to 5,000 nm (7,500 to 10,000 km) at a rate of 80 nm (147 km) per day (Rugh et al. 2001, Jones and Swartz 2002). Although some calves are born along the coast of California (Shelden et al. 2004), most are born in the shallow, protected waters on the Pacific coast of Baja California from Morro de Santo Domingo (28°N) south to Isla Creciente (24°N) (Urbán-Ramirez et al. 2003). The main calving sites are Laguna Guerrero Negro, Laguna Ojo de Liebre, Laguna San Ignacio, and Estero Soledad (Rice et al. 1981).

A group of gray whales known as the Pacific Coast Feeding Aggregation feeds along the Pacific coast between southeastern Alaska and northern to central California throughout the summer and fall (NMFS 2001, Calambokidis et al. 2002, Calambokidis et al. 2004b). The gray whales in this feeding aggregation are a small proportion (a few hundred individuals) of the overall eastern North Pacific population and arrive and depart from these feeding grounds concurrently with the migration to and from the wintering grounds (Calambokidis et al. 2002, Angliss and Outlaw 2008). Although some site fidelity is known to occur, there is considerable interannual variation since many individuals do not return to the same feeding site in successive years (Calambokidis et al. 2000, Calambokidis et al. 2004).

The Eastern North Pacific stock of gray whale transits through southern California during its northward and southward migrations between approximately December and June. Gray whales follow three routes from within approximately 5 to 100 nm (9 to 185 km) from shore (Bonnell and Dailey 1993). The nearshore route follows the shoreline between Point Conception and Point Vicente but includes a more direct line from Santa Barbara to Ventura and across Santa Monica Bay. Around Point Vicente or Point Fermin, some whales veer south towards Santa Catalina Island and return to the nearshore route near Newport Beach. Others join the inshore route that includes the northern chain of the Channel Islands along Santa Cruz Island and Anacapa Island and east along the Santa Cruz Basin to Santa Barbara Island and the Osborn Bank. From here, gray whales migrate east directly to Santa Catalina Island and then to Point Loma or Punta Descanso or southeast to San Clemente Island (SCI) and on to the area near Punta Banda. A significant portion of the Eastern North Pacific stock passes by SCI and its associated offshore waters (Carretta et al. 2000). The offshore route follows the undersea ridge from Santa Rosa Island to the mainland shore of Baja California and includes San Nicolas Island and Tanner and Cortes banks (Bonnell and Dailey 1993).

Peak abundance of gray whales off the coast of San Diego is January during the southward migration, and in March during the migration north; although females with calves, which depart Mexico later than males or females without calves, can be sighted from March through May or June (Leatherwood 1974; Poole 1984; Rugh et al. 2001; Stevick et al. 2002; Angliss and Outlaw 2008). Gray whales are infrequent migratory transients through the oceanside portions of SSTC only during cold-water months (Carretta et al. 2000). Migrating gray whales that might infrequently transit through SSTC would not be expected to forage, and would likely be present for minutes to less than one or two hours at typical travel speeds of 3 knots (approximately 3.5 miles per hour) (Perryman et al. 1999, Mate and Urbán-Ramirez 2003).

A mean group size of 2.9 gray whales was reported for both coastal (16 groups) and non-coastal (15 groups) areas around SCI (Carretta et al. 2000). The largest group reported was nine animals. The largest group reported by U.S. Navy (1998) was 27 animals. Gray whales are not expected in the SSTC from July through November (Rice et al. 1981), and are excluded from warm season analysis. Even though gray whale transitory occurrence is infrequent along SSTC, a cold season density is estimated at 0.014 animals per km² for purposes of conservative analysis (Table 3.9-1).

Reproduction/Breeding – Although some calves are born along the coast of southern California, most are born in the shallow, protected waters on the Pacific coast of Baja California (Urbán-Ramirez et al. 2003).

Diving Behavior – Gray whales dive to 160 to 200 feet for 5 to 8 minutes when foraging. In the breeding lagoons, dives are usually less than 6 minutes (Jones and Swartz, 2002), although dives as long as 26 minutes have been recorded (Harvey and Mate 1984). Gray whales may remain submerged near the surface for 7 to 10 minutes and travel 1600 feet or more before resurfacing to breathe when migrating. The maximum known dive depth is 560 feet (Jones and Swartz 2002). Migrating gray whales sometimes exhibit a unique snorkeling behavior—they surface cautiously, exposing only the area around the blow hole, exhale quietly without a visible blow, and sink silently beneath the surface (Jones and Swartz 2002). Mate and Urbán-Ramirez (2003) noted that 30 of 36 locations for a migratory gray whale with a satellite tag were in water <330 feet deep, with the deeper water locations all in the SCB within the Channel Islands. Whales in that study maintained consistent speed indicating directed movement. There has been

only one study yielding a gray whale dive profile, and all information was collected from a single animal that was foraging off the west coast of Vancouver Island (Malcolm and Duffus 2000; Malcolm et al. 1996). They noted that the majority of time was spent near the surface on interventilation dives (<10 feet depth) and near the bottom (extremely nearshore in a protected bay with mean dive depth of 60 feet, range 46-72 feet depth). There was very little time spent in the water column between surface and bottom. Foraging depth on summer feeding grounds is between 160-200 feet (50-60 meters [m]) (Jones and Swartz 2002). Based on this very limited information, the following is a rough estimate of depth distribution for gray whales: 50 percent at <13 feet (surface and interventilation dives) and 50 at 13-59 feet. However, most gray whales would be expected at shallower depths during transit through southern California where foraging does not occur due to migration and limited suitable bottom prey habitat.

Acoustics – Au (2000) reviewed the characteristics of gray whale vocalizations. Gray whales produce broadband signals ranging from 100 hertz (Hz) to 4 kilohertz (kHz) (and up to 12 kHz) (Dahlheim et al. 1984, Jones and Swartz 2002). The most common sounds on the breeding and feeding grounds are knocks (Jones and Swartz 2002), which are broadband pulses from about 100 Hz to 2 kHz and most energy at 327 to 825 Hz. The source level for knocks is approximately 142 decibels referenced to 1 micropascal at 1 meter (dB re 1 μ Pa at 1 m) (Cummings et al. 1968). During migration, individuals most often produce low-frequency moans (Crane and Lashkari 1996). The structure of the gray whale ear is evolved for low-frequency hearing (Ketten 1992). The ability of gray whales to hear frequencies below 2 kHz has been demonstrated in playback studies (Cummings and Thompson 1971; Dahlheim and Ljungblad 1990; Moore and Clarke 2002) and in their responsiveness to underwater noise associated with broadband oil and gas activities (Malme et al. 1986; Moore and Clarke 2002). Gray whale responses to noise include changes in swimming speed and direction to move away from the sound source; abrupt behavioral changes from feeding to avoidance, with a resumption of feeding after exposure; changes in calling rates and call structure; and changes in surface behavior, usually from traveling to milling (e.g., Moore and Clarke 2002). Gailey et al. (2007) reported no apparent behavioral disturbance for Western Pacific gray whales in response to low-frequency seismic survey.

3.9.1.5.2 Odontocetes (Toothed whales)

Bottlenose Dolphin

Stock—California Coastal

Population Status – There are two distinct populations of bottlenose dolphins within southern California, a coastal population found within 0.5 nm of shore and a larger offshore population (Hansen 1990, Bearzi et al. 2009). The California Coastal stock is the only one of these two stocks likely to regularly occur within the SSTC. The California Coastal stock of bottlenose dolphins is not listed under the ESA, and is not considered a strategic stock under the MMPA.

Based on photographic mark-recapture surveys conducted along the San Diego coast in 2004 and 2005, population size for the California Coastal stock of the bottlenose dolphin is estimated to be 323 individuals (CV = 0.13, 95 percent CI 259-430; Dudzik et al. 2006, Carretta et al. 2007). This estimate does not reflect that approximately 35 percent of dolphins encountered lack identifiable dorsal fin marks (Defran and Weller 1999). If 35 percent of all animals lack distinguishing marks, then the true population size would be closer to 450-500 animals (Carretta et al. 2007).

Distribution – The bottlenose dolphin California Coastal stock occurs at least from Point Conception south into Mexican waters, at least as far south as San Quintin, Mexico. In southern California, animals are found within 500 m of the shoreline 99 percent of the time and within 250 m 90 percent of the time (Hanson and Defran 1993). Occasionally, during warm-water incursions such as during the 1982–1983 El Niño event, their range extends as far north as Monterey Bay (Wells et al. 1990). Bottlenose dolphins in the SCB appear to be highly mobile within a narrow coastal zone (Defran et al. 1999), and exhibit little

seasonal site fidelity to the SCB region (Defran and Weller 1999) and along the California coast; over 80 percent of the dolphins identified in Santa Barbara, Monterey, and Ensenada have also been identified off San Diego (Maldini-Feinholz 1996, Defran et al. 1999, Defran, unpublished data, Carretta et al. 2007, Bearzi 2009). Bottlenose dolphins could occur in the SSTC at variable frequencies and periods throughout the year based on localized prey availability (Defran et al. 1999). The coastal stock utilizes a limited number of fish prey species with up to 74 percent being various species of surfperch or croakers, a group of non-migratory year-round coastal inhabitants (Defran et al. 1999, Allen et al. 2006). For southern California, common croaker prey species include spotfin croaker, yellowfin croaker, and California corbina, while common surfperch species include barred surfperch and walleye surfperch (Allen et al. 2006). The corbina and barred surfperch are the most common surf zone fish where bottlenose dolphins have been observed foraging (Allen et al. 2006). Defran et al. (1999) postulated that the coastal stock of bottlenose dolphins showed significant movement within their home range (Central California to Mexico) in search of preferred but patchy concentrations of nearshore prey (i.e., croakers and surfperch). Bearzi et al (2009), in an analysis of coastal bottlenose dolphins in the vicinity of Santa Monica, also concluded that low individual re-sighting rates indicates a large coastal bottlenose dolphin distribution influenced by prey distribution. After finding concentrations of prey, animals may then forage within a more limited spatial extent to take advantage of this local accumulation until such time that prey abundance is reduced; the dolphins then shift location once again to be over larger distances (Defran et al. 1999, Bearzi 2009). An at-sea density estimate of 0.202 animals/km² was used for acoustic impact modeling for both the warm and cold seasons (Table 3.9-1).

Reproduction/Breeding – Newborn calves are seen throughout the year and reproduction may be influenced by productivity and food abundance (Urian et al. 1996).

Diving Behavior – California coastal stock bottlenose dolphins feed primarily on surf perches (Family Embiotocidae) and croakers (Family Sciaenidae) (Norris and Prescott 1961; Walker 1981; Schwartz et al. 1992; Hanson and Defran 1993), and also consume squid (*Loligo opalescens*) (Schwartz et al. 1992). Navy bottlenose dolphins have been trained to reach maximum diving depths of about 984 feet (Ridgway et al. 1969). Reeves et al. (2002) noted that the presence of deep-sea fish in the stomachs of some offshore individual bottlenose dolphins suggests that they dive to depths of more than 1,638 feet. Dive durations up to 15 minutes have been recorded for trained individuals (Ridgway et al. 1969). Typical dives expected for the California Coastal Stock are more shallow and of a much shorter duration. However, bottlenose dolphins utilize the entire water column by feeding on prey that concentrate near the surface, midwater areas and benthic areas (Hastie et al. 2005).

Acoustics – Sounds emitted by bottlenose dolphins have been classified into two broad categories: pulsed sounds (including clicks and burst-pulses) and narrow-band continuous sounds (whistles), which usually are frequency modulated (FM). Whistles range in frequency from 0.8 to 24 kHz but can also go much higher. Clicks and whistles have a dominant frequency range of 110 to 130 kHz and a source level of 218 to 228 dB re 1 µPa at 1 m (peak to peak levels; Au 1993) and 3.5 to 14.5 kHz with a source level of 125 to 173 dB re 1 µPa at 1 m, respectively (Ketten 1998). The bottlenose dolphin has a functional high-frequency hearing limit of 160 kHz (Au 1993) and can hear sounds at frequencies as low as 40 to 125 Hz (Turl 1993). Inner ear anatomy of this species has been described (Ketten 1992). Electrophysiological experiments suggest that the bottlenose dolphin brain has a dual analysis system: one specialized for ultrasonic clicks and the other for lower-frequency sounds, such as whistles (Ridgway 2000). The audiogram of the bottlenose dolphin shows that the lowest thresholds occurred near 50 kHz at a level around 45 dB re 1 µPa (Nachtigall et al. 2000, Finneran and Houser 2006, Finneran and Houser 2007). Below the maximum sensitivity, thresholds increased continuously up to a level of 137 dB re 1 µPa at 75 Hz. Above 50 kHz, thresholds increased slowly up to a level of 55 dB re 1 µPa at 100 kHz, then increased rapidly above this to about 135 dB re 1 µPa at 150 kHz. Scientists have reported a range of best sensitivity between 25 and 70 kHz, with peaks in sensitivity occurring at 25 and 50 kHz at levels of 47

and 46 dB re 1 μ Pa (Nachtigall et al. 2000). Temporary threshold shifts (TTS) in hearing have been experimentally induced and behavioral responses observed in captive bottlenose dolphins (Ridgway et al. 1997, Schlundt et al. 2000, 2006, Nachtigall et al. 2003, Finneran et al. 2002, 2005, 2007b). Ridgway et al. (1997) observed changes in behavior at the following minimum levels for 1 second tones: 186 dB re 1 μ Pa at 3 kHz, 181 dB re 1 μ Pa at 20 kHz, and 178 dB re 1 μ Pa at 75 kHz. TTS levels were 194 to 201 dB re 1 μ Pa at 3 kHz, 193 to 196 dB re 1 μ Pa at 20 kHz, and 192 to 194 dB re 1 μ Pa at 75 kHz. Schlundt et al. (2000) exposed bottlenose dolphins to intense tones (0.4, 3, 10, 20, and 75 kHz); the animals demonstrated altered behavior at source levels of 178 to 193 dB re 1 μ Pa, with TTS after exposures between 192 and 201 dB re 1 μ Pa at 1 m (though one dolphin exhibited TTS after exposure at 182 dB re 1 μ Pa). Nachtigall et al. (2003) determined threshold for a 7.5 kHz pure tone stimulus. No shifts were observed at 165 or 171 dB re 1 μ Pa, but when the sound level reached 179 dB re 1 μ Pa, the animal showed the first sign of TTS. Recovery apparently occurred rapidly, with full recovery apparently within 45 minutes following sound exposure. TTS measured between 8 and 16 kHz (negligible or absent at higher frequencies) after 30 minutes of sound exposure (4 to 11 kHz) at 160 dB re 1 μ Pa (Nachtigall et al. 2004).

3.9.1.6 Non-Threatened and Non-Endangered Pinnipeds

3.9.1.6.1 Phocids (True seals)

Pacific Harbor Seal

Stock—California

Population Status – The harbor seal is not listed under the ESA, and the California stock, some of which occurs in the SSTC, is not considered a strategic stock under the MMPA. The California stock has increased from the mid-1960s to the mid-1990s, although the rate of increase may have slowed during the 1990s as the population has reached and may be stabilizing at carrying capacity (Hanan 1996; Carretta et al. 2008).

A complete count of all harbor seals in California is impossible because some are always away from the haulout sites. A complete pup count (as is done for other pinnipeds in California) is also not possible because harbor seals are precocious, with pups entering the water almost immediately after birth (Carretta et al. 2008). Population size is estimated by counting the number of seals ashore during the peak haul-out period (May to July) and by multiplying this count by the inverse of the estimated fraction of seals on land.

Based on the most recent harbor seal counts (26,333 in May-July 2004, Lowry et al. 2005) and Hanan's revised correction factor, the harbor seal population in California is estimated by NMFS to number 34,233 (Carretta et al. 2008). Of the estimated California population (34,233), less than 30 percent are thought to reside within southern California due to lack of suitable haul-out sites because of significant beach urbanization (Lowry et al. 2008).

Distribution – Harbor seals are considered abundant throughout most of their range from Baja California to the eastern Aleutian Islands. An unknown number of harbor seals also occur along the west coast of Baja California, at least as far south as Isla Asuncion, which is about 100 miles south of Punta Eugenia. Peak numbers of harbor seals haul-out on land during late May to early June, which coincides with the peak of their molt. They favor sandy, cobble, and gravel beaches (Stewart and Yochem 1994), with multiple haul-outs identified along the California mainland and Channel Islands (Carretta et al. 2007).

There are limited at-sea density estimates for pinnipeds within southern California. Harbor seals do not make extensive pelagic migrations, but do travel 300 to 500 km on occasion to find food or suitable breeding areas (Carretta et al. 2008). Based on likely foraging strategies, Grigg et al. (2009) reported

seasonal shifts in harbor seal movements based on prey availability. When at sea, they remain in the vicinity of haul-out sites and forage close to shore in shallow waters. In relationship to the entire California stock, harbor seals do not have a significant mainland California distribution south of Point Mugu due to beach urbanization and potential disturbance impacts.

While harbor seals could potentially be found in the SSTC throughout the year, their abundance is not expected to be large. However, as a conservative overestimate of likely occurrence in the SSTC, local densities for purposes of impact analysis are estimated at 0.010 animals/km² during the warm season (May to September) and 0.020 animals/km² during the cold season (November to April) (Table 3.9-1).

Reproduction/Breeding – Nursing of pups begins in late February, and pups start to become weaned in May. Breeding occurs between late March and early May on the offshore southern and northern Channel Islands. There are some mainland breeding sites, with the closest being the Children's Pool in La Jolla (approximately 14 miles north of Point Loma and the ROI).

Diving Behavior – While feeding, harbor seals dive to depths of 33 to 130 feet in the case of females with nursing pups, and 260 to 390 feet in the case of other seals and dives as deep as 1,463 feet have been recorded (Eguchi and Harvey 2005).

Acoustics – Harbor seals produce a variety of airborne vocalizations including snorts, snarls, and belching sounds (Bigg 1981). Adult males produce low frequency vocalizations underwater during the breeding season (Hanggi and Schusterman 1994; Van Parijs et al. 2003, Bjorgesaeter et al. 2004, Bodson et al. 2006). Male harbor seals produce communication sounds in the frequency range of 100 to 1,000 Hz (Bodson et al. 2006). The harbor seal hears almost equally well in air and underwater (Kastak and Schusterman 1998). Seals in general have an extremely broad range of best hearing sensitivity underwater, with flat audiograms between 1 and 50 kHz and good sensitivity to sounds between 100 Hz and 1 kHz (Kastelein et al. 2009). The high-frequency portion of their audiograms shows a functional upper frequency cutoff around 60 kHz. Peak hearing sensitivity for harbor seals is around 32 kHz in water and 12 kHz in air (Terhune and Turnball 1995, Kastak and Schusterman 1998, Wolski et al. 2003, Kastelein et al. 2009).

3.9.1.6.2 Otariids (Sea lions and fur seals)

California Sea Lion

Stock – United States

Population Status – The California sea lion is not listed under the ESA, and the U.S. stock, some of which occurs in the SSTC, is not considered a strategic stock under the MMPA. The entire stock cannot be counted because all age and sex classes are never ashore at the same time. In lieu of counting all sea lions, pups are counted during the breeding season (because this is the only age class that is ashore in its entirety), and the number of births is estimated from the pup count after accounting for pup mortality (Carretta et al. 2007). The size of the population is then estimated from the number of births and the proportion of pups in the population. Censuses are conducted in July after all pups have been born. Based on these censuses, the U.S. Stock has increased from the early 1900s to the present with the exception of four major declines in the number of pups counted which occurred during El Niño events in 1983-1984, 1992-1993, 1998, and 2003 (Carretta et al. 2008).

The NMFS population estimate of the U.S. stock of California sea lions is 238,000 (Carretta et al. 2008), with a minimum estimate based on a 2005 shore-based survey of all age and sex classes of 141,842 (NMFS, unpubl. data, Carretta et al. 2008). Based on data from NMFS and presented in Carretta et al. 2007, there is indication that the California sea lion may have reached the environmental Carrying

Capacity. It is unclear, but possible, that the OSP level for sea lions as defined by the MMPA may have been reached but more data is needed to ensure the leveling in growth persists (Carretta et al. 2008).

Distribution – Nearly all of the U.S. Stock (more than 95 percent) breeds and gives birth to pups on San Miguel, San Nicolas, and Santa Barbara islands. Some movement has been documented between the U.S. Stock and Western Baja Mexico Stock, but rookeries in the United States are widely separated from the major rookeries of western Baja California. Smaller numbers of pups are born on San Clemente Island, the Farallon Islands, and Año Nuevo Island (Lowry et al. 1992). The California sea lion is by far the most commonly-sighted pinniped species at sea or on land in the vicinity of the SSTC. In California waters, sea lions represented 97 percent (381 of 393) of identified pinniped sightings at sea during the 1998–1999 NMFS surveys (Carretta et al. 2000). They were sighted during all seasons and in all areas with survey coverage from nearshore to offshore areas (Carretta et al. 2000). However, within context of the SSTC sea lions while potentially present at-sea, are not frequently sighted within the ocean waters of SSTC, but rather more commonly seen hauled-out on piers and buoys within and leading into San Diego Bay, north of the SSTC (Merkel Inc. 2008). In a study of California sea lion reaction to human activity, Holcomb et al. (2009) showed that in general sea lions are rather resilient to human disturbance.

The distribution and habitat use of California sea lions varies with the sex of the animals and their reproductive phase. Adult males haul-out on land to defend territories and breed from mid-to-late May until late July. Individual males remain on territories for 27 to 45 days without going to sea to feed. During August and September, after the mating season, the adult males migrate northward to feeding areas as far away as Washington (Puget Sound) and British Columbia (Lowry et al. 1992). They remain there until spring (March through May), when they migrate back to the breeding colonies. Thus, adult males are present in offshore areas of the SSTC only briefly as they move to and from rookeries. Distribution of immature California sea lions is less well known, but some make northward migrations that are shorter in length than the migrations of adult males (Huber 1991). However, most immature sea lions are presumed to remain near the rookeries, and remain near SSTC for most of the year. Adult females remain near the rookeries throughout the year. Most births occur from mid-June to mid-July (peak in late June).

Survey data from 1975 to 1978 were analyzed to describe the seasonal shifts in the offshore distribution of California sea lions near the Channel Islands (Bonnell and Ford 1987). The seasonal changes in the center of distribution were attributed to changes in the distribution of the prey species. If California sea lion distribution is determined primarily by prey abundance as influenced by variations in local, seasonal, and interannual oceanographic variation, these same areas might not be the center of sea lion distribution every year. Melin et al. (2008) showed that foraging female sea lions showed significant variability in individual foraging behavior, and foraged further offshore and at deeper depths during El Niño years as compared to non-El Niño years.

There are limited published at-sea density estimates for pinnipeds within southern California. The density of California sea lions is higher during cold-water months ($0.190/\text{km}^2$) versus the warmer months ($0.060/\text{km}^2$) (Table 3.9-1). At-sea densities likely decrease during warm-water months because females spend more time ashore to give birth and attend their pups. Radio-tagged female California sea lions at San Miguel Island spent approximately 70 percent of their time at sea during the nonbreeding season (cold-water months) and pups spent an average of 67 percent of their time ashore during their mother's absence (Melin et al. 2000). Different age classes of California sea lions are found in the SSTC throughout the year (Lowry et al. 1992). Although adult male California sea lions feed in areas north of the SSTC, animals of all other ages and sexes spend most, but not all, of their time feeding at sea during winter; thus, winter estimates likely are somewhat low. During warm-water months, a high proportion of the adult males and females are hauled out at terrestrial sites during much of the period, so the summer estimates are low to a greater degree.

Reproduction/Breeding – The pupping and mating season for sea lions begins in late May and continues through July (Heath 2002).

Diving Behavior – Over one third of the foraging dives by breeding females are one to two minutes in duration; 75 percent of dives are less than three minutes, and the longest recorded dive was 9.9 minutes (Feldkamp et al. 1989). Approximately 45 percent of dives were to depths of 66 – 160 feet (Feldkamp et al. 1989). Costa et al. (2007) reported both shallow and deep dives greater than 328 feet by both male and female sea lions. Melin et al. (2008) documented mean dives depths of 62 to 915 feet but that most individuals could make dives to 1,312 feet. Much of the variation in duration and depth of dives appears to be related to sea lions foraging on vertically-migrating prey. Longer dives to greater depths occur during the day, and shorter dives to shallower depths occur at night, when prey migrate toward the surface (Feldkamp et al. 1989, Costa et al. 2007, Melin et al. 2008).

Acoustics – California sea lions produce two types of underwater sounds: clicks (or short-duration sound pulses) and barks (Schusterman et al. 1966, 1967, Schusterman and Baillet 1969). All underwater sounds have most of their energy below 4 kHz (Schusterman et al. 1967). The range of overall hearing sensitivity underwater is between 0.25 and 64 kHz (Schusterman et al. 1972, Kastak and Schusterman 1998, Finneran et al 2003, Southall et al 2005). The range of maximal sensitivity presented in this study was between one and 28 kHz with best sensitivity at 16 kHz. Between 28 and 36 kHz there is a loss in sensitivity of 60 dB/octave. However, sea lions can hear frequencies at least as high as 64 kHz, given intense acoustic signals. The California sea lion shows poor hearing at frequencies below 1,000 Hz (Kastak and Schusterman 1998). The best range of sound detection is from 2.0 to 16 kHz (Schusterman, 1974). Kastak and Schusterman (2002) determined that hearing sensitivity worsens with depth—hearing thresholds were lower in shallow water, except at the highest frequency tested (35 kHz), where this trend was reversed.

In-air, California sea lions make incessant, raucous barking sounds; these have most of their energy at less than 2 kHz (Schusterman et al. 1967). Males vary both the number and rhythm of their barks depending on the social context; the barks appear to control the movements and other behavior patterns of nearby sea lions (Schusterman 1977). Females produce barks, squeals, belches, and growls in the frequency range of 0.25 to 5.0 kHz, while pups make bleating sounds at 0.25 to 6.0 kHz. Peak sensitivities in air are shifted towards lower frequencies; the effective upper hearing limit is approximately 36 kHz (Schusterman 1974).

3.9.1.7 Current Mitigation Measures

The physical topography (Sections 3.2 and 3.5), lack of significant marine mammal occurrence within the SSTC, and the type of proposed Navy training events at SSTC allow for effective mitigation procedures. Gray whales are seldom present in the shallow offshore waters of the SSTC, or if migrating near the outer edge of the boat lanes rarely present for longer than the one to two hours it would take to transit past SSTC. If large marine mammals such as gray whales were to approach a training area—even far beyond the mitigation zone—they would be immediately obvious to the shore or safety-boat observers. As described in Section 3.9.1.4, the SSTC is not known to be a preferred feeding site for small marine mammals such as bottlenose dolphins and pinnipeds, although their presence cannot be ruled out. Therefore, the principal concern for mitigation is the protection of dolphins and pinnipeds that occasionally transit through the site.

Based on NMFS promulgated criteria and in-water propagation of sound and underwater detonations described in Section 3.9.2.3, the buffer zones described below are derived from by empirical data (very shallow water [VSW]) and modeled estimates of propagated peak-pressure and energy (within the range of hearing of marine mammal species) of the range to onset-TTS described in Section 3.9.2.4.

The following mitigation measures, which are situation/location dependent for underwater detonations and Elevated Causeway System (ELCAS) training, incorporate existing range procedures at SSTC and are consistent with existing training objectives and activities, as well as established human safety procedures. In case of unanticipated conflict, human safety considerations will take precedence and such conflicts are always used to make incremental improvements in the procedures used in subsequent activities.

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 marine mammals. 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 marine mammals 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 marine mammal has been seen in the zone and, together, both search the surface within and beyond the mitigation zone for marine mammals (and other protected species such as sea turtles).
5. The observers (boat and shore based) will indicate that the area is not clear any time a marine mammal is sighted in the mitigation zone or moving toward it and, subsequently, indicate that the area is clear of marine mammals when the animal is out and moving away and no other marine mammals have been sighted.
6. Initiation of the detonation sequence will only begin on final receipt of an indication from the shore observer that the area is clear of marine mammals and will be postponed on receipt of an indication from that any observer that the area is not clear of marine mammals.
7. Following the detonation, visual monitoring of the mitigation zone continues for 30 minutes for the appearance of any marine mammal in the zone. Any marine mammal appearing in the area will be observed for signs of possible injury.
8. Any marine mammal observed after an 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):

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 marine mammals 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 marine mammals (and other protected species such as sea turtles).
5. If a marine mammal is sighted within the 1,500 foot or 500 yard mitigation zone or moving towards it, underwater detonation events will be suspended until the marine mammal has voluntarily left the area and the area is clear of marine mammals for at least 30 minutes.
6. Immediately following the detonation, visual monitoring for marine mammals within the mitigation zone will continue for 30 minutes. Any marine mammal 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 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 for ELCAS/Pile Driving Activities on SSTC oceanside:

1. A mitigation zone will be established at 150 feet or 50 yards from ELCAS pile driving and pile removal events. This mitigation zone is base on the predicted range to Level A harassment (180 dB RMS) for cetaceans, and is being applied conservatively to both cetaceans and pinnipeds.
2. Monitoring will be conducted within the 150 foot or 50 yard mitigation zone surrounding ELCAS pile driving and removal events for the presence of marine mammals (and other protected species such as sea turtles) before, during, and after pile driving and removal events.
3. If marine mammals are found within the 150 foot or 50 yard mitigation zone, pile removal events will be halted until the marine mammals (or sea turtles) have voluntarily left the mitigation zone.
4. Monitoring for marine mammals (or 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 marine mammals.
5. Monitoring observer(s) will implement shut-down/delay procedures when applicable by calling for shut-down to the hammer operator when marine mammals (or sea turtles) are sighted within the mitigation zone.

6. Soft Start - Providing additional protection for marine mammals (and 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 marine mammals 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 marine mammals 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.

3.9.1.7.1 Mitigation Effectiveness

Mitigation of potential impacts depends on observers and environmental conditions during the training event, among other things. For underwater detonations and ELCAS training, observers watch a buffer zone for the presence of marine mammals. These zones make best use of the available platforms and assets. The efficacy of visual detection depends on several factors related to the observers, environment, and monitoring platforms.

Training activities involving underwater detonation occur during daylight hours with Beaufort sea-states of three or less at SSTC. Training activities involving ELCAS occur 24-hours per day, but involve the use of floodlights at night to ensure the visibility of operations. Mitigation zones are clearly visible from the shore where the beach slopes up to provide an elevated position for a stable observation deck, on the ELCAS itself, and/or in boats for complete binocular-aided observation of the mitigation area. More importantly, physical characteristics of the environment and local circumstances substantially increase the probability of animals being on the surface. That is, conditions are substantially better for visual mitigation at SSTC than those encountered during offshore activities when mitigation is used and deep-diving mammals can be encountered. More specifically, negative biases (availability and observer) are much reduced at SSTC compared to deeper water locations where water depth exceeds the diving abilities of sea lions, harbor seals, bottlenose dolphins, and gray whales.

Given these near-shore characteristics, the percent detection or detection effectiveness for various species that are usually associated with deeper at-sea zones and other methods of observation do not apply nor do the detection probabilities associated with assessment surveys in deep water from ships or planes (Barlow 1995, Barlow 1999, Barlow et al. 2001, Buckland et al. 1993). While survey detection probabilities may not apply, environmental variables (sea state, relative visibility, glare, swell height) and observer training and locations at SSTC favor very good detection rates. In addition, for personnel safety reasons, VSW underwater detonations are conducted during daylight hours and not conducted if sea states get higher than Beaufort 3, meaning that, in general, there will be less surface chop and smoother seas thus enhancing marine mammal detection.

Mysticetes such as gray whales are rarely, if ever, present in the VSW portion of the SSTC. The VSW area of SSTC on the ocean side is not known to be a preferred feeding site for small marine mammals. The principal mitigation concern during underwater detonations is for protection of small odontocetes (dolphins) and pinnipeds, most likely California sea lions, that may occasionally transit through. Were marine mammals to approach the VSW zone, even at a distance beyond the 1,200 foot mitigation zone, it is likely they would be detectable to the shore or safety-boat observers. The very shallow depths maximizes the probability of marine mammals being on the surface and increases probability of visual detection. When combined with the low numbers of marine mammals typically in these zones, the few

marine mammals in or transiting through these shallow areas are not diving deeply or for extended periods of time.

Because of the coastal nature of SSTC and near-shoreline volumes, marine animals will be at the surface much more frequently and not diving deeply or for extended periods of time as is assumed in deeper water. Though they will be easily sighted, numbers of marine mammals in the vicinity of activities are expected to be quite low, as there are no seal or sea lion haul-outs nor are there intensively used dolphin feeding grounds within the SSTC.

Finally, similar to other Navy range complexes, a report on SSTC underwater detonations by explosive type, observations of interactions with marine mammals, and associated marine mammal monitoring will be reported annually to NMFS' Office of Protected Resources.

3.9.1.7.2 ELCAS Mitigation Considered but Rejected

As discussed in Section 3.9.1.7, the Navy will monitor an ELCAS mitigation zone for the presence of marine mammals (and sea turtles) before, during, and after pile driving and removal events. If marine mammals (or sea turtles) are found in the mitigation zone, pile driving and removal will be halted until the marine mammals have voluntarily left the zone. Mitigation measures that other, generally longer term and much larger pier and bridge construction projects have implemented in the past are listed as follows, with an explanation of why the Navy is not proposing to implement them.

A significant reason for not considering these mitigations is that the engineering needed to both develop, and more importantly field deploy, these mitigations is often not available under the remote expeditionary nature that characterizes field training with the ELCAS. There is generally a lack of facility based infrastructure to support the mitigation deployment. In addition, these measures are part of much longer term (sometime several years) projects where deployment time of the mitigation can be factored into a given construction project over several months. By contrast, an entire ELCAS training event from construction, to use, to disassembly usually is only scheduled to occur for periods of up to two to three weeks or shorter. Deploying of additional significant hardware-based mitigations would not be practical, nor meet the Navy's Title 10 requirements for training. The range of additional ELCAS mitigations considered but rejected fall into two classes. One is deploying various engineering solutions such as sound dampening measure or material change, and the other is seasonal or daily restrictions.

1) Adding sound dampening measures - Following are a list of sound dampening measures that other pier construction and repair projects have considered or used in the past that help to attenuate some sound from pile driving, but for which the Navy asserts are not practical for ELCAS training. These measures are not used in actual ELCAS operations overseas or easily adaptable for ELCAS training at SSTC. In addition, the purpose of ELCAS training is to teach personnel to construct an ELCAS as they would overseas in as quick a manner as possible. Adding in sound dampening measures that are not used in real world conditions would not only confuse personnel trying to learn and recertify their capabilities in ELCAS construction, but divert the limited amount of Navy personnel available to ELCAS support units away from necessary training while they implement these measures.

Bubble curtain - Air bubble curtains infuse the area surrounding the pile with air bubbles, creating a bubble screen that inhibits the propagation of some sound from pile driving and removal. The effectiveness of air curtain design in reducing underwater sound propagation is highly variable ranging from reduction of zero to perhaps 15 dB in source level (CADOT 2009). However, the exact optimum design of air bubble curtains is still slightly qualitative, based on site conditions and engineering issues. As designed, there is no latitude in the ELCAS construction equipment to allow installation of bubble curtains. Typical bubble curtain arrangements for larger pier construction projects would not have the necessary support (power, air compressors, piping, etc.) found at remote ELCAS deployment sites within the SSTC.

Cofferdam - Cofferdams are temporary structures used to isolate an area generally submerged underwater from the water column. Cofferdams are most commonly fabricated from sheet piling or inflatable water bladders. As designed, there is no latitude in the ELCAS construction equipment to allow installation of cofferdams;

Isolation casing - Isolation casings are hollow casings slightly larger in diameter than the piling to be driven. The casing, typically a larger hollow pile, is inserted into the water column and bottom substrate. The casing then is dewatered, and the piling is driven within the dewatered isolation casing. As designed, there is no latitude in the ELCAS construction equipment to allow installation of isolation cases.

Cushion blocks - Cushion blocks are blocks of material used with impact hammer pile drivers. They consist of blocks of material placed atop a piling during pile driving to minimize the noise generated while driving the pile. Materials typically used for cushion blocks include wood, nylon, and micarta blocks. The effectiveness of these materials within both the construction world and as potential ELCAS mitigation is not sufficiently studied, and its unknown if cushion blocks would effectively and significantly lower pile driving noise levels. Use of cushion blocks would require additional time to prepare and deploy on each ELCAS pile. The result could be significant time delays between individual ELCAS pile driving resulting in delays to the overall ELCAS training.

Changing pile material or size - Different pile materials, such as concrete, and/or smaller piles could reduce the sound intensity and associated ZOIs during ELCAS construction at SSTC. The ELCAS, however, is a pre-manufactured system using 24 inch steel piles, designed for optimal operation overseas and deployment on specified Navy cargo ships. Navy personnel are not able to use incompatible piles in this pre-manufactured system, which might compromise the ELCAS' military specifications and design.

2) Seasonal or Daily Restrictions - Changing the time when pile driving or removal occurs is another construction based technique. The following are two temporal measures that other civilian pier construction and repair projects have considered or used in the past to help minimize impacts to marine mammals, but for which the Navy asserts are not practical for ELCAS training.

Constructing ELCAS at a different time of year - Shifting ELCAS training to summer months may help with transitory migratory species, such as the gray whale, which are not present during the summer within southern California. The actual amount of pile removal exposures for gray whales is very small, and as explained earlier much more easy to mitigate with the applicable mitigation zone. Navy training cycles and curriculums are set to a fixed annual training schedule; however, to ensure that personnel are adequately trained for deployment, and resources are available to conduct that training. Restricting ELCAS training by season would adversely impact the Navy's ability to ensure that personnel are adequately prepared for deployment, while not lending significant protection to marine mammals.

Daylight Restriction - Restricting ELCAS pile driving and removal to only daylight hours could conceivably avoid impact to marine mammals by making visual sighting within the ELCAS mitigation zone easier. However, ELCAS operations in real world conditions are performed 24 hours a day to enable forces to offload materials from the ship to shore (via the ELCAS) as quickly as possible. Sailors need to train for these real world conditions, including night-time operations. Navy training cycles and curriculums, as well as resulting field deployments to training sites such as the SSTC, are set to a fixed annual training schedule with daily milestones of accomplishments that also include night time training. In addition, while under construction, there is significant floodlight use both on the ELCAS itself and at the pile driving or removal location pointing into the water so that operators can observe the results of these events. This same lighting would afford additional sighting opportunities for marine mammals within the 50 yard ELCAS mitigation zone at night.

3.9.2 Environmental Consequences

Potential effects on marine mammals from SSTC activities can be separated into two broad categories: acoustic and nonacoustic impacts, both of which are addressed in this EIS. The possibility that human-generated sound could harm marine mammals or significantly interfere with their “normal” activities is an issue of increasing concern (NRC 2005). Evaluating potential acoustic effects requires an understanding of the technical issues inherent to sound and its propagation in the ocean environment. In addition, it is important to understand potential impacts in the context of the regulatory framework. The following subsections of this EIS provide information on the analytical framework used to assess potential acoustic impacts, including a description of both regulatory and conceptual issues. The criteria used to model and assess marine mammal responses to sound are then summarized. A description of current mitigation measures and their effectiveness is also provided. Finally, the remaining subsections evaluate the potential for the specific Navy SSTC activities to result in impacts to marine mammals.

3.9.2.1 General Approach to Analysis

Each alternative analyzed in this EIS includes multiple types of training activities (for example, Mine Countermeasures, Amphibious Operations, Naval Special Warfare). Likewise, many activities (for example, vessel movements, aircraft overflights, and underwater detonations) are common to many training scenarios. Accordingly, the analysis of the consequences to marine mammals is organized by specific activity and/or stressors associated with that activity.

The following general steps were used to analyze the potential environmental consequences of the alternatives to marine mammals:

- Identify those aspects of the Proposed Action that are likely to act as stressors to marine mammals by having a direct or indirect effect on the physical, chemical, and biotic environment. As part of this step, the spatial extent of these stressors, including changes in that spatial extent over time, were identified. The results of this step identified those aspects of the Proposed Action that required detailed analysis in this EIS.
- Identify marine mammal resources that may occur in the action area.
- Identify the marine mammal resources that are likely to co-occur with the stressors in space and time, and the nature of that co-occurrence (exposure analysis).
- Determine whether and how marine mammals are likely to respond given their exposure to the proposed activities based on available scientific knowledge of their probable responses.
- Consider the effectiveness of proposed mitigation measures in avoiding, offsetting, and reducing the intensity of any potential adverse impacts to marine mammals.
- Determine implications of the estimated risks under the MMPA.

Following this general approach, the types of activities that could affect marine mammals include underwater detonations, aircraft activities (related to sound propagation into the water column), marine vessel activities (small boats, service craft, etc.), and amphibious and beach activities. 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 marine mammals 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, 48, 50, 54, 55, 58, 59, 61-66, 68, 72, 74-76, and N10, Table 2-1 and Table 2-2) are not anticipated to cause localized increases in turbidity that are in excess of nearshore processes or discharge of pollutants into the water column offshore; therefore, they are also

excluded from this analysis. Beach and inland activities have a low potential for impact on marine mammals because there are no breeding or haul-out areas within the SSTC ROI. Based on both anecdotal observations and through several recent Navy funded surveys, there are few marine mammal species present within the back portions of San Diego Bay south of the Coronado Bay Bridge (Merkel Inc. 2008).

3.9.2.2 Regulatory and Biological Framework

The following discussion outlines the biological framework within which potential impacts can be categorized. This discussion includes an explanation of potential indicators of physiological and behavioral effects, MMPA Level A and Level B harassment criteria, harassment zones, temporary threshold shift (TTS), and auditory masking. The biological framework can then be combined with the existing regulatory framework of injury (MMPA Level A harassment) and behavioral disruption (MMPA Level B harassment) to establish appropriate levels of impact. The Navy submitted an application for an Incidental Harassment Authorization to NMFS per the requirements of MMPA for proposed training activities that have the potential to incidentally take marine mammals.

As summarized by the National Academies of Science, the possibility that human-generated sound could harm marine mammals or significantly interfere with their “normal” activities has been an issue of concern (National Research Council [NRC] 2005). Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present in the vicinity of the sound, and the effects that sound may have on the physiology and behavior of those marine mammals. Although it is known that sound is important for marine mammal communication, navigation, and foraging (NRC 2003, NRC 2005), there are many unknowns in assessing the effects and significance of marine mammal responses to sound exposures related to the context for the exposure and the disposition of the marine mammal (Southall et al. 2007). For this reason, the Navy enlisted the expertise of NMFS as a cooperating agency. Their input assisted the Navy in developing a conceptual analytical framework for evaluating what sound levels marine mammals might receive as a result of Navy training actions, whether marine mammals might respond to these exposures, and whether that response might have a mode of action on the biology or ecology of marine mammals such that the response should be considered a potential harassment. From this framework of evaluating the potential for harassment incidents to occur, an assessment of whether acoustic sources might impact populations, stocks or species of marine mammals can be conducted.

Starting with a sound source, the attenuation of an emitted sound due to propagation loss is determined. Uniform animal distribution is overlaid onto the calculated sound fields to assess if animals are physically present at sufficient received sound levels to be considered “exposed” to the sound. If the animal is determined to be exposed, two possible scenarios must be considered with respect to the animal’s physiology—effects on the auditory system and effects on nonauditory system tissues. These are not independent pathways and both must be considered since the same sound could affect both auditory and nonauditory tissues. Note that the model does not account for any animal response; rather the animals are considered stationary, accumulating energy until the threshold is tripped. Potential impacts to the auditory system are assessed by considering the characteristics of the received sound (e.g., amplitude, frequency, duration) and the sensitivity of the exposed animals. Some of these assessments can be numerically based (e.g., TTS, Permanent Threshold Shift [PTS], perception). Others will be necessarily qualitative, due to lack of information, or will need to be extrapolated from other species for which information exists. Potential physiological responses to the sound exposure are ranked in descending order, with the most severe impact (auditory trauma) occurring at the top and the least severe impact occurring at the bottom (the sound is not perceived).

1. Auditory trauma represents direct mechanical injury to hearing related structures, including tympanic membrane rupture, disarticulation of the middle ear ossicles, and trauma to the inner ear structures such as the organ of Corti and the associated hair cells. Auditory trauma is always

injurious but could be temporary and not result in PTS. Auditory trauma is always assumed to result in a stress response.

2. Auditory fatigue refers to a loss of hearing sensitivity after sound stimulation. The loss of sensitivity persists after, sometimes long after, the cessation of the sound. The mechanisms responsible for auditory fatigue differ from auditory trauma and would primarily consist of metabolic exhaustion of the hair cells and cochlear tissues. The features of the exposure (e.g., amplitude, frequency, duration, temporal pattern) and the individual animal's susceptibility would determine the severity of fatigue and whether the effects were temporary (TTS) or permanent (PTS). Auditory fatigue (PTS or TTS) is always assumed to result in a stress response.
3. Sounds with sufficient amplitude and duration to be detected among the background ambient noise are considered to be perceived. This category includes sounds from the threshold of audibility through the normal dynamic range of hearing (i.e., not capable of producing fatigue). To determine whether an animal perceives the sound, the received level, frequency, and duration of the sound are compared to what is known of the species' hearing sensitivity.

Since audible sounds may interfere with an animal's ability to detect other sounds at the same time, perceived sounds have the potential to result in auditory masking. Unlike auditory fatigue, which always results in a stress response because the sensory tissues are being stimulated beyond their normal physiological range, masking may or may not result in a stress response, depending on the degree and duration of the masking effect. Masking may also result in a unique circumstance where an animal's ability to detect other sounds is compromised without the animal's knowledge. This could conceivably result in sensory impairment and subsequent behavior change; in this case, the change in behavior is the lack of a response that would normally be made if sensory impairment did not occur. For this reason, masking also may lead directly to behavior change without first causing a stress response. The features of perceived sound (e.g., amplitude, duration, temporal pattern) are also used to judge whether the sound exposure is capable of producing a stress response. Factors to consider in this decision include the probability of the animal being naïve or experienced with the sound (i.e., what are the known/unknown consequences of the exposure).

By extension, this does not result in a stress response (not perceived). Potential impacts to tissues other than those related to the auditory system are assessed by considering the characteristics of the sound (e.g., amplitude, frequency, duration) and the known or estimated response characteristics of nonauditory tissues. Some of these assessments can be numerically based (e.g., exposure required for rectified diffusion). Others will be necessarily qualitative, due to lack of information. Each of the potential responses may or may not result in a stress response.

1. Direct tissue effects – Direct tissue responses to sound stimulation may range from tissue shearing (injury) to mechanical vibration with no resulting injury. Any tissue injury would produce a stress response, whereas noninjurious stimulation may or may not.
2. Indirect tissue effects – Based on the amplitude, frequency, and duration of the sound, it must be assessed whether exposure is sufficient to indirectly affect tissues. For example, the hypothesis that rectified diffusion occurs is based on the idea that bubbles that naturally exist in biological tissues can be stimulated to grow by an acoustic field. Under this hypothesis, one of three things could happen: (1) bubbles grow to the extent that tissue hemorrhage occurs (injury); (2) bubbles develop to the extent that a complement immune response is triggered or nervous tissue is subjected to enough localized pressure that pain or dysfunction occurs (a stress response without injury); or (3) the bubbles are cleared by the lung without negative consequence to the animal. The probability of rectified diffusion, or any other indirect tissue effect, will necessarily be based on what is known about the specific process involved. Given the single point source underwater explosives and broadband impulsive sounds from pile driving, the two main underwater activities with potential to affect marine mammals at SSTC, indirect tissue effects are not a factor. While

presented here in context of the framework discussion, indirect tissue effects are not considered in the impact analysis discussed later.

3. No tissue effects – The received sound is insufficient to cause either direct mechanical) or indirect effects to tissues. No stress response occurs.

3.9.2.2.1 Stress Response

The acoustic source is considered a potential stressor if, by its action on the animal, via auditory or nonauditory means, it may produce a stress response in the animal. The term “stress” has taken on an ambiguous meaning in the scientific literature, but with respect to the discussions of allostasis and allostatic loading, the stress response will refer to an increase in energetic expenditure that results from exposure to the stressor and which is predominantly characterized by either the stimulation of the sympathetic nervous system or the hypothalamic-pituitary-adrenal axis (Reeder and Kramer 2005). The presence and magnitude of a stress response in an animal depends on a number of factors. These include the animal’s life history stage (e.g., neonate, juvenile, adult), the environmental conditions, reproductive or developmental state, and experience with the stressor. Not only will these factors be subject to individual variation, but they will also vary within an individual over time. Prior experience with a stressor may be of particular importance as repeated experience with a stressor may dull the stress response via acclimation (St. Aubin and Dierauf 2001). In considering potential stress responses of marine mammals to acoustic stressors, each of these should be considered. For example, is the acoustic stressor in an area where animals engage in breeding activity? Are animals in the region resident and likely to have experience with the stressor (i.e., repeated exposures)? Is the region a foraging ground or are the animals passing through as transients? What is the ratio of young (naïve) to old (experienced) animals in the population? It is unlikely that all such questions can be answered from empirical data; however, they should be addressed in any qualitative assessment of a potential stress response as based on the available literature.

Marine mammals naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with conspecifics, and interactions with predators all contribute to the stress a marine mammal experiences. In some cases, naturally occurring stressors can have profound impacts on marine mammals; for example, chronic stress, as observed in stranded animals with long-term debilitating conditions (e.g., disease), has been demonstrated to result in an increased size of the adrenal glands and an increase in the number of epinephrine-producing cells (Clark et al. 2006). Anthropogenic activities have the potential to provide additional stressors above and beyond those that occur naturally. Potential stressors resulting from anthropogenic activities must be considered not only as to their direct impact on the animal but also as to their cumulative impact with environmental stressors already experienced by the animal.

Studies on the stress response of odontocete cetaceans to acute acoustic stimuli were previously discussed (Thomas et al., 1990, Miksis et al., 2001, Romano et al. 2004). Other types of stressors include the presence of vessels, fishery interactions, acts of pursuit and capture, the act of stranding, and pollution. In contrast to the limited amount of work performed on stress responses resulting from sound exposure, a considerably larger body of work exists on stress responses associated with pursuit, capture, handling and stranding. Pursuit, capture and short-term holding of belugas has been observed to result in a decrease in thyroid hormones and increases in epinephrine (St. Aubin and Geraci 1988) . In dolphins, the trend is more complicated with the duration of the handling time potentially contributing to the magnitude of the stress response (St. Aubin et al. 1996, Ortiz and Worthy 2000, St. Aubin 2002). Elephant seals demonstrate an acute cortisol response to handling, but do not demonstrate a chronic response; on the contrary, adult females demonstrate a reduction in the adrenocortical response following repetitive chemical immobilization (Engelhard et al. 2002). With respect to anthropogenic sound as a stressor, the

current limited body of knowledge will require extrapolation from species for which information exists to those for which no information exists.

The stress response may or may not result in a behavioral change, depending on the characteristics of the exposed animal. However, provided a stress response occurs, we assume that some contribution is made to the animal's allostatic load. Allostasis is the ability of an animal to maintain stability through change by adjusting its physiology in response to both predictable and unpredictable events (McEwen and Wingfield 2003). The same hormones associated with the stress response vary naturally throughout an animal's life, providing support for particular life history events (e.g., pregnancy) and predictable environmental conditions (e.g., seasonal changes). The allostatic load is the cumulative cost of allostasis incurred by an animal and is characterized with respect to an animal's energetic expenditure.

Perturbations to an animal that may occur with the presence of a stressor, either biological (e.g., predator) or anthropogenic (e.g., construction), can contribute to the allostatic load (McEwen and Wingfield 2003). Additional costs are cumulative and additions to the allostatic load over time may contribute to reductions in the probability of achieving ultimate life history functions (e.g., survival, maturation, reproductive effort and success) by producing pathophysiological states. The contribution to the allostatic load from a stressor requires estimating the magnitude and duration of the stress response, as well as any secondary contributions that might result from a change in behavior.

If the acoustic source does not produce tissue effects, is not perceived by the animal, or does not produce a stress response by any other means, it is assumed that the exposure does not contribute to the allostatic load. Additionally, without a stress response or auditory masking, it is assumed that there can be no behavioral change. Conversely, any immediate effect of exposure that produces an injury is assumed to also produce a stress response and contribute to the allostatic load.

3.9.2.2.2 Behavior

Acute stress responses may or may not cause a behavioral reaction. However, all changes in behavior are expected to result from an acute stress response. This expectation is based on the idea that some sort of physiological trigger must exist to change any behavior that is already being performed. The exception to this rule is the case of masking. The presence of a masking sound may not produce a stress response, but may interfere with the animal's ability to detect and discriminate biologically relevant signals. The inability to detect and discriminate biologically relevant signals hinders the potential for normal behavioral responses to auditory cues and is considered a behavioral change. Numerous behavioral changes can occur as a result of stress response and, for each potential behavioral change, the magnitude in the change and the severity of the response needs to be estimated. Certain conditions, such as stampeding (i.e., flight response) or a response to a predator, might have a probability of resulting in injury. For example, a flight response, if significant enough, could produce a stranding event. Under the MMPA, such an event would be considered a MMPA Level A harassment. Each altered behavior may also have the potential to disrupt biologically significant events (e.g., breeding or nursing) and may need to be qualified as MMPA Level B harassment. Exposures to sonar resulting in non-TTS behavioral disturbance and exposure to at-sea explosions resulting in sub-TTS behavioral disturbance are quantified as MMPA Level B harassment. All behavioral disruptions have the potential to contribute to the allostatic load. This secondary potential is signified by the feedback from the collective behaviors to allostatic loading (physiology block). The response of a marine mammal to an anthropogenic sound source will depend on the frequency content, duration, temporal pattern and amplitude of the sound as well as the animal's prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). The direction of the responses can vary, with some changes resulting in either increases or decreases from baseline (e.g., decreased dive times and increased respiration rate). Responses can also overlap; for example, an increased respiration rate is likely to be coupled to a flight response. Differential responses between and within species are expected since hearing ranges vary across species and the behavioral ecology of individual species is unlikely to completely

overlap. A review of marine mammal responses to anthropogenic sound was first conducted by Richardson and others in 1995. A more recent review (Nowacek et al. 2007) addresses studies conducted since 1995 and focuses on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated. The following sections provide a very brief overview of the state of knowledge of behavioral responses. The overviews focus on studies conducted since 2000 but are not meant to be comprehensive; rather, they provide an idea of the variability in behavioral responses that would be expected given the differential sensitivities of marine mammal species to sound and the wide range of potential acoustic sources to which a marine mammal may be exposed. Estimates of the types of behavioral responses that could occur for a given sound exposure should be determined from the literature that is available for each species, or extrapolated from closely related species when no information exists.

Flight Response

A flight response is a dramatic change in normal movement to a directed and rapid movement away from the perceived location of a sound source. Little information on flight responses of marine mammals to anthropogenic signals exists, although observations of flight responses to the presence of predators have occurred (Connor and Heithaus 1996). Flight responses have been speculated as being a component of marine mammal strandings associated with sonar activities (NOAA 2001).

Response to Predators

Evidence suggests that at least some marine mammals have the ability to acoustically identify potential predators. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by certain groups of killer whales, but not others. The seals discriminate between the calls of threatening and non-threatening killer whales (Deecke et al. 2002), a capability that should increase survivorship while reducing the energy required for attending to and responding to all killer whale calls. The occurrence of masking or hearing impairment provides a means by which marine mammals may be prevented from responding to the acoustic cues produced by their predators. Whether or not this is a possibility depends on the duration of the masking/hearing impairment and the likelihood of encountering a predator during the time that predator cues are impeded.

Diving

Changes in dive behavior can vary widely. They may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive. Variations in dive behavior may reflect interruptions in biologically significant activities (e.g., foraging) or they may be of little biological significance. Variations in dive behavior may also expose an animal to potentially harmful conditions (e.g., increasing the chance of ship-strike) or may serve as an avoidance response that enhances survivorship. The impact of a variation in diving resulting from an acoustic exposure depends on what the animal is doing at the time of the exposure and the type and magnitude of the response. Nowacek et al. (2004) reported disruptions of dive behaviors in foraging North Atlantic right whales when exposed to an alerting stimulus, an action, they noted, that could lead to an increased likelihood of ship strike. However, the whales did not respond to playbacks of either right whale social sounds or vessel noise, highlighting the importance of the sound characteristics in producing a behavioral reaction. Conversely, Indo-Pacific humpback dolphins have been observed to dive for longer periods of time in areas where vessels were present and/or approaching (Ng and Leung 2003). In both of these studies, the influence of the sound exposure cannot be decoupled from the physical presence of a surface vessel; thus, complicating interpretations of the relative contribution of each stimulus to the response. Indeed, the presence of surface vessels, their approach and speed of approach, seemed to be significant factors in the response of the Indo-Pacific humpback dolphins (Ng and Leung 2003). Low frequency signals of the Acoustic Thermometry of Ocean Climate (ATOC) sound source were not found to affect dive times of humpback whales in Hawaiian waters (Frankel and Clark 2000) or to overtly affect elephant seal dives (Costa et al. 2003). However, they did produce subtle effects that varied in direction and degree among the individual seals, illustrating the equivocal nature of behavioral effects and consequent difficulty in

defining and predicting them. Due to past incidents of beaked whale strandings associated with sonar operations, feedback paths are provided between avoidance and diving and indirect tissue effects. This feedback accounts for the hypothesis that variations in diving behavior and/or avoidance responses can possibly result in nitrogen tissue supersaturation and nitrogen off-gassing, possibly to the point of deleterious vascular bubble formation (Jepson et al. 2003). Although hypothetical, the potential process is being debated within the scientific community.

Foraging

Disruption of feeding behavior can be difficult to correlate with anthropogenic sound exposure, so it is usually inferred by observed displacement from known foraging areas, the appearance of secondary indicators (e.g., bubble nets or sediment plumes), or changes in dive behavior. Noise from seismic surveys was not found to impact the feeding behavior in western gray whales off the coast of Russia (Yazvenko et al. 2007) and sperm whales engaged in foraging dives did not abandon dives when exposed to distant signatures of seismic airguns (Madsen et al. 2006). Balaenopterid whales exposed to moderate low-frequency signals similar to the ATOC sound source demonstrated no variation in foraging activity.

Vocalizations

Vocal changes in response to anthropogenic noise can occur across the repertoire of sound production modes used by marine mammals, such as whistling, echolocation click production, calling, and singing. Changes may result in response to a need to compete with an increase in background noise or may reflect an increased vigilance or startle response. For example, in the presence of low-frequency active sonar, humpback whales have been observed to increase the length of their "songs" (Miller et al. 2000, Fristrup et al. 2003), possibly due to the overlap in frequencies between the whale song and the low-frequency active sonar. A similar compensatory effect for the presence of low frequency vessel noise has been suggested for right whales; right whales have been observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks et al. 2007). Killer whales off the northwestern coast of the United States have been observed to increase the duration of primary calls once a threshold in observing vessel density (e.g., whale watching) was reached, which has been suggested as a response to increased masking noise produced by the vessels (Foote et al. 2004). In contrast, both sperm and pilot whales potentially ceased sound production during the Heard Island feasibility test (Bowles et al. 1994), although it cannot be absolutely determined whether the inability to acoustically detect the animals was due to the cessation of sound production or the displacement of animals from the area.

Avoidance

Avoidance is the displacement of an individual from an area as a result of the presence of a sound. It is qualitatively different from the flight response in its magnitude (i.e., directed movement, rate of travel, (Croll et al. 2001), whereas five out of six North Atlantic right whales exposed to an acoustic alarm interrupted their foraging dives (Nowacek et al. 2004). Although the received sound pressure level at the animals was similar in the latter two studies, the frequency, duration, and temporal pattern of signal presentation were different. These factors, as well as differences in species sensitivity, are likely contributing factors to the differential response. A determination of whether foraging disruptions incur fitness consequences will require information on or estimates of the energetic requirements of the individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal.

Breathing

Variations in respiration naturally vary with different behaviors and variations in respiration rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Mean exhalation rates of gray whales at rest and while diving

were found to be unaffected by seismic surveys conducted adjacent to the whale feeding grounds (Gailey et al., 2007). Studies with captive harbor porpoises showed increased respiration rates upon introduction of acoustic alarms (Kastelein et al. 2000, Kastelein et al. 2006) and emissions for underwater data transmission (Kastelein et al. 2005). However, exposure of the same acoustic alarm to a striped dolphin under the same conditions did not elicit a response (Kastelein et al. 2006), again highlighting the importance in understanding species differences in the tolerance of underwater noise when determining the potential for impacts resulting from anthropogenic sound exposure.

Social Relationships

Social interactions between mammals can be affected by noise via the disruption of communication signals or by the displacement of individuals. Disruption of social relationships depends on the disruption of other behaviors (e.g., caused avoidance, masking, etc.) and no specific overview is provided here. However, social disruptions must be considered in context of the relationships that are affected. etc.). Oftentimes avoidance is temporary, and animals return to the area once the noise has ceased. However, longer term displacement is possible, which can lead to changes in abundance or distribution patterns of the species in the affected region if they do not become acclimated to the presence of the sound (Blackwell et al. 2004, Bejder et al. 2006, Teilmann et al. 2006). Acute avoidance responses have been observed in captive porpoises and pinnipeds exposed to a number of different sound sources (Kastelein et al. 2000, Finneran et al. 2003, Kastelein et al. 2006). Short term avoidance of seismic surveys, low frequency emissions, and acoustic deterrents has also been noted in wild populations of odontocetes (Bowles et al. 1994, Goold 1996, Stone et al. 2000, Morton and Symonds 2002) and to some extent in mysticetes (Gailey et al. 2007), while longer term or repetitive/chronic displacement for some dolphin groups and for manatees has been suggested to be due to the presence of chronic vessel noise (Haviland-Howell et al. 2007, Miksis-Olds et al. 2007).

Orientation

A shift in an animal's resting state or an intentional change via an orienting response represent behaviors that would be considered mild disruptions if occurring alone, and are placed at the bottom of the framework behavior list. As previously mentioned, the responses may co-occur with other behaviors; for instance, an animal may initially orient toward a sound source, and then move away from it. Thus, any orienting response should be considered in context of other reactions that may occur.

Proximate Life Functions

Proximate life history functions are the functions that the animal is engaged in at the time of acoustic exposure. The disruption of these functions, and the magnitude of the disruption, is something that must be considered in determining how the ultimate life history functions are affected. Consideration of the magnitude of the effect to each of the proximate life history functions is dependent upon the life stage of the animal. For example, an animal on a breeding ground which is sexually immature will suffer little consequence to disruption of breeding behavior when compared to an actively displaying adult of prime reproductive age.

Ultimate Life Functions

The ultimate life functions are those that enable an animal to contribute to the population (or stock, or species, etc.). The impact to ultimate life functions will depend on the nature and magnitude of the perturbation to proximate life history functions. Depending on the severity of the response to the stressor, acute perturbations may have nominal to profound impacts on ultimate life functions. For example, underwater detonations in an area that is utilized for foraging, but not for breeding, may disrupt feeding by exposed animals for a brief period of time. Because of the brevity of the perturbation, the impact to ultimate life functions may be negligible. By contrast, weekly training over a period of years may have a more substantial impact because the stressor is chronic. Assessment of the magnitude of the stress response from the chronic perturbation would require an understanding of how and whether animals

acclimate to a specific, repeated stressor and whether chronic elevations in the stress response (e.g., cortisol levels) produce fitness deficits. The proximate life functions are loosely ordered in decreasing severity of impact. Mortality (survival) has an immediate effect, in that no future reproductive success is feasible and there is no further addition to the population resulting from reproduction. Severe injuries may also lead to reduced survivorship (longevity) and prolonged alterations in behavior. The latter may further affect an animal's overall reproductive success and reproductive effort. Disruptions of breeding have an immediate impact on reproductive effort and may impact reproductive success. The magnitude of the effect will depend on the duration of the disruption and the type of behavior change that was provoked. Disruptions to feeding and migration can affect all of the ultimate life functions; however, the impacts to reproductive effort and success are not likely to be as severe or immediate as those incurred by mortality and breeding disruptions. Taking into account these considerations, it was determined if there were population and species effects.

3.9.2.2.3 Integration of Physiological and Behavioral Effects

This section presents a biological framework within which potential effects can be categorized and then related to the existing regulatory framework of injury (MMPA Level A harassment) and behavioral disruption (MMPA Level B harassment). The information presented in the previous sections is used to develop specific numerical exposure thresholds and risk function exposure estimations. Exposure thresholds are combined with underwater detonation and sound propagation models and species distribution data to estimate the potential exposures.

Sound exposure may affect multiple biological traits of a marine animal; however, existing protective regulations (i.e., MMPA) provide guidance as to which traits should be used when determining impacts. Specifically, impacts that qualify as Level A harassment should address injury and impacts that qualify as Level B harassment should address behavioral disruption. This guidance reduces the number of traits that must be considered in establishing a biological framework of impact assessment.

The biological framework discussed in the SSTC EIS is structured according to physiological and behavioral effects resulting from exposure to acoustics and pressure. The range of effects may then be assessed to determine which qualify as harassment under MMPA regulations. Physiology and behavior are chosen over other biological traits for several reasons, including the fact that: (1) they are consistent with regulatory statements defining harassment; (2) they are components of other biological traits that may be relevant; and (3) they are a more sensitive and immediate indicator of effect. For example, ecology is not used as the basis of the framework because the ecology of an animal is dependent upon the interaction of an animal with the environment. The animal's interaction with the environment is driven both by its physiological function and its behavior, and an ecological impact may not be observable over short periods of observation. Anatomy is not used because disruption of an animal's anatomy would necessarily result in a change in physiological function.

A "physiological effect" is defined within the context of this EIS as one in which the normal physiological function of the animal is altered in response to sound or underwater detonation exposure. Physiological function is any of a collection of processes ranging from biochemical reactions to mechanical interaction and operation of organs and tissues within an animal. A physiological effect may range from the most significant of impacts (e.g., mortality, serious injury) to lesser impacts that would define the lower end of the physiological impact range (e.g., non-injurious distortion of auditory tissues). This latter physiological effect is important to the integration of the biological and regulatory frameworks and is described in later sections.

A "behavioral effect" is one in which the normal behavior of an animal, or patterns of behavior, are overtly disrupted in response to an exposure. Examples of behaviors of concern can be derived from the harassment definitions of the MMPA.

In this EIS, the term “normal” is used to qualify distinctions between physiological and behavioral effects. Its use follows the convention of normal daily variation in physiological and behavioral function without the influence of anthropogenic acoustic sources. As a result, this EIS uses the following definitions:

- A physiological effect is a variation in an animal’s physiology that results from an anthropogenic sound exposure and exceeds the normal daily variation in physiological function.
- A behavioral effect is a variation in an animal’s behavior or behavior patterns that results from an anthropogenic sound exposure and exceeds the normal daily variation in behavior, but which arises through normal physiological process (it occurs without an accompanying physiological effect).

The definitions of “physiological effect” and “behavioral effect” used here are specific to this EIS and should not be confused with more global definitions applied to the field of biology.

It is reasonable to expect some physiological effects to result in subsequent behavioral effects. For example, a marine mammal that suffers a severe injury may be expected to alter diving or foraging such that variation in these behaviors is outside that which is considered normal for the species. If a physiological effect is accompanied by a behavioral effect, the overall effect is characterized as a physiological effect; physiological effects take precedence over behavioral effects with regard to their ordering. This approach provides the most conservative evaluation of effects with respect to severity, provides a rational approach to dealing with the overlap of the definitions, and avoids circular arguments.

The severity of physiological effects decreases with decreasing exposure (acoustic or blast-wave) and/or increasing distance from the sound source. The same generalization does not consistently hold for behavioral effects because they do not depend solely on received sound levels. Behavioral responses also depend on an animal’s learned responses, innate response tendencies, motivational state, the pattern of the sound exposure, and the context in which sounds are presented. However, to provide a tractable approach to predicting acoustic impacts that is relevant to the terms of behavioral disruption described in the MMPA; it is assumed herein that the severity of behavioral effects also decreases with decreasing sound exposure and/or increasing distance from the sound source. Figure 3.9-1 shows the relationships between severity of effects, source distance, and sound exposure as defined in this EIS.

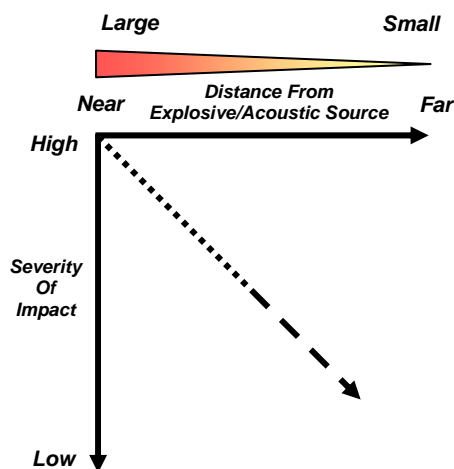


Figure 3.9-1: Relationship between Severity of Effects, Source Distance, and Exposure Level

3.9.2.2.4 Level A and Level B Harassment

Categorizing potential effects as either physiological or behavioral effects allows them to be related to the harassment definitions. For military readiness activities, MMPA Level A harassment includes any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild. Injury, as defined in this LOA request and previous rulings (NOAA 2001, 2002a, 2008b, 2008c), is the destruction or loss of biological tissue from a species. The destruction or loss of biological tissue will result in an alteration of physiological function that exceeds the normal daily physiological variation of the intact tissue. For example, increased localized histamine production, edema, production of scar tissue, activation of clotting factors, white blood cell response, etc., may be expected following injury.

Therefore, this EIS assumes that all injury is qualified as a physiological effect and, to be consistent with prior actions and rulings (NOAA 2001, 2008b, 2008c), all injuries (slight to severe) are considered MMPA Level A harassment. Public Law 108-136 (2004) amended the MMPA definitions of Level B harassment for military readiness activities, which applies to this action. For military readiness activities, MMPA Level B harassment is defined as “any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behaviors are abandoned or significantly altered.” Unlike MMPA Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects may cause MMPA Level B harassment.

For example, some physiological effects (such as TTS) can occur that are non-injurious but that can potentially disrupt the behavior of a marine mammal. These include temporary distortions in sensory tissue that alter physiological function, but that are fully recoverable without the requirement for tissue replacement or regeneration. For example, an animal that experiences a temporary reduction in hearing sensitivity suffers no injury to its auditory system, but may not perceive some sounds due to the reduction in sensitivity. As a result, the animal may not respond to sounds that would normally produce a behavioral reaction. This lack of response qualifies as a temporary disruption of normal behavioral patterns—the animal is impeded from responding in a normal manner to an acoustic stimulus. The harassment status of slight behavior disruption has been addressed in workshops, previous actions, and rulings (NOAA 2001, 2008b, 2008c; DoN 2001a). The conclusion is that a momentary behavioral reaction of an animal to a brief, time-isolated acoustic event does not qualify as MMPA Level B harassment. A more general conclusion, that MMPA Level B harassment occurs only when there is “a potential for a significant behavioral change or response in a biologically important behavior or activity,” is found in recent rulings (NOAA 2002a, 2008b, 2008c). Public Law 108-136 (2004) amended the definition of MMPA Level B harassment for military readiness activities, which applies to this action. For military readiness activities, MMPA Level B harassment is defined as “any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns...to a point where such behaviors are abandoned or significantly altered.”

Although the temporary lack of response discussed above may not result in abandonment or significant alteration of natural behavioral patterns, the acoustic effect inputs used in the acoustic model assume that temporary hearing impairment (slight to severe) is considered MMPA Level B harassment. Although modes of action are appropriately considered, the conservative assumption used here is to consider all hearing impairment as harassment from TTS. As a result, the actual incidental harassment of marine mammals associated with this action may be less than predicted via the analytical framework.

To assess the potential for harassment, two quantities are of interest:

- The number of animals with probability of being present in the zone of influence (ZOI) for injury but not detected.
- The expected number of marine mammals within various radii of the detonation point (i.e., ZOI ranges for mortality, injury, and behavioral disruption) is included in the considerations. This quantity is ordinarily referred to as “incidental take.”

For this EIS, estimates of the numbers of species within the harassment zones and exposed to the various sound sources were calculated assuming that none of the current mitigation measures routinely used for SSTC activities were implemented. Harassment that may result from Navy activities described in this EIS is unintentional and incidental to those activities.

3.9.2.2.5 Harassment Zones

The volumes of ocean in which Level A and B harassment are predicted to occur are described as harassment zones. All animals predicted to be in a zone are considered “exposed” within the applicable harassment category.

The Level A harassment zone extends from the source out to the distance and exposure where slight injury is predicted to occur. The acoustic exposure that produces slight injury is the threshold value defining the outermost limit of the Level A harassment zone. A dual criterion approach promulgated by NMFS rulemaking was used to determine potential impact ranges for Level A (see Section 3.9.2.3). Criterion included 100 percent mortality, which could occur from either maximum shock wave pressure or bulk cavitation, and slight injury. Slight injury included onset gastro-intestinal tract injury, which could occur from maximum shock wave pressure, and onset permanent threshold shift (PTS) which could occur from either maximum shock wave pressure or weighted energy flux density. Use of the threshold associated with the onset of slight injury (onset PTS) as the most distant point and least injurious exposures account of all more serious injuries by inclusion within the Level A harassment zone.

The Level B harassment zone begins just beyond the point of slightest injury and extends outward from that point. It includes all animals that may potentially experience Level B harassment. Physiological effects extend beyond the range of slightest injury to a point where slight temporary distortion of the most sensitive tissue occurs, but without destruction or loss of that tissue. The animals predicted to be in this zone experience Level B harassment by virtue of temporary impairment of sensory function (i.e., altered physiological function) that can disrupt behavior. Beyond that distance, the Level B harassment zone continues to the point at which no biologically significant behavioral disruption is expected to occur. Onset of temporary impact criterion included onset TTS which could occur from either maximum shock wave pressure or weighted energy flux density.

3.9.2.2.6 Auditory Tissues as Indicators of Physiological Effects

The mammalian auditory system consists of the outer ear, middle ear, inner ear, and central nervous system. Sound waves are transmitted through the outer and middle ears to fluids within the inner ear. The inner ear contains delicate electromechanical hair cells that convert the fluid motions into neural impulses that are sent to the brain. The hair cells within the inner ear are the most vulnerable to overstimulation by noise exposure (Yost 1994). Very high sound levels may rupture the eardrum or damage the small bones in the middle ear (Yost 1994). Lower level exposures may cause permanent or temporary hearing loss—called a noise-induced threshold shift or simply threshold shift (TS) (Miller 1974; Ward 1997). A TS may be permanent, called a permanent threshold shift (PTS), or temporary, called a TTS. Still lower exposures may result in auditory masking interfering with an animal’s ability to hear other concurrent sounds.

A TTS is a result of auditory system fatigue following stimulation. The fatigue is believed to be caused by temporary changes in neural function, hair-cell function, and reductions in oxygen availability within the

inner ear fluids. Collectively, these qualify as physiological changes that would exceed the normal daily variation in physiological function specific to those components of the auditory system. A PTS results from injury, which may occur at multiple levels of the auditory system. Tissue destruction can produce both localized and distributed variations in physiology depending on the type, location, and magnitude of the injury. With respect to auditory tissues, destruction of tissues associated with PTS would, at a minimum, result in localized changes in the physiology of the tissue that exceeds its normal daily variation in physiological function. Therefore, both TTS and PTS are physiological effects.

The amount of TS depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure. Threshold shifts increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy would lead to approximately equal effects (Ward 1997). For intermittent sounds, less TS occurs from continuous exposure with the same energy; further, some recovery occurs between exposures (Kryter et al. 1966, Ward 1997). The relationships between sound exposure parameters and resulting TS are not well understood for impulsive sounds. The TSs from impulsive sounds are more difficult to characterize than TSs from continuous-type sounds, in part because of the wide variety of impulsive sound waveforms that may be encountered (Hamernik et al. 1991).

The magnitude of TS normally decreases with the amount of time post-exposure (Miller, 1974). The amount of TS just after exposure is called the initial TS. If the TS eventually returns to zero (i.e., the threshold returns to the pre-exposure value), the TS is a TTS. Because the amount of TTS depends on the time post-exposure, it is common to use a subscript to indicate the time in minutes after exposure (Quaranta et al. 1998). For example, TTS₂ means a TTS measured two minutes after exposure. If the TS does not return to zero but leaves some finite amount of TS, that remaining TS is a PTS. The distinction between PTS and TTS is based on whether there is a complete recovery of TS following a sound exposure.

3.9.2.2.7 Mortality and the Level A Harassment Zone

Within the Level A harassment zone is a sub-region in which animals exposed to the blast are not expected to survive. Marine mammals can be killed by underwater explosions due to the response of air cavities, such as the lungs and bubbles in the intestines, to the shock wave (Elsayed 1997, Elsayed and Gorbunov 2007). The criterion for mortality used in this EIS is the onset of extensive lung hemorrhage. Extensive lung hemorrhage is considered debilitating and potentially fatal as a result of air embolism or suffocation. In this EIS, all marine mammals within the calculated radius for onset of extensive lung injury (i.e., onset of mortality) are counted as lethal exposures. The range at which onset of extensive lung hemorrhage is expected to occur is greater than the ranges at which 50 to 100 percent lethality would occur from closest proximity to the charge or from presence within the bulk cavitation region. (The region of bulk cavitation is an area near the surface above the detonation point in which the reflected shock wave creates a region of cavitation within which smaller animals would not be expected to survive.) Because the range for onset of extensive lung hemorrhage for smaller animals exceeds the range for bulk cavitation and all more serious injuries, all smaller animals within the region of cavitation and all animals (regardless of body mass) with more serious injuries than onset of extensive lung hemorrhage are accounted for in the lethal exposures estimate. The calculated maximum ranges for onset of extensive lung hemorrhage depend upon animal body mass, with smaller animals having the greatest potential for impact, as well as water column temperature and density.

3.9.2.2.8 Injury and the Level A Harassment Zone

The remainder of the Level A harassment zone, which extends beyond the sub-region defining lethal exposures, encompasses all remaining non-lethal injuries that could potentially occur to marine mammals as a result of blast exposure. The criteria used to define the outer edge of the Level A harassment zone is the range at which PTS begins to occur (onset PTS). The auditory system consists of delicate tissues (e.g., hair cells) that are sensitive to pressure changes and responsive to sound exposures that are well below levels likely to cause trauma to non-auditory, air containing structures. PTS is non-recoverable and must result from the destruction of tissues within the auditory system (e.g., tympanic membrane rupture, disarticulation of the middle ear ossicles, and hair-cell damage).

Therefore, PTS qualifies as an injury and is classified as Level A harassment under the wording of the MMPA.

Onset PTS is indicative of the minimum level of injury that can occur due to sound exposure. All other forms of trauma would occur closer to the sound source than the range at which onset PTS occurs.

3.9.2.2.9 TTS and the Level B Harassment Zone

The Level A harassment zone extends from the detonation point outward to that point where the slightest injury may occur. Therefore, the Level B harassment zone begins just beyond the point at which the slightest amount of injury occurs and extends outward to the distance and exposure where the onset of TTS is expected to occur. Consistent with previous NMFS rulings, single, time-isolated impulsive events such as that described in this EIS are considered incapable of causing significant behavioral disruption at levels below those causing TTS. Because of the transient nature of the sources used in this action, the limited number of detonations, and temporal spacing of detonations, no significant behavioral effects that qualify as Level B harassment would occur in this action (NMFS 2009a, 2009b). As a result, only physiological effects need be considered in the development of harassment criteria. The Level B harassment zone only includes the region in which TTS is predicted to occur. TTS is recoverable and, as in recent rules (NMFS 2009a, 2009b), is considered to result from the temporary, non-injurious distortion of hearing-related tissues. In this EIS, the smallest measurable amount of TTS (onset TTS) is taken as the best indicator for slight temporary sensory impairment. The acoustic exposure associated with onset TTS is used to define the outer limit of the portion of the Level B harassment zone attributable to physiological effects. This follows from the concept that hearing loss potentially affects a marine mammal's ability to react normally to the sounds around it; it potentially disrupts normal behavior by preventing it from occurring. Therefore, the potential for TTS qualifies as a Level B harassment that is mediated by physiological effects upon the auditory system.

3.9.2.2.10 Level B Behavioral Effects

This EIS defines behavioral effects as variations in an animal's behavior that exceed the normal daily variation in behavior, do not meet the definition of a physiological effect, and which follow an anthropogenic sound exposure. Level B harassment includes only those acts which disturb or are likely to disturb by causing disruption of behavioral patterns to the point where those patterns are abandoned or significantly altered. Previous actions and rules (NMFS 2009a, 2009b, DoN 2008a, DoN 2008b) have concluded that a momentary behavioral reaction of an animal to a brief, time-isolated acoustic event does not qualify as Level B harassment. That Level B harassment occurs only when there is "a potential for a significant behavioral change or response in a biologically important behavior or activity". This conclusion is further supported by the National Defense Authorization Act of 2004 (Public Law [PL] 108-136) for actions involving military readiness, as defined in Section 11.

The short-duration events proposed for this action are brief and time-isolated. In this EIS and consistent with prior rules (e.g., NMFS 2009a, 2009b), they are considered incapable of causing behavioral effects beyond slight, momentary disruption and are unlikely to have any significant biological impact upon exposed animals. Furthermore, the transient nature of impulsive sources proposed for this action, the

limited number of detonations required for the completion of the action, the temporal spacing of detonations (on the order of days), and the dynamic and patchy nature of offshore animal distributions makes it unlikely that any animal would be exposed to more than one acoustic event. These conclusions are considered as limiting factors in the development of harassment zones for this proposed action.

3.9.2.2.11 Auditory Masking

Natural and artificial sounds can disrupt behavior by masking, or interfering with an animal's ability to hear other sounds. Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher levels. If the second sound were man-made, it could be potentially harassing—according to the MMPA—if it disrupted hearing-related behavior such as communications or echolocation. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs during the sound exposure. Because masking (without a resulting TS) is not associated with abnormal physiological function, it is not considered a physiological effect in this EIS, but rather a potential behavioral effect.

The most intense underwater sounds in the proposed action are those produced by detonations and pile driving. Given that the energy distribution of detonations and pile driving cover a broad frequency spectrum, sound from these sources would likely be within the audible range of most marine mammals. However, the time scale of the shots is very limited; the pulse lengths are short, the repetitions of the shots are few, and the total time per year during which detonations occur is small. The probability for any detonation or pile driving resulting from this proposed action masking acoustic signals important to the behavior and survival of marine mammal species is negligible. Additionally, for reasons outlined above, any masking event that did occur would be considered transient and insignificant and would not qualify as Level B harassment. Masking effects are not considered as contributing to exposure estimates in this EIS.

3.9.2.3 Criteria for Assessing Marine Mammal Response to Underwater Detonations

The effects of an at-sea explosion on a marine mammal depends on many factors, including the size, type, and depth of both the animal and the explosive charge; the depth of the water column; the standoff distance between the charge and the animal; and the sound propagation properties of the environment. Potential impacts can range from brief acoustic effects (such as behavioral disturbance), tactile perception, physical discomfort, slight injury of the internal organs and the auditory system, to death of the animal (Yelverton et al. 1973, O'Keeffe and Young 1984, DoN 2001). Non-lethal injury includes slight injury to internal organs and the auditory system; however, delayed lethality can be a result of individual or cumulative sublethal injuries (DoN 2001a). Short-term or immediate lethal injury would result from massive combined trauma to internal organs as a direct result of proximity to the point of detonation (DoN 2001a).

In this EIS, several standard acoustic metrics (Urick 1983) are used to describe the thresholds for predicting potential physical impacts from underwater pressure waves:

- Total energy flux density or Sound Exposure Level (SEL). For plane waves (as assumed here), SEL is the time integral of the instantaneous intensity, where the instantaneous intensity is defined as the squared pressure divided by the impedance of sea water. Thus, SEL is the instantaneous pressure amplitude squared, summed over the duration of the signal and has dB units referenced to 1 micropascal squared second ($\mu\text{Pa}^2\text{-s}$).
- 1/3-octave SEL. This is the SEL in a 1/3-octave frequency band. A 1/3-octave band has upper and lower frequency limits with a ratio of 21:3, creating bandwidth limits of about 23 percent of center frequency.

- Positive impulse. This is the time integral of the initial positive pressure pulse of an explosion or explosive-like wave form. Standard units are Pascal seconds (Pa-sec), but pounds per square inch milliseconds (psi-ms) also are used.
- Peak pressure. This is the maximum positive amplitude of a pressure wave, dependent on charge mass and range. Units used here are psi, but other units of pressure, such as μPa and Bar, also are used.

This section summarizes the marine mammal impact criteria, thresholds, and ranges used for the subsequent modeled calculations:

- Criterion. Specific impact that could be used to represent a broad type of impacts (mortality, injury, harassment). For example, onset of severe lung injury (extensive lung hemorrhage) is used in this EIS as a criterion for the onset of mortality.
- Threshold. The specific level of sound pressure, impulse, or energy needed to cause the specific impact stated in a criterion.
- Range. The maximum horizontal distance from the detonation point where the threshold level is predicted to occur.

To assess the effects of underwater explosions at SSTC, two types of criteria are necessary, those for mortality injury (i.e. Level A harassment) and those for non-injurious physiological and/or behavioral disruption (i.e. Level B harassment). The SSTC criteria are based on those numeric criteria as specified by NMFS in recent NMFS rule making (NMFS 2009a, 2009b), which involved a single, underwater detonations isolated in time. These criteria are presented in Table 3.9-2.

3.9.2.3.1 Harassment Threshold for Sequential Detonations

There may be rare occasions when sequential underwater detonations are part of a static location event. For sequential detonations, accumulated energy over the entire training time is the natural extension for energy thresholds since energy accumulates with each subsequent shot.

For sequential detonations, the acoustic criterion for behavioral harassment is used to account for behavioral effects significant enough to be judged as harassment, but occurring at lower sound energy levels than those that may cause TTS. The behavioral harassment threshold is based on recent rulemaking from NMFS (NMFS 2009a, 2009b) for the energy-based TTS threshold.

The research on pure tone exposures reported in Schlundt et al. (2000) and Finneran and Schlundt (2004) provided the pure-tone threshold of 192 dB as the lowest TTS value. This value is modified for explosives by (a) interpreting it as an energy metric, (b) reducing it by 10 dB to account for the time constant of the mammal ear, and (c) measuring the energy in 1/3 octave bands, the natural filter band of the ear. The resulting TTS threshold for explosives is 182 dB re 1 $\text{mPa}^2\text{-s}$ in any 1/3 octave band. As reported by Schlundt et al. (2000) and Finneran and Schlundt (2004), instances of altered behavior in the pure tone research began 5 dB lower than those causing TTS. The behavioral harassment threshold is derived by subtracting 5 dB from the 182 dB re 1 $\text{mPa}^2\text{-s}$ in any 1/3 octave band threshold, resulting in a 177 dB re 1 $\mu\text{Pa}^2\text{-s}$ behavioral disturbance harassment threshold for multiple successive explosives.

Table 3.9-2: Marine Mammal Effects Criteria For Underwater Detonations From Explosives < 2,000 lbs Net Explosive Weight

	Criterion	Criterion Definition	Threshold	Comments
Mortality	Mortality Onset of extensive lung injury	Shock Wave Goertner's modified positive impulse, indexed to the surface	$I = 42.9 (M/34)^{1/3}$ psi-msec <i>calculated to be</i> 30.5 psi-msec	For all size classes of marine mammals
Level A Harassment	Slight Injury Onset of slight lung injury	Shock Wave Goertner's modified positive impulse, indexed to the surface	$I = 19.7 (M/42)^{1/3}$ psi-msec <i>calculated to be</i> 13 psi-msec	For all size classes of marine mammals
	Slight Injury 50% tympanic membrane rupture	Shock Wave Total SEL, for any single exposure	205 dB re:1 μ Pa ² -sec	All marine mammals
Level B Harassment	Physiological Disruption TTS	Sound Exposure Greatest SEL in any 1/3-octave band, over all exposures	182 dB re1 μ Pa ² -sec	Greatest SEL for frequencies \geq 100 Hz for odontocetes and \geq 10 Hz for mysticetes
	Physiological Disruption TTS	Sound Exposure Peak pressure, for any single exposure	23 psi	All marine mammals
	Behavioral Disruption Sub-TTS	Sound Exposure Greatest SEL in any 1/3-octave band, over all exposures	177 dB re:1 μ Pa ² -sec	Greatest SEL for frequencies \geq 100 Hz for odontocetes and \geq 10 Hz for mysticetes

3.9.2.4 Criteria for ELCAS pile driving and removal

Since 1997, NMFS has been using generic sound exposure thresholds to determine when an activity in the ocean that produces impact sound (i.e., pile driving) result in potential take of marine mammals by harassment (70 CFR 1871). NMFS is developing new science-based thresholds to improve and replace the current generic exposure level thresholds, but the criteria have not been finalized (Southall et al. 2007). Current NMFS criteria (70 FR 1871) regarding exposure of marine mammals to underwater impulsive sounds (e.g., impact pile driving) is that cetaceans exposed to sound levels of 180 dB root mean squared (RMS in units of dB re 1 μ Pa) or higher and pinnipeds exposed to 190 dB RMS or higher are considered to have been taken by Level A (i.e., injurious) harassment. Marine mammals (cetaceans and pinnipeds) exposed to impulse sounds of 160 dB RMS but below injurious thresholds (i.e., 180 or 190 dB) are considered to have been taken by Level B behavioral harassment. Marine mammals (cetaceans and pinnipeds) exposed to continuous noise of 120 dB RMS (e.g., vibratory pile driving) or above are considered to have been taken by Level B behavioral harassment.

3.9.2.5 Acoustic Modeling of the Marine Environment

In context of ocean sounds within and adjacent to the SSTC, anticipated ocean noise can be characterized as two types of noises:

1. Ambient noise as a combination of natural noise from breaking waves, spray, bubble formation and collapse, molecular thermal agitation, rainfall, and biologics (fish sounds, snapping shrimp sounds,

marine mammal vocalizations, etc.), and often indistinct anthropogenic (human made) noise from passing vessels, small powered boats, aircraft overflights, etc.

2. Point source anthropogenic noise produced by a single, identifiable source usually close to the point of reference (e.g., an underwater explosion at SSTC, temporary pile driving).

3.9.2.5.1 Multiple Indistinguishable Sources: Ambient Noise

More detailed discussions on ambient ocean noise are provided in Richardson et al. 1995, Deane 1997, 2000, NRC 2003, Hildebrand 2005, Hildebrand 2009, which list specific case studies highlighting the sources and frequency content of natural and anthropogenic ocean noise sources. With the exception of sonar, many of these sources are applicable and contribute to ambient noise within the SSTC. Surf noise, biological noise, large vessel and small boat traffic, and aircraft overflights are likely to be the most dominant ambient noise sources within SSTC (Richardson et al. 1995, Deane 1997, Deane 2000, Hildebrand 2009).

Wenz (1962) provided a generalized portrait of ocean noise used to predict, model, and understand the noise level from unidentifiable sources. These curves provide a noise spectrum level (units are dB re $1\mu\text{Pa}^2/\text{Hz}$) that an idealized receiver with omni-directional reception capabilities may experience at a particular moment depending on location. Although ambient noise is always present, the individual sources that contribute to it do not necessarily create sound continuously. For example, rain is periodic, and wind speeds change with weather patterns. Seasonal trends are likely related to changes in average wind speeds with season (McDonald et al. 2006). Given the nearshore distribution of the training areas within the SSTC, surf zone noise (breaking waves, etc.) is likely to be a constant ambient noise source. In the northern hemisphere, ambient noise in deep water can be dominated by shipping, particularly at frequencies between 5 and 500 Hz (Richardson et al. 1995, NRC 2003, Hildebrand 2009). By most estimates, there has been an increase of underwater noise associated with increased commercial shipping traffic, especially in areas near major ports. Several studies have documented an approximate equivalent 3 dB per decade increase in ocean noise attributed to commercial shipping (Hildebrand 2005, McDonald et al. 2006, Hildebrand 2009). In terms of logarithmic scaling used in sound measurements, this 3 dB increase is equivalent to a doubling of noise energy levels every 10 years over the last few decades.

Distant and localized shipping traffic approaching San Diego Bay can contribute to the general acoustic environment over a wide frequency range and large geographic area. However, it should be noted that shallow water noise levels from shipping traffic are highly variable primarily because of differences in local acoustic propagation and seafloor absorption characteristics in shallow water vice deep water (MacDonald et al. 2009). While the distribution and timing of shipping traffic is not uniform, this type of ambient ocean noise is prevalent in and around major ports including San Diego (Heitmeyer et al. 2004).

3.9.2.5.2 Single Discrete Sources: Underwater Explosions

Underwater detonations produced during SSTC training events represent a single, known source. Chemical explosives create a bubble of expanding gases as the material burns. The bubble can oscillate underwater or, depending on charge-size and depth, be vented to the surface in which case there is no bubble-oscillation with its associated low-frequency energy. Explosions produce very brief, broadband pulses characterized by rapid rise-time, great zero-to-peak pressures, and intense sound, sometimes described as impulse. Close to the explosion, there is a very brief, great-pressure acoustic wave-front. The signal's rapid onset time, in addition to great peak pressure, can cause auditory impacts, although the brevity of the signal can include less SEL than expected to cause impacts. The transient signal gradually decays in magnitude as it broadens in duration with range from the source. The waveform transforms to approximate a low-frequency, broadband signal with a continuous sound energy distribution across the spectrum. In addition, underwater explosions are relatively brief, transitory events when compared to the existing ambient noise within San Diego Bay and at the SSTC. Ambient noise can be composed of natural

sources such as wind, surf, and biological activity (e.g., snapping shrimp, fish calls, and marine mammal vocalizations), as well as generalized distance sound from human activities of which shipping is the dominant component (Richardson et al. 1995; NRC 2003, 2005).

The impacts of an underwater explosion to a marine mammal are dependent upon multiple factors including the size, type, and depth of both the animal and the explosive. Depth of the water column and the distance from the charge to the animal also are determining factors as are boundary conditions that influence reflections and refraction of energy radiated from the source. The severity of physiological effects generally decreases with decreasing exposure (impulse, sound exposure level, or peak pressure) and/or increasing distance from the sound source. The same generalization consistently is not applicable for behavioral effects, because they solely do not depend on sound exposure level. Behavioral responses also depend on an animal's learned responses, innate response tendencies, motivational state, pattern of the sound exposure, and context in which sounds are presented. Potential impacts can range from brief acoustic effects, tactile perception, and physical discomfort to both lethal and non-lethal injuries. Disturbance of ongoing behaviors could occur as a result of noninjurious physiological responses to both the acoustic signature and shock wave from the underwater explosion. Nonlethal injury includes slight injury to internal organs and auditory system. The severity of physiological effects generally decreases with decreasing sound exposure and/or increasing distance from the sound source. Injuries to internal organs and the auditory system from shock waves and intense impulsive noise associated with explosions can be exacerbated by strong bottom-reflected pressure pulses in reverberant environments (Gaspin 1983, Ahroon et al. 1996). The same generalization applies to behavioral effects, but is complicated by the fact that behavioral responses also depend on an animal's learned responses, innate response tendencies, motivational state, pattern of the sound exposure, and the context in which the sound is presented. While there are little data on the consequences of sound exposure from underwater detonations on behavioral or vital rates of marine mammals, exposure to sounds resulting from Navy underwater explosive training would be brief as each event is relatively discrete and separate in time and space from other similar events. In addition, the overall size of the explosives used at the SSTC is much smaller than those used during larger Fleet ship and aircraft training events.

3.9.2.5.3 Predictive Modeling for Underwater Detonations – Modeling Framework

All underwater detonations proposed for SSTC were modeled as if they will be conducted in shallow water of 24 to 72 feet, including those that would normally be conducted in very shallow water (VSW) depths of zero to 24 feet. Modeling in deeper than actual water depths causes the modeled results to be more conservative (i.e., over prediction of propagation and potential exposures) than if the underwater detonations were modeled at their actual, representative depths when water depth is less than 24 feet. As will be discussed later, in deeper water there is less sound and energy propagation interference associated with the sea bottom and water surface.

The effects that underwater detonations have on a marine mammals is dependent upon multiple factors including size of the detonation, type of detonation, species of marine mammal, and depth of both the mammal and detonation. Depth of the water column and distance from the charge to the marine mammal also are determining factors. To quantify impacts, the U.S. Navy has developed simulations that determine exposures of protected species during training operations.

The Navy's underwater explosive effects simulation requires six major process components:

- A training event description including explosive type.
- Physical oceanographic and geoacoustic data for input into the acoustic propagation model representing seasonality of the planned operation.

- Biological data for the area including density (and multidimensional animal movement for those training events with multiple detonations).
- An acoustic propagation model suitable for the source type to predict impulse, energy, and peak pressure at ranges and depths from the source.
- The ability to collect acoustic and animal movement information to predict exposures for all animals during a training event (dosimeter record).
- The ability for post-operation processing to evaluate the dosimeter exposure record and calculate exposure statistics for each species based on applicable thresholds.

An impact model, such as the one used for the SSTC analysis, simulates the conditions present based on location(s), source(s), and species parameters by using combinations of embedded models (Mitchell et al. 2008). The software package used for SSTC consists of two main parts: an underwater noise model and bioacoustic impact model (Lazauski et al. 1999, Lazauski and Mitchell 2006, Lazauski and Mitchell 2008).

Location-specific data characterize the physical and biological environments while exercise-specific data construct the training operations. The quantification process involves employment of modeling tools that yield numbers of exposures for each training operation. During modeling, the exposures are logged in a time-step manner by virtual dosimeters linked to each simulated animal. After the operation simulation, the logs are compared to exposure thresholds to produce raw exposure statistics. It is important to note that dosimeters only were used to determine exposures based on energy thresholds, not impulse or peak pressure thresholds. The analysis process uses quantitative methods and identifies immediate short-term impacts of the explosions based on assumptions inherent in modeling processes, criteria and thresholds used, and input data. The estimations should be viewed with caution, keeping in mind that they do not reflect measures taken to avoid these impacts (i.e., mitigations). Ultimately, the goals of this acoustic impact model were to predict acoustic propagation, estimate exposure levels, and reliably predict impacts. Figure 3.9-2 shows the conceptual model framework used for the SSTC impact analysis.

Predicting Impulse, Energy, and Peak Pressure - Predictive sound analysis software incorporates specific bathymetric and oceanographic data to create accurate sound field models for each source type. Oceanographic data such as the sound speed profiles, bathymetry, and seafloor properties directly affect the acoustic propagation model. Depending on location, seasonal variations, and the oceanic current flow, dynamic oceanographic attributes (e.g., sound speed profile) dramatically can change with time. The sound field model is embedded in the impact model as a core feature used to analyze sound and pressure fields associated with SSTC underwater detonations.

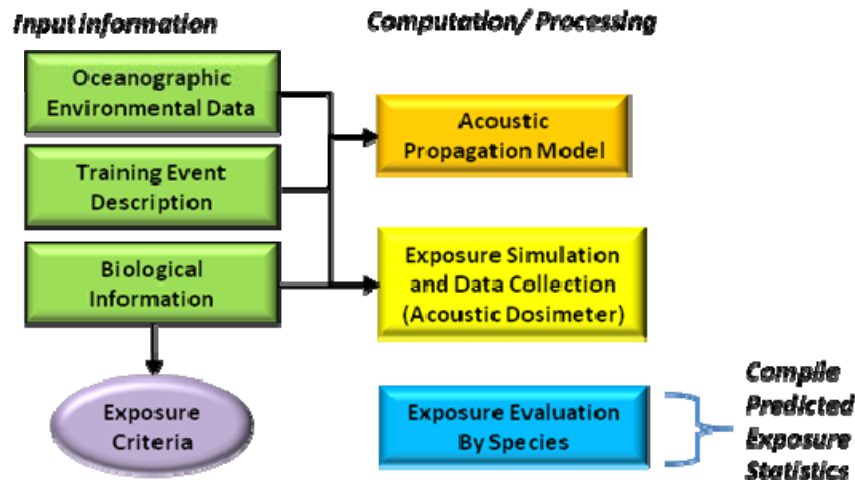


Figure 3.9-2: Generalized Modeling Process for Estimating Exposures from SSTC Underwater Detonations

The sound field model for SSTC detonations was the Reflection and Refraction in Multilayered Ocean/Ocean Bottoms with Shear Wave Effects (REFMS) model (Version 6.03). The REFMS model calculates the combined reflected and refracted shock wave environment for underwater detonations using a single, generalized model based on linear wave propagation theory (Cagniard 1962, Britt 1986, Britt et al. 1991). The Cagniard model used in REFMS sometimes is referred to as Generalized Ray Theory in seismology.

The required inputs for the REFMS model include:

- representation of the layered water and sediment environment including compressional wave speed, sediment and water density, and layer depth;
- explosive weight, type, and depth; and
- receiver depth and range from the source.

Similitude equations calculate constants for each explosive type in terms of trinitrotoluene (TNT) equivalents referred to as similarity parameters for explosives. Britt et al. (1991) indicated that care should be taken in using similitude for small charges. REFMS models the variation of physical properties (i.e., sound speed, shear wave speed, and density) with depth in the ocean water column and at the seafloor. The water column and seafloor are represented with up to 300 homogeneous layers depending on the environment where detonations occur.

The model outputs include positive impulse, sound exposure level (sound exposure level; total and in 1/3-octave bands) at specific ranges and depths of receivers (i.e., marine mammals), and peak pressure. The shock wave consists of two parts, a very rapid onset “impulsive” rise to positive peak over-pressure followed by a reflected negative under-pressure rarefaction wave (Figure 3.9-3). Propagation of shock waves and sound energy in the shallow-water environment is constrained by boundary conditions at the surface and seafloor (Figure 3.9-4). In Figure 3.9-4, a hypothetical source is shown below the sea surface and above the seabed, indicating energy from the explosion reaches a subsurface receiver via multi-paths. An iso-speed water column was used for illustrative purposes, because it resembles the simplified SSTC situation. The iso-speed condition indicates no refraction of paths from changes in sound speed.

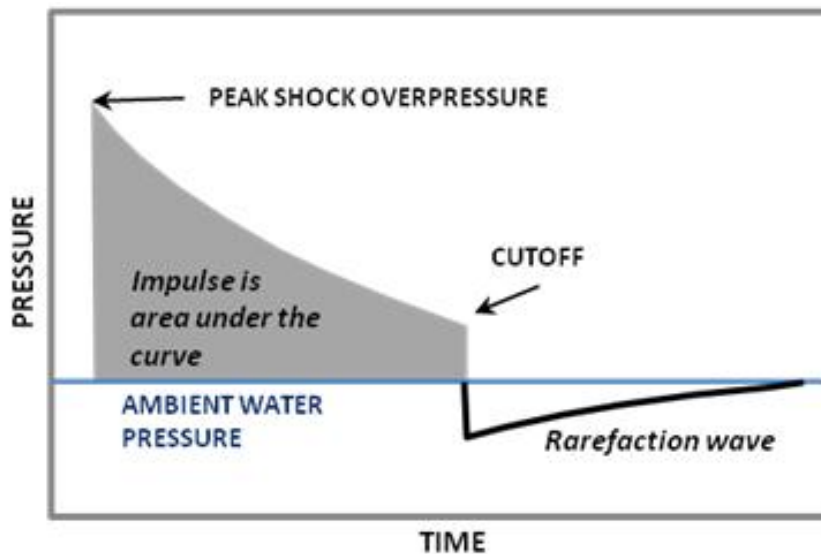


Figure 3.9-3: Generalized Shock Wave

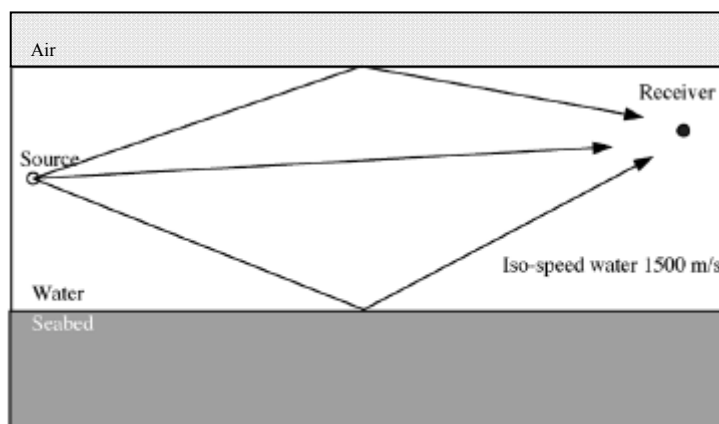


Figure 3.9-4: Generalized Pathways of Shock Waves and Sound Energy

(Adapted from Siderius and Porter 2006).

Estimating Exposures - Multiple locations (in Boat Lanes and Echo area) and charge depths were used to determine the most realistic spatial and temporal distribution of detonation types associated with each training operation for a representative year. Additionally, the effect of sound on an animal depends on many factors including:

- properties of the acoustic source(s): source level (SL), spectrum, duration, and duty cycle;
- sound propagation loss from source to animal, as well as, reflection and refraction;
- received sound exposure measured using well-defined metrics;
- specific hearing;
- exposure duration; and
- masking effects of background and ambient noise.

To estimate exposures sufficient to be considered injury or significantly disrupt behavior by affecting the ability of an individual animal to grow (e.g., feeding and energetics), survive (e.g., behavioral reactions leading to injury or death, such as stranding), reproduce (e.g., mating behaviors), and/or degrade habitat quality resulting in abandonment or avoidance of those areas, dosimeters were attached to the virtual animals during the simulation process. Propagation and received impulse, SEL, and peak pressure are a function of depth, as well as range, depending on the location of an animal in the simulation space. As stated previously, dosimeters were used to collect and retain exposure logs for SEL with associated time stamps.

Predicting Impacts - Predicting impacts to marine mammals from underwater detonations required knowledge regarding the criteria levels associated with mortality, injury, and physiological and behavioral disruption. Criteria and thresholds associated with impulse, SEL, and peak pressure are used to determine impact to internal organs and sensitive auditory tissues. In addition, disruption of behaviors from MSEs was considered. Exposures were quantified based on exceeding the associated thresholds. Note that efforts to minimize exposure to impacts (i.e., proposed mitigation) are not quantified or applied to these estimated exposures.

3.9.2.5.4 Predictive Modeling for Underwater Detonations- Modeling Specifics

The exposure quantities calculated by modeling were based on input data and processes described above. While many modeling parameters and associated process are provided, with greater technical detail in Jordan (2008), the following descriptions elaborate on the generalized process flow as applicable to the SSTC.

Explosive weight, water depth, and charge depth - Charge weights used at SSTC vary in size from 0.03 lbs of PETN to 29 lbs NEW of plastic bonded explosives with additives (PBXN). REFMS requires conversion of explosive types to equivalent weights calculated from similitude equations. Standard similitude formulas facilitate explosive propagation modeling using the free-field source properties close to the source, starting at a nominal source-level range of 3.3 ft. Weak shock theory is used to estimate the waveform and levels to ranges beyond a few meters for all ranges because the amplitudes of explosive waveforms are small. Corresponding simulated parameters for the REFMS model for each explosive type, including their discrete NEW (as referenced to TNT), sequence, and position depths below the water surface were chosen to represent each training type. Additionally, four discrete water depths and locations within the SSTC training areas were used (i.e., Echo sub-area and oceanside Boat Lanes [Figure 2-1]).

Charge depths within the water column were not fixed but relative to the surface and seafloor at the locations within the Boat Lanes. Relative charge depth was calculated as the surface to 5 ft below the surface for surface charge depth, depth divided by two for the “mid” charge depth (e.g., mid-depth within a 56-ft water column was 28 ft), and seafloor depth plus 1 or 2 ft for bottom charge depth.

Sound Speed Profiles - Sound speed profiles to use in the SSTC analysis for all 12 months were acquired from a classified web site maintained by the Naval Oceanographic Office. Unfortunately, these profiles did not specifically cover the nearshore region represented by the oceanside boat lanes or Echo sub-area of the SSTC. The closest Naval Oceanographic Office sound speed profile site was approximately five nautical miles west of the western side of the oceanside Boat Lanes. While this area has a deeper water column and slightly different profiles when compared to empirically measured profiles during SSTC underwater explosive testing, sound speed measurements from the shallower location were only slightly less than the deeper Naval Oceanographic Office location by approximately 100 ft per sec (~2%).

To reconcile this discrepancy, several sensitivity tests were performed to quantify the relative influence of the sound speed profiles on the final Zone of Influence (ZOI) calculations, as well as subsequent marine mammal exposure estimates. Essentially, a 2% increase in sound speed statistically yielded the same 2% increase in ZOI, which was not threshold independent because of the differences in sound speed from

month to month. Given this low percentage, the REFMS model was modified to allow uniform adjustments in the sound speed profiles within the water column. This adjustment was applied to all Naval Oceanographic Office sound speed profiles (one for each month). After each sound speed profile was adjusted, the corresponding ZOIs were computed by the modified REFMS model and tabulated for each given threshold. To report representative values for the warm and cold seasons, mean and standard deviation statistics were calculated for May–October and November–April, respectively.

Sediment Properties - The bottom sediment was assumed to be consistent throughout the site and was equivalent to the much greater area encompassing southern California. Based on a previous experience in modeling for this region, the bottom sediment for the entire region was considered sandy-silt (Hamilton 1980). The sound-speed ratio for sandy-silt was 1.145 grams per cubic centimeter (g/cm^3) with a wet density of 1.941 g/cm^3 (Hamilton 1980).

Charge Depths and Ranges - The limits of each ZOI and threshold were defined as the distance to the onset of the impact based on each specific threshold. ZOIs were determined for each threshold using REFMS, which concurrently supplied multiple two-dimensional computational points (depth and range). At simulated SSTC sites where the water depths are between 24 and 72 ft, the selected discrete computational points of depth and range were consistent for all thresholds. This two dimensional (range and depth) distribution yielded more than 60 discrete points of REFMS results for evaluating the ZOIs for marine mammal thresholds (impulse [psi-msec], total SEL and SEL in 1/3-octave bands [dB re $1\mu\text{Pa}^2\text{-sec}$], and peak pressure ([psi]).

Animal Movement - Animal movement was used for modeling Multiple Successive Explosive events (i.e., sequential charges). Movement of animals within the virtual SSTC environment was two dimensional in nature, because the shallow water depth placed a constraint on diving. Only lateral movement (changes in x-y position) based on expected species specific swim speeds (Table 3.9-3) was considered between Multiple Successive Explosive events. Therefore, it was not necessary to establish a depth restriction for the range points above, because the water depths at SSTC were shallow. These maximum SEL ranges then were used to form concentric circles to determine the area affected at or above the exposure thresholds. The number of mammals within this area whose levels are greater than the thresholds for single detonations were summed, scaled by the species densities to quantify the total exposures, and then reported in 1/100ths. By reporting potential exposures to 0.01 of an individual, no error was included by the simulation, only that of the density estimates. One exposure occurred at $0.5 < \text{exposure} < 1.49$ for Marine Mammal Protection Act determination. Inasmuch as their placement and movement (Multiple Successive Explosive events only) randomly were initialized, 1,000 separate simulations usually are necessary to determine a statistical mean of mammal exposures with standard deviations less than 2% for underwater detonations.

Table 3.9-3: Estimated Marine Mammal Swim Speeds used in SSTC Multiple Successive Explosive Events Modeling

Species	Swim Speeds (meters/second)
California sea lion	2.00
Pacific harbor seal	1.00
Bottlenose dolphin	3.08
Gray whale	1.86

When Multiple Successive Explosive events were modeled, the statistical computation became time-dependent. Each mammal swam within the rectangular plane or simulated range space. Mammal movements were initialized by using a random compass heading, swim speed with a random 10% variation of the species mean, and a straight path across the range (Jordan 2008). The animals did not react to the acoustic operations or avoid them in any way. Mammals that exit the defined range space

before the next detonation randomly were replaced along the range boundary with a new random swim speed and heading towards the inside of the range space with its dosimeter set to an SEL of zero. Those mammals outside the range space with SELs greater than the thresholds normally are counted towards the final exposure level. This approach kept the population constant throughout the training operation. However, the recorded received levels on the dosimeters were below the explosive thresholds. Thus, exposures reported herein only represent those animals found inside the range space for all training operations (Jordan 2008).

Zones of Influence (ZOI) - The outer boundary of the ZOI is defined by the maximum radius (i.e., range) at which the exposure threshold occurs (Table 3.9-2). For the SSTC determination of the ZOI, improvements concurrently were made to the REFMS tool to allow multiple depths and range points given each threshold (Jordan 2008). In the ZOI determinations, single detonations were considered separate events. Multiple Successive Explosive events were handled differently in terms of ZOIs based on the total and 1/3-octave band SEL thresholds. The spatial and temporal distribution of the detonations, as well as the incoherent accumulation of the resultant SELs, were needed to model Multiple Successive Explosive events.

Computational Process - The schematic of the computational sequence shows five processing steps as a sequence of calculations (Figure 3.9-5). Software processing modules (red font) are stated for each step with two ultimate outcomes, ZOIs and marine mammal exposures.

The monthly in-situ sound speed profiles were acquired from the Generalized Digital Environmental Model (GDEM) database. Two preprocessing routines (Interpolate Generalized Digital Environmental Model Profiles [INSVP] and Reflection and Refraction Multi-Layered Ocean/Ocean Bottoms with Shear Wave Effects Input Data [REFMSIN]) were executed to process the environmental conditions and create the initial REFMS input dataset. The explosive characteristics, detonation location, position in the water column, bottom sediment properties, and local sound speed profiles were used to determine wave propagation characteristics of the detonations at the SSTC with the REFMS model. REFMS resolved the traveling explosive compression wave using applicable spreading rules. REFMS was the basis for the two core computation phases (REFMS Modification 1 Marine Species Effects [REFMSMOD1] and Species Simulation Movement [SPESIM]). Static (REFMSMOD1) and dynamic (SPESIM) routines sequentially were executed to determine estimated exposures for cases of single detonations and Multiple Successive Explosive events. REFMSMOD1 is an enhanced version of the original REFMS software that explicitly evaluated the ZOIs using specific NMFS criteria and thresholds. SPESIM tracked the individual received SELs with the virtual dosimeter, when an operation included Multiple Successive Explosive events. This tool includes species movement and uses the acoustic property predictions of REFMS to dynamically evaluate the exposures. Exposure values were not retained for multiple training operations because all were considered independent of one another.

For very shallow water (VSW where water depth is less than 24 ft), in-situ empirical data regarding propagation of sources was available and used to assess impacts in a separate report (unpublished Naval Special Warfare Command [NSWC]/Anteon Corporation 2005). In their analysis REFMS and in-situ data for small charges were compared. One of the major findings was that REFMS predictions made for VSW were unreliable because of the strong influence of boundary conditions. REFMS was not designed to model impulsive sources at boundaries where bottom sediments and surface conditions, such as in the surf zone. Test data and model estimations indicated good predictability when water depth was near 24 ft, therefore, propagation modeling was deemed suitable and performed where empirical data were unavailable (water depth of 24–72 ft).

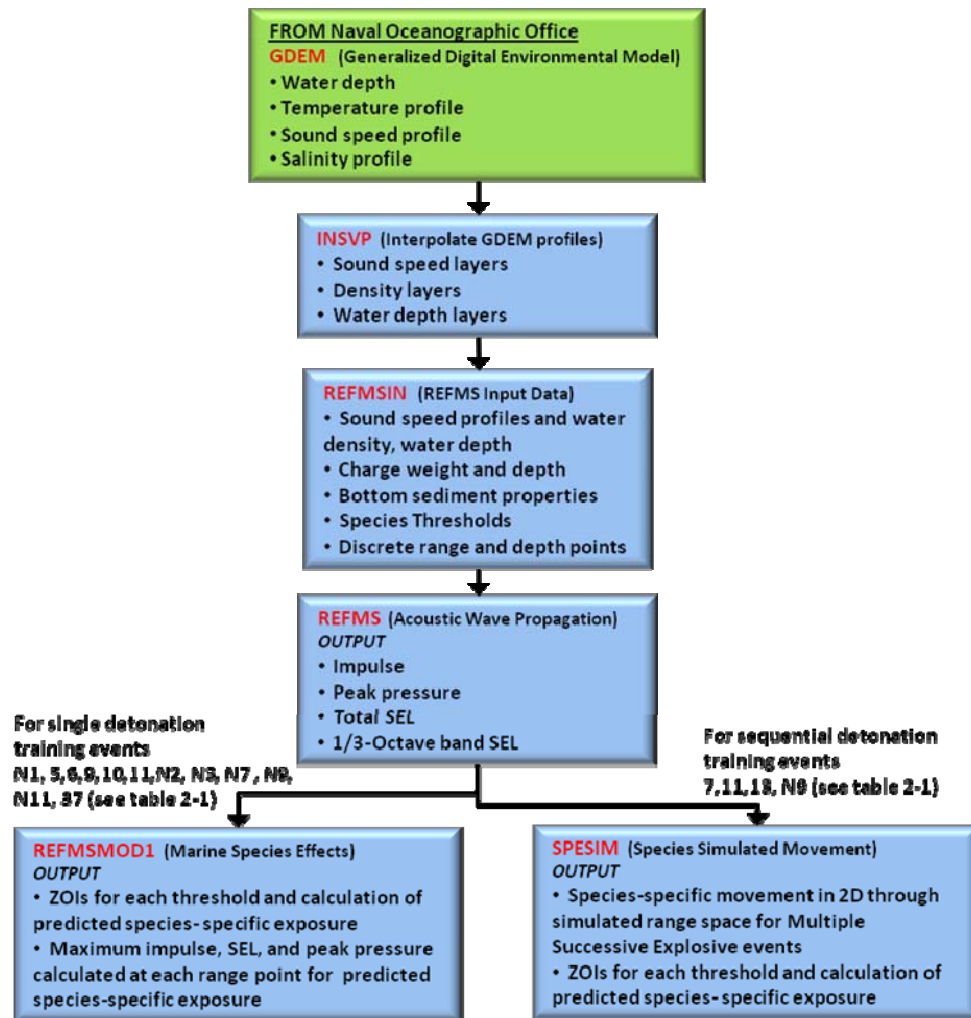


Figure 3.9-5: Computational Sequence for Determining Effects of Underwater Detonations at SSTC

Therefore, all marine mammal exposures presented are modeled conservatively to have occurred between 24-72 feet. Likely propagation and associated exposure for any underwater detonation event in water less than 24 feet is likely to be much less.

3.9.2.5.5 Key SSTC Modeling Caveats and Assumptions

The exposure quantities predicted from modeling of training events rely on many factors but are influenced greatly by assumptions, methods, and criteria used during the process. In general, the SSTC impact assessment is a conservative approach (i.e., over predicts likely exposures) based on some generalities that have to be assumed because of training event parameters, criteria application, or model limitations. Therefore, the caveats and modeling assumptions described below should be considered when evaluating the marine mammal predicted exposures within the context of this EIS.

Of note, these assumptions and resulting model estimations do not account for the protective nature of the Navy's current or proposed mitigations, which in reality would eliminate or reduce any potential exposures.

Modeling Assumptions - Operational Assumptions

- Oceanographically, there are two seasons at SSTC, a warm season from May–October and a cold seasons from November–April.
- Underwater training events represent SSTC range schedule maximums with range time fully booked.
- This authorization does not account for training schedule change, event cancelations due to weather or other unforeseen factors, unit deployments which would mean fewer personnel needing training, and other real-world and exercise conditions that may result in fewer annual underwater detonations.
- All training operations were evenly distributed across months with 50% of the events occurring during each season (50% during warm season, 50% during cold season).
- No two training operations were assumed to occur during the same day, and each training event was treated as an isolated event.
- Each training activity for single detonations was treated as an isolated event; therefore, exposures represent short-term and immediate impacts. Events with single explosions did not take into account animal movement.
- Events with Multiple Successive Explosive events were treated as training events requiring the accumulation of received energy (SEL) with consideration of mammal movement. Movement within the virtual SSTC environment was two-dimensional and did not take into account depth as a dimension; therefore, marine mammals were assumed to be in the water column where the effect of the detonations was greatest.
- Sequential charges are either conducted with a 10 second delay between detonations or 30 minute delay between detonations. However, the actual temporal relationships between explosions can be longer depending on conditions (set-up, operator experience, weather, marine mammal sighting, etc.).
- All underwater detonations proposed for SSTC were modeled as if they will be conducted in shallow water of 24 to 72 feet, including those that would normally be conducted in very shallow water (VSW) depths of zero to 24 feet.

Modeling Assumptions - Biological Assumptions

- Marine mammals and associated densities are considered to always be present within SSTC and densities are spread evenly through all of the oceanside SSTC Boat Lanes. [In fact, marine mammal presence within SSTC is variable, dynamic, and very patchy, but REFMS currently does not have algorithms to address this complexity, nor is the state of science adequate for predicting patchy marine mammal occurrence at small spatial scales]
- Percentage of time pinnipeds haul out was not factored into the modeling, although California sea lions and harbor seals may not be exposed during the time they are out of the water.
- Mean marine mammal densities were used during exposure calculations and took into account the worst-case water depth, animal depth, and sound speed profile to conservatively (i.e., over predict) the greatest amount of potential exposures.
- All estimated exposures are seasonal averages (mean) plus one standard deviation.

Criteria Assumptions

The quantitative exposure modeling methodology produces numbers of individuals exposed to the effects of underwater explosions exceeding the thresholds used. All estimated exposures are seasonal averages (mean) plus one standard deviation (σ) using one-half of the yearly training tempo. This provides a conservative approach to estimating exposures typical of training during a single year. Mitigation methods were not quantified and implementation is not reflected in exposure estimates. Results from acoustic impact exposure models should be regarded as exceedingly conservative estimates that are strongly influenced by limited biological data. While the numbers generated from these models provide predictions of marine mammal exposures for consultation with NMFS, the short duration and limited geographic extent of explosive events does not necessarily mean that these exposures will ever be realized.

3.9.2.5.6 Model Results Explanation

Acoustic exposures are evaluated based on their potential direct effects on marine mammals, and these effects are then assessed in the context of the species biology and ecology to determine if there is a mode of action that may result in the acoustic exposure warranting consideration as a harassment level effect.

A large body of research on terrestrial animal and human response to airborne sound exists, but results from those studies are not readily extendible to the development of behavioral criteria and thresholds for marine mammals. For example, “annoyance” is one of several criteria used to define impact to humans from exposure to industrial sound sources. Comparable criteria cannot be developed for marine mammals because there is no scientifically acceptable method for determining whether a nonverbal animal is annoyed (NRC 2003). Further, differences in hearing thresholds, dynamic range of the ear, and the typical exposure patterns of interest (e.g., human data tend to focus on eight hour-long exposures) make extrapolation of human sound exposure standards inappropriate. At the present time there is no general scientifically accepted consensus on how to account for behavioral effects on marine mammals exposed to anthropogenic sounds including explosions (NRC 2003, NRC 2005).

3.9.2.6 Estimating Marine Mammal Exposures from Pile Driving Activities

Noise associated with ELCAS installation activities includes a loud impulsive sound derived from driving piles into the soft sandy substrate of the SSTC waters to temporarily support a causeway of linked pontoons. Two hammer-based methods will be used to install/remove ELCAS piles: impact pile driving for installation and vibratory driving for removal. The impact hammer is a large metal ram attached to a crane. A vertical support holds the pile in place and the ram is dropped or forced downward. The energy is then transferred to the pile which is driven into the seabed. The ram is lifted by a diesel power source.

At the end of the training, a vibratory hammer attached to the pile head will be used to remove piles by applying a rapidly alternating force to the pile by rotating eccentric weights about shafts, resulting in an upward vibratory force on the pile. The vertical vibration in the pile disturbs or “liquefies” the sediment next to the pile causing the sediment particles to lose their frictional grip on the pile.

Since 1997, NMFS has been using generic sound exposure thresholds to determine when an activity in the ocean that produces impact sound (i.e., pile driving) results in potential take of marine mammals by harassment (70 CFR 1871). NMFS is developing new science-based thresholds to improve and replace the current generic exposure level thresholds, but the criteria have not been finalized (Southall et al. 2007). Current NMFS criteria (70 FR 1871) regarding exposure of marine mammals to underwater impulsive sounds (e.g., impact pile driving) is that cetaceans exposed to sound levels of 180 dB root mean squared (RMS in units of dB re 1 μ Pa) or higher and pinnipeds exposed to 190 dB RMS or higher are considered to have been taken by Level A (i.e., injurious) harassment. Marine mammals (cetaceans and pinnipeds) exposed to impulse sounds of 160 dB RMS but below injurious thresholds (i.e., 180 or 190 dB)

are considered to have been taken by Level B behavioral harassment. Marine mammals (cetaceans and pinnipeds) exposed to continuous noise of 120 dB RMS (e.g., vibratory pile driving) or above are considered to have been taken by Level B behavioral harassment.

The methodology for analyzing potential impacts from ELCAS activities is similar to that of analyzing explosives, which is presented in Section 3.9.2.4. The ELCAS analysis includes two steps used to calculate potential exposures:

1. Estimate the zone of influence for Level A injurious and Level B behavioral exposures for both impact pile driving and vibratory pile removal using the practical spreading loss model.
2. Estimate the number of species exposed using species density estimates (Table 3.9-1) and estimated zones of influence.

The practical spreading loss model is used to estimate the attenuation of underwater sound over distance. NOAA and USFWS have accepted the use of the practical spreading loss model to estimate transmission loss of sound through water for past pile driving calculations (California Department of Transportation [CADOT] 2009). The formula for this propagation loss can be expressed as:

$$TL = F * \log (D1/D2)$$

Where:

TL = transmission loss (the sound pressure level at D1 minus the sound pressure level at D2, in RMS, dB re 1 μ Pa)

F = attenuation constant

D1 = distance at which the targeted transmission loss occurs

D2 = distance from which the transmission loss is calculated

The attenuation constant (F) is site-specific factor based on several conditions, including water depth, pile type, pile length, substrate type, and other factors. Measurements conducted by the CADOT and other consultants (Greeneridge Science) indicate that the attenuation constant (F) can vary from 5 to 30. For pile driving sounds that are higher frequency (e.g., smaller-diameter steel piles), the transmission loss can be higher than losses associated with piles that predominantly produce lower frequencies (e.g., larger diameter piles). Small-diameter steel H-type piles have been found to have high F values in the range of 20 to 30 near the pile (i.e., between 10 and 20 meters) (CADOT 2009). In the absence of empirically measured values at SSTC, the F value for SSTC is assumed to be on the low (conservative) end of the small-diameter steel piles (F=20). In subsequent consultation with the NMFS Office of Protected Resources, it was requested that the Navy take a still more conservative approach and use a F value of F=15.

The exposures predicted from ELCAS assessment rely on many factors but are influenced greatly by assumptions, methods, and criteria used. The following list of assumptions, caveats, and limitations is not exhaustive but reveals several features of the technical approach that influence exposure prediction:

1. Significant scientific uncertainties are implied and carried forward in any analysis using marine mammal density data as a predictor for animal occurrence within a given geographic area.
2. The assessment conservatively assumed that all ELCAS training would occur along the oceanside of SSTC. In actuality, they are also conducted in the Bravo Beach training area on the Bayside of SSTC-N. Marine mammals are rarely encountered within this southern portion of San Diego Bay, and given this lack of occurrence, exposures to marine mammals during ELCAS training in the Bay is not expected. By assuming that all ELCAS training would occur on the oceanside of SSTC-N, exposure estimates may overrepresent actual potential exposures. For example, the estimates may be double of what they might actually be if half of the ELCAS training was to occur on the Bayside.
3. Marine mammal are assumed to be uniformly distributed within the ocean waters adjacent SSTC.
4. The tempo of training activities was divided evenly throughout the year with two oceanographic seasons, defined as warm and cold at this location, each having ½ total events for simulated purposes.
5. There are data limitations. Some of the data supporting the analysis was derived from other projects with different environmental and project conditions (animal densities, pile driving source levels, and transmission loss parameters).

The ELCAS exposure assessment methodology is an estimate of the numbers of individuals exposed to the effects of ELCAS activities exceeding NMFS established thresholds. Of significant note in these exposure estimates, mitigation methods were not quantified within the assessment and successful implementation of mitigation is not reflected in exposure estimates. Results from acoustic impact exposure assessments should be regarded as conservative estimates that are strongly influenced by limited biological data. While the numbers generated from the ELCAS exposure calculations provide conservative overestimates of marine mammal exposures for consultation with NMFS, the short duration and limited geographic extent of ELCAS training would further limit actual exposures.

3.9.2.7 Other Effects Considered

There is the potential for non-auditory impacts on marine mammals from direct physical injury from underwater detonations or collisions with vessels. The use of currently implemented monitoring and marine mammal buffer zones (as defined in the next section) during mine detonation activities can prevent such impacts on marine mammals. Vessel operators avoid surface obstructions during transit and combined with low transit speeds, minimize the potential of collision with a marine mammal.

3.9.2.8 No Action Alternative

3.9.2.8.1 Underwater Detonations

Small explosives, up to 20 pounds, will be used as part of exercises to neutralize simulated mines as well as qualification/certification training. Under the No Action Alternative and presented in Section 3.8.2.2.3 (Table 3.8-10), the exercises are conducted up to 103 times a year in the offshore boat lanes at SSTC. As presented in Table 3.9-4, underwater detonation activities are distributed throughout the SSTC boat lanes, with larger charge weights utilized in the center boat lanes at SSTC-N and SSTC-S.

As indicated in Section 3.4, Hazardous Materials and Waste (Table 3.4-5), the major byproducts of these detonations are nitrogen, carbon dioxide, water, and carbon monoxide. Only trace amounts of organic compounds would be left following an underwater detonation of explosives. At such concentrations, these substances would not affect water quality and would have no direct effect on marine mammals.

Table 3.9-4: SSTC Underwater Detonation Range Protocol

Charge Size	Boat Lane													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Y1	Y2	R1	R2	G1	G2	B1	B2	O1	O2	W1	W2	P1	P2
VSW (0 – 4 fathoms)														
Off bottom (< 3.6 lb)		x	x	x	x	x	x	x	x			x	x	
Bottom (< 5 lb)		x	x	x	x	x	x	x	x			x	x	
Bottom (< 15 lb)			x	x	x	x	x	x						
Shallow (4 – 12 fathoms)														
< 5 lb single		x	x	x	x	x	x	x	x			x	x	
< 15 lb (multiple)			x	x	x	x	x	x						
15 – 29 lb					x	x								

Note: VSW off bottom (<3.6 lbs, SWAG) bayside activities occur in Echo
 “X” denotes activity occurs in boat lane

Severity of an effect often is related to the distance between the sound source and a marine mammal and is influenced by source characteristics (Richardson and Malme 1995). For SSTC, zones of exposure were estimated for the different charge weights, charge depths, water depths, and seasons. These ZOI calculated ranges are shown in Table 3.9-5. For single detonations, the ZOI were calculated using the range associated with onset TTS while for those events with multiple charges the calculation was based on the non-TTS behavior disruption. Calculating the zones of influence in terms of total SEL, 1/3-octave bands SEL, impulse, and peak pressure for sequential (10 sec timed) and sequential detonations (> 30 minutes) were slightly different than the single detonations. For the sequential explosives, ZOI calculations considered spatial and temporal distribution of the detonations, as well as the effective accumulation of the resultant acoustic energy. To calculate the ZOI, sequential detonations were modeled such that explosion SEL were summed incoherently to predict zones while peak pressure was not.

Based on the modeling approach applied, as discussed in Section 3.9.2.4, and without consideration of current mitigation measures, activities under the No Action Alternative injury (Level A harassment) to marine mammals is not anticipated. However, underwater detonation activities could result in non-injurious (Level B) harassment to cetaceans and pinnipeds. For evaluation of TTS, a dual criteria is used, allowing one value to be presented as a TTS exposure level. This TTS dual criterion reduces the TTS to a single exposure level where the maximum truncated value is picked under the SEL (182 dB) or peak pressure (23 psi) column. Specifically, 78 annual exposures to pressure from underwater detonations could result in TTS (Level B harassment, Table 3.9-6). Of these 78 annual exposures, 52 exposures could result in TTS for bottlenose dolphins and 26 exposures could result in TTS for California sea lions due to pressures from underwater detonations. Exposures for harbor seals and gray whales are not anticipated due to low species density and the limited zone of influence of the underwater detonations. As mentioned previously, these exposure modeling results are estimates of marine mammal underwater detonation sound exposures without consideration of standard mitigation and monitoring procedures. Table 3.9-6 summarizes the species exposure levels for all detonations over an entire year in the SSTC ROI.

Table 3.9-5: Maximum Underwater Detonation Zones of Influence for “No Action” Alternative

Underwater Detonation Operation	Charge Weight Used ¹	Season	Level B Harrassment	Level A Harrassment		Mortality
			Onset of TTS ² / Non-TTS ³ (yards)	Onset of slight lung injury (13.0 psi-msec) (yards)	50% TM rupture (205 dB re 1μPa ² -sec) (yards)	Onset of extensive lung injury (30.5 psi-msec) (yards)
Mine Countermeasures	20	Warm	470	360	80	80
		Cold	450	160	80	80
Floating Mine	≤ 5	Warm	240	20	80	20
		Cold	260	20	80	20
Unmanned Underwater Vehicle Activities	20	Warm	440	360	80	80
		Cold	400	150	80	80
Marine Mammal Systems Activities (sequential)	13	Warm	330/380	130	70	80
		Cold	410/430	140	70	80
Marine Mammal Systems Activities (individual)	13	Warm	320	130	60	80
		Cold	350	140	70	80
Dive Platoon ⁴ (mid-depth)	3.5	Warm	330/430	70	130	40
		Cold	410/610	70	130	40
Dive Platoon ⁴ (bottom)	3.5	Warm	330/470	80	90	50
		Cold	370/560	90	90	50
Mine Neutralization ⁴	3.5	Warm	330/470	80	90	50
		Cold	370/560	90	90	50

¹ Charge weights are listed in pounds

² Maximum ZOI based on greatest range from dual criteria (182 dB re 1μPa²-sec or 23 psi)

³ Behavioral Disruption Non-TTS (listed only for (sequential detonations)

⁴ Sequential Detonations

Table 3.9-6: Modeled Estimates of Exposed Species from Underwater Detonations Without Implementation of Mitigation Measures: No Action Alternative

Species			NO ACTION ALTERNATIVE: Season Average Mammals Exposure (All Sources)			
			Level B Behavior (MSE only)	Level B TTS	Level A Injury	Level A Mortality
			177 dB	182 dB / 23 psi	205 dB / 13.0 psi-ms	30.5 psi-ms
Cetaceans	Gray Whale	Warm	-	-	-	-
		Cold	0	0	0	0
	Coastal Bottlenose Dolphin	Warm	16	26	0	0
		Cold	24	26	0	0
Pinnipeds	California Sea Lion	Warm	4	0	0	0
		Cold	24	26	0	0
	Harbor Seal	Warm	0	0	0	0
		Cold	0	0	0	0
Total Exposures			68	78	0	0

In addition to possible exposures that could result in TTS, modeling indicates that the No Action Alternative could also result in the potential for 68 non-physiological behavioral exposures. While physiological impacts were predicted for all activities, non-physiological behavioral impacts were predicted only for those exercises which involved multiple detonations during a training scenario. Coastal bottlenose dolphins were predicted to have a similar number of non-physiological behavioral exposures in both the warm (16) and cold (24) seasons, while California sea lions were predicted to have a higher number of non-physiological behavioral exposures during the cold season (24) than in the warm season (4).

To reduce the potential for behavioral or physiological damage such as TTS, or tissue injury, a buffer zone is established each detonation area. As discussed in Section 3.9.1.7, operations would not be conducted if marine mammals are present in the buffer zone. The buffer zone for VSW underwater detonations (in zero to 24 feet of water), would be the largest zone of influence as discussed in Section 3.9.2.4.3 (1,200 feet). The buffer zone for shallow water underwater detonation activities (in 24 to 72 feet of water depth) would be based on the rounding up the largest zone of influence from a single detonation shown in Table 3.9-5: 1,500 feet (500 yards). This type of mitigation would likely prevent animals from being exposed to the loudest explosive effects that could potentially result in behavioral, TTS or PTS and more intense behavioral reactions. The implementation of the current mitigation and monitoring procedures in the SSTC, as described in Section 3.9.2.7, will minimize the potential for impacts to individual marine mammals or marine mammal stocks from underwater detonations.

3.9.2.8.2 Aircraft Activities

Various types of helicopters are regularly used in training exercises throughout the ROI. These aircraft overflights produce airborne noise and some of this energy is transmitted into the water. Marine mammals could be exposed to noise associated with aircraft overflights while at the surface or while submerged. In addition to sound, marine mammals could react to the shadow of a low-flying aircraft and/or, in the case of helicopters, surface disturbance from the downdraft.

Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors and has been addressed by Urick (1972), Young (1973), Eller and Cavanagh (2000), Laney and Cavanagh (2000), and others. Sound is transmitted from an airborne source to a receptor underwater by four principal means:

1. Direct path, refracted upon passing through the air-water interface.
2. Direct-refracted paths reflected from the bottom in shallow water.
3. Lateral (evanescent) transmission through the interface from the airborne sound field directly above.
4. Scattering from interface roughness due to wave motion.

Aircraft sound is refracted upon transmission into water because sound waves move faster through water than through air (a ratio of about 0.23:1). Based on this difference, the direct sound path is totally reflected if the sound reaches the surface at an angle more than 13 degrees from vertical. As a result, most of the acoustic energy transmitted into the water from an aircraft arrives through a narrow cone with a 26-degree apex angle extending vertically downward from the aircraft (Figure 3.9-6). The intersection of this cone with the surface traces a “footprint” directly beneath the flight path, with the width of the footprint being a function of aircraft altitude.

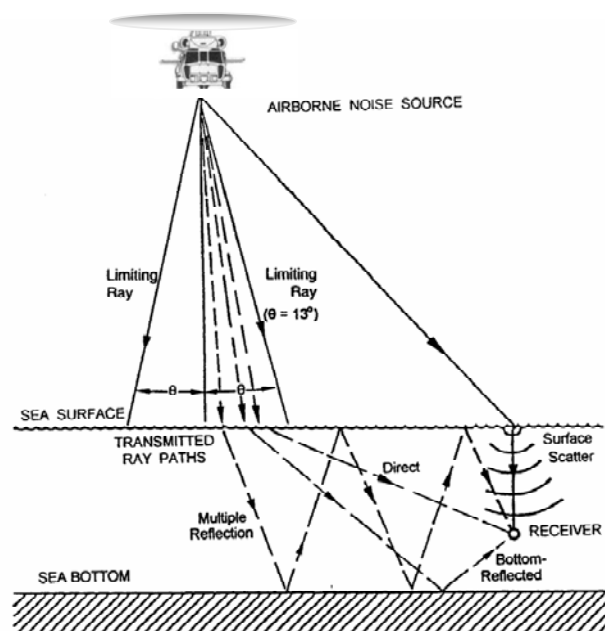


Figure 3.9-6: Characteristics of Sound Transmission through Air-Water Interface

Helicopter overflights can occur throughout SSTC for a variety of training exercises, such as mine countermeasure activities (Activities 4, 6, 7, and 12, Table 2-1), amphibious activities (Activities 16, 25,

26, Table 2-1), and Naval Special Warfare (NSW) activities (Activities 29 and 30, Table 2-1). Unlike fixed-wing aircraft, helicopter training activities can occur at low altitudes (approximately 100 feet) over the water, which increases the likelihood that marine mammals would respond.

Very little data are available regarding reactions of cetaceans to helicopters. One study observed that sperm whales showed no reaction to a helicopter until the whales encountered the downdrafts from the propellers (Clarke 1956). Other species such as bowhead whales and beluga whales show a range of reactions to helicopter overflights, including diving, breaching, change in direction or behavior, and alteration of breathing patterns, with belugas exhibiting behavioral reactions more frequently than bowheads (38 and 14 percent of the time, respectively) (Patenaude et al. 2002). These reactions were less frequent as the altitude of the helicopter increased to 150 m or higher.

Helicopter activities would have the greatest impact when flying low and hovering at altitudes down to 100 feet. Noise modeling indicates that the predicted sound level at a depth of 1 foot resulting from the overflight of an SH-60 helicopter at 100 feet would be approximately 100 to 118 dB re 1 μ Pa (frequencies of 20 Hz and 5 kHz). This could cause some marine mammals to dive and move away from the aircraft. For example, gray whales will react 10 percent of the time to helicopter sounds transmitted underwater in excess of 115 dB re 1 μ Pa and react 50 percent of the time to sounds in excess of 120 dB re 1 μ Pa (Moore and Clarke 2002). Given the variable and sparse seasonal density of gray whales (Table 3.9-1), the probability of a helicopter overflight occurring over a migrating whale is low. Aircraft overflights over a cetacean in the water may elicit short-term reactions such as a dive, but they are highly unlikely to disrupt overall behavioral patterns such as migrating, nor would they be likely to result in serious injury.

One seal species (harbor) and one sea lion species (California) occur regularly within the ROI. Helicopters are used in studies of several species of seals hauled out and is considered an effective means of observation (Gjertz and Børset 1992, Bester et al. 2002, Bowen et al. 2006), although they have been known to elicit behavioral reactions such as fleeing (Hoover 1988). Jehl and Cooper (1980) indicated that low-flying helicopters, humans on foot, sonic booms, and loud boat noises were the most disturbing influences to pinnipeds. In other studies, harbor and other species of seals and sea lions showed no reaction to helicopter overflights (Gjertz and Børset 1992). However, there are no known haul-out locations for these two species within the SSTC. Additionally, the typical flight path of aircraft used in training activities does not overlap any known haul-out locations for harbor seals or sea lions. Thus, the likelihood of a harbor seal or California sea lion being hauled out and underneath the flight path of an aircraft is extremely low. It is possible that an animal could be temporarily hauled out on a buoy or dock and aircraft overflights may elicit short-term reactions such as flushing into the water, but they are highly unlikely to disrupt overall behavioral patterns such as foraging or breeding as the disturbance is transient and short-term in nature, allowing the animal to return to its previous behavioral state. Similarly, aircraft overflights of pinnipeds in the water may elicit short-term reactions such as startle or alert reactions. However, they are highly unlikely to disrupt overall behavior patterns such as migrating, breeding, feeding and sheltering, nor would they be likely to result in serious injury.

Marine mammals exposed to low-altitude helicopter overflights under the No Action Alternative could exhibit short-term behavioral responses, but not to the extent where natural behavioral patterns would be abandoned or considerably altered. Helicopter overflights are not expected to result in chronic stress because it is extremely unlikely that individual animals would be repeatedly exposed. As such, helicopter overflights are not expected to result in Level A or Level B harassment as defined by the MMPA and helicopter overflights over territorial waters would have no notable effect on marine mammals.

3.9.2.8.3 Marine Vessels

Overview

A variety of vessels including standard and amphibious ships, small boats, and hovercraft (collectively referred to as vessels) will be used for SSTC activities. Vessel movements have the potential to affect marine mammals by directly striking or disturbing individual animals. The probability of vessel and marine mammal interactions occurring in the ROI is dependent upon several factors including numbers, types, and speeds of vessels; the regularity, duration, and spatial extent of activities; the presence/absence and density of marine mammals; and protective measures implemented by the Navy. Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to two weeks. Under the No Action Alternative, marine vessels both mechanically driven and self-propelled are utilized in 41 of the 78 training activities (Activities 1- 3, 5 -14, 16, 18, 20 - 28, 32 - 35, 37 - 41, 44 - 46, 49, 51 - 53, 57, 77, 78, Table 2-1). The vast majority of these exercises use less than five marine vessels, both mechanically driven and self-propelled (Appendix C). These activities are widely dispersed throughout the marine areas of SSTC, which encompasses approximately 15 nm². Consequently, as these operations are spread throughout the year, as well as on any particular day of training activities, the density of ships within the ROI at any given time is extremely low.

Disturbance Associated with Vessel Movements

Marine mammals are frequently exposed to vessels due to research, ecotourism, commercial and private fishing traffic, and government activities. The presence of vessels has the potential to alter the behavior patterns of marine mammals. It is difficult to differentiate between responses to vessel sound and visual cues associated with the presence of a vessel; thus, it is assumed that both play a role in prompting reactions from animals. Anthropogenic sound has increased in the marine environment over the past 50 years (Richardson et al. 1995, NRC 2003) and can be attributed to vessel traffic, marine dredging and construction, oil and gas drilling, geophysical surveys, sonar, and underwater explosions.

Marine mammals react to vessels in a variety of ways. Some respond negatively by retreating or engaging in antagonistic responses (breaching, fluke-slapping, etc.) while other animals ignore the stimulus altogether (Watkins 1986, Terhune and Verboom 1999). The predominant reaction is either neutral or avoidance behavior, rather than attraction behavior. For example, species of delphinids can vary widely in their reaction to vessels. Many exhibit mostly neutral behavior, but there are frequent instances of observed avoidance behaviors (Hewitt 1985; Würsig et al. 1998). In addition, approaches by vessels can elicit changes in behavior, including a decrease in resting behavior or change in travel direction (Bejder et al. 2006). Alternately, some of the delphinid species exhibit behavior indicating attraction to vessels. This can include solely approaching a vessel (David 2002), and species such as common, rough-toothed and bottlenose dolphins are frequently observed bow riding or jumping in the wake of a vessel (Norris and Prescott 1961; Shane et al. 1986; Würsig et al. 1998; Ritter 2002). These behavioral alterations are short-term and would not result in any lasting effects.

Gray whale responses to noise include changes in swimming speed and direction to move away from the sound source; abrupt behavioral changes from feeding to avoidance, with a resumption of feeding after exposure; changes in calling rates and call structure; and changes in surface behavior, usually from traveling to milling (e.g., Moore and Clarke 2002). Gailey et al. (2007) reported no apparent behavioral disturbances for gray whales in response to low-frequency seismic survey.

Marine vessels are one of the most frequent sources of sound in the marine environment within SSTC. Vessel noise is caused by both engine noise transmission through the hull and cavitations from propellers producing both narrow and broadband sounds. Hovercraft were recorded in the frequency ranges of 50 to 2000 Hz with a source level up to 121 dB re 1 μ Pa (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 μ Pa (Blackwell and Greene 2005), with most spectral energy centered around 87 Hz.

The probability of Landing Craft, Air Cushion (LCAC) and marine mammal interactions occurring in the ROI is dependent upon several factors including the regularity, duration, and spatial extent of activities; the presence/absence and density of marine mammals; and protective measures implemented by the Navy. Activities involving LCAC occur four times a year, involve small numbers of vessels, and occur along the boat and beach lanes of SSTC-N and SSTC-S. Consequently, the density of ships within the ROI during LCAC activities is extremely low, which when combined with the low densities of marine mammals, minimizes disturbance effects on marine mammals in the area; therefore, any effects would be extremely localized.

Sound produced may also be produced by vessels involved in the ELCAS training. Vessel noise is a combination of narrowband, tonal sounds at specific frequencies with broadband sounds with energy spread as a continuum across a wide range of frequencies up to 100 kHz (Greene and Moore 1995). Source levels of boats used during SSTC ELCAS are expected to be low with small boats using outboards (120-150 dB) to tugboats working with barges (140 – 160 dB).

Marine vessel traffic related to the SSTC activities would pass near marine mammals only on an incidental basis. Most of the studies mentioned previously examine the reaction of animals to vessels that approach and intend to follow or observe an animal (i.e., whale watching vessels, research vessels, etc.). Reactions to vessels not pursuing the animals, such as those transiting through an area or engaged in training exercises, may be similar but would likely result in less stress to the animal because they would not intentionally approach animals. Cetacean species pay little attention to transiting vessel traffic as it approaches, although they may engage in last minute avoidance maneuvers (Laist et al. 2001). As previously noted, quick avoidance maneuvers are short-term alterations and are not expected to permanently impact a marine mammal.

Vessel movements under the No Action Alternative are not expected to result in chronic stress because, as discussed above, Navy vessel density in the ROI would remain low and the Navy implements mitigation measures to avoid marine mammals. General disturbance associated with vessel movements is not expected to result in Level A or Level B harassment as defined by the MMPA and vessel disturbances are highly unlikely to disrupt overall behavior patterns such as migrating, breeding, feeding and sheltering, of marine mammals in the ROI.

Vessel Collisions with Marine Mammals

Ship strikes are known to affect large whales in southern California waters. The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives. These species are primarily large, slow moving whales. Smaller marine mammals (for example, bottlenose dolphins) move quickly throughout the water column and are often seen riding the bow wave of large ships.

After reviewing historical records and computerized stranding databases for evidence of ship strikes involving baleen and sperm whales, Laist et al. (2001) found that accounts of large whale ship strikes involving motorized boats date back to at least the late 1800s. Ship collisions remained infrequent until the 1950s, after which point they increased. Laist et al. (2001) concluded that most strikes occur over or near the continental shelf, that ship strikes likely have a negligible effect on the population status of most whale populations, but that for small populations or segments of populations the impact of ship strikes may be significant. However, in the near-shore waters of the ROI, any large whale appearing in the shallow water boat lanes would be readily apparent. Between 1975 and 2002, only two ship strikes of

gray whales have been reported in the waters offshore of Point Loma, only one of which was attributed to naval activities.

Small numbers of California sea lions, harbor seals, or bottlenose dolphin may encounter Navy vessels in the SSTC. Given the low density of Navy ships in the ROI, the likelihood that a vessel collision would occur under the No Action Alternative is very low. Vessel collisions in territorial waters are highly unlikely and do not represent a notable source of effect on marine mammals.

Any marine mammal observed after a vessel collision 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 animals status.

3.9.2.8.4 Amphibious and Beach Activities

This section deals primarily with amphibious and beach activities that may have a potential to impact marine mammals. Beach and inland activities have a low potential for impact on marine mammals because there are no breeding or haul-out areas within the SSTC ROI. The following sections address those Amphibious and Beach activities that may affect the marine mammals expected to occur at SSTC.

ELCAS/Pile Driving

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 approximately 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. At the end of the training, a vibratory hammer 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.

The methodology for assessing impacts of pile installation and removal during ELCAS training on marine mammals is discussed in Section 3.9.2.5. It describes NMFS established Level A and B harassment thresholds, the practical spreading loss model, and the methodology for estimating ZOIs and marine mammal exposures for ELCAS pile driving and removal.

Actual noise levels of ELCAS pile driving at SSTC depend on the type of hammer used, the size and material of the pile, and the substrate the piles are being driven into. Using known equipment, installation procedures, and applying certain constants derived from other west coast measured pile driving, predicted underwater sound levels from ELCAS pile driving can be calculated. The ELCAS uses 24-inch diameter hollow steel piles, installed using a diesel impact hammer to drive the piles into the sandy on-shore and near-shore substrate at SSTC. For a dock repair project in Rodeo, California in San Francisco Bay, RMS underwater sound level for a 24 inch steel pipe pile driven with a diesel impact hammer in less than 4.6 m (15 ft) of water depth was measured at 189 dB re 1µPa from approximately 10 m (33 ft) away. RMS sound level for the same type and size pile also driven with a diesel impact hammer, but in greater than 11.0 m (36 ft) of water depth, was measured to be 190 to 194 dB RMS during the Amoco Wharf repair project in Carquinez Straits, Martinez, California (CADOT 2009). The areas where these projects were conducted have a silty sand bottom with an underlying hard clay layer, which because of the extra effort required to drive into clay, would make these measured pile driving sound levels louder (more conservative) than they would if driving into SSTC's sandy substrate. Given the local bathymetry and

smooth sloping sandy bottom at SSTC, ELCAS piles will be driven in water depths of 11 m (36 ft) or less. Therefore, for the purposes of this analysis, both the Rodeo repair project (189 RMS) and the low end of the measured values of the Amoco Wharf repair projects (190 RMS) are considered to be reasonably representative of sound levels that would be expected during ELCAS pile driving at SSTC.

Using an this estimated RMS measurement of 190 dB re 1uPa at 10 m (33 ft), the circular zone of influence (ZOI) surrounding a 24-inch steel diesel-driven pile can be estimated to have a radius of 1,094 yards for the Level B behavioral harassment threshold (160 RMS) and 46 yards for Level A injurious harassment for cetaceans (180 dB RMS) and 11 yards feet for Level A injurious harassment for pinnipeds (190 dB RMS) (Table 3.9-7). It should be noted that ELCAS pier construction starts with piles being driven near the shore and extends offshore. Near the shore, the area of influence would be a semi-circle and towards the end of the ELCAS (approximately 1,200 feet from the shore) would be a full circle. The above calculated area of influence conservatively assumes that all ELCAS piles driven are all driven offshore at SSTC, producing a circular zone of influence.

Noise levels derived from piles removed via vibratory extractor are different than those driven with an impact hammer. Steel pilings and a vibratory driver were used for pile driving at the Port of Oakland (CADOT 2009). Underwater sound levels during this project for a 24-inch steel pile in 11 m (36 ft) of water depth was field measured to be 160 dB RMS. The area where this projects was conducted has a harder substrate, which because of the extra effort required to drive the pile, would make these measured pile driving sound levels louder (more conservative) than they would if driving into SSTC's sandy substrate. Conservatively using this RMS measurement for SSTC, the zone of influence (ZOI) for a 24-inch steel pile removed via a vibratory extractor out to the 120 dB RMS Level B behavioral harassment threshold can be estimated to be 5,076 feet (Table 3.9-7). Additionally, the distances to the 180 dB RMS Level A harassment threshold for cetaceans and the 190 dB RMS Level A harassment threshold for pinnipeds can be estimated as 1 yard and less than 1 yard, respectively. As discussed above, the above calculated area of influence conservatively assumes that all ELCAS piles driven are all driven offshore at SSTC, producing a circular zone of influence.

Table 3.9-7: Maximum Zones of Influence for ELCAS Activities

	Level B (Continuous noise)	Level B (Impulse)	Level A (Cetaceans)	Level A (Pinnipeds)
	120 dB RMS	160 dB RMS	180 dB RMS	190 dB RMS
Installation (Pile Driving)	N/A	1,094 yards	46 yards	11 yards
Removal (Vibratory)	5,076 yards	N/A	1 yard	< 1 yard

Based on the assessments conducted, using the methodology discussed in Section 3.9.2.5, and without consideration of current mitigation measures, activities under the No Action Alternative are not anticipated to expose marine mammals to injury (Level A harassment). However, ELCAS activities could result in limited non-injurious (Level B) harassment to cetaceans and pinnipeds during pile removals. Specifically, 30 annual exposures are predicted from pile installation activities (20 bottlenose dolphins and 10 California sea lions), and 144 annual exposures (3 gray whales, 84 bottlenose dolphins, 51 California sea lions, and 6 harbor seals) from pile removal activities could result in Level B harassment (Table 3.9-8). As mentioned previously, these exposure modeling results are estimates of marine mammal ELCAS sound exposures without consideration of standard mitigation and monitoring procedures.

Table 3.9-8: Estimates of Exposed Species to ELCAS Activities Without Implementation of Mitigation Measures: No Action Alternative

Species			NO ACTION ALTERNATIVE: Annual Estimated Mammals Exposure			
			Level B (Continuous)	Level B (Impulse)	Level A (Cetaceans)	Level A (Pinnipeds)
			120 dB RMS	160 dB RMS	180 dB RMS	190 dB RMS
Cetaceans	Gray Whale	Installation	N/A	0	0	0
		Removal	3	N/A	0	0
	Coastal Bottlenose Dolphin	Installation	N/A	20	0	0
		Removal	84	N/A	0	0
Pinnipeds	California Sea Lion	Installation	N/A	10	0	0
		Removal	51	N/A	0	0
	Harbor Seal	Installation	N/A	0	0	0
		Removal	6	N/A	0	0
Total Exposures			144	30	0	0

As presented for underwater detonations, behavioral responses from exposure to ELCAS pile driving can range from no observable response to other behavioral responses discussed previously (Southall 2007, NOAA 2009). According to the severity scale response spectrum proposed by Southall et al. (2007), responses classified as from 0-3 are brief and minor, those from 4-6 have a higher potential to affect foraging, reproduction, or survival and those from 7-9 are likely to affect foraging, reproduction, and survival. While there is little data on the consequences of sound exposure on vital rates of marine mammals, given the limited duration of ELCAS training (<10 days), and the implementation of the current mitigation and monitoring procedures in the SSTC, as described in Section 3.9.2.7, potential for impacts to individual marine mammals or marine mammal stocks from ELCAS activities will be minimal.

3.9.2.8.5 Other Acoustic Sources

Mine Location—Acoustic Pingers

To facilitate inert mine recovery, high-frequency (35 to 43 kHz) pingers are occasionally attached to mines. The source level of the acoustic pinger is 70 - 75 dB re 1 μ Pa-m and these high frequency sounds attenuate rapidly in seawater, so any behavioral effects on marine mammals would be localized if they occurred at all. These emissions were not included in the modeling so potential marine mammals exposures from these sources were not estimated. However, it is unlikely that effects to marine mammals from these sources would be significant because of the limited emission times, rapid attenuation rate of high-frequency sound, and the limited area affected by these sources. Location pingers for inert mines do not constitute an adverse effect on the physiology and behavior of marine mammals and are not carried forward in this EIS.

Diver Recall Devices

Underwater exercises involving Navy divers include an underwater notification system alerting divers to return to boats or shore to conclude exercises. The noise associated with the Audible Recall Device (ARD) is broadband, though most energy is concentrated between 200 and 300 Hz. The duration of a

diver recall device is one second or less and propagation models indicate that levels drop to below 2 psi-sec within 23 feet of the source. The ARD is only used at periodic intervals when needed to alert or recall underwater divers and do not represent a continuous acoustic source. Disturbance effects on the behavior of marine mammals, if any, would be extremely localized and short-term on the order of seconds to minutes. Potential avoidance behavior constitutes a minor and temporary change in behavior, with no adverse effect to overall behavior patterns. Therefore, recall devices are not carried forward in this EIS analysis.

3.9.2.9 Alternative 1 (Preferred Alternative)

Under Alternative 1, the Navy would increase the tempo of training, introduce new types of training activities, conduct existing routine training at additional locations within SSTC training areas, establish shallow water minefield, introduce new platforms and equipment, and increase access and availability to SSTC training areas. These components are discussed in detail in the following subsections.

3.9.2.9.1 Underwater Detonations

Underwater detonations occur in shallow water (less than 72 feet) within oceanside training lanes and the shock waves propagate over a mostly homogeneous sand substrate. As presented in Section 3.8.2.2.3 (Table 3.8-10), underwater detonations would increase measurably from 103 activities under the No Action Alternative to 311 activities under Alternative 1. Under Alternative 1, five additional activities would be conducted: Shock Wave Generator (SWAG) (N1) and Unmanned Underwater Vehicle (UUV) Neutralization (N3), Airborne Mine Neutralization System (AMNS) (N7), Demolition Requalification and Training/Underwater Detonations (N9), and NSW Underwater Demolition Training (N11), and the footprint of activities would be expanded to include SWAG detonations of up to 15 grams Net Explosive Weight (NEW) within San Diego Bay (Table 2-2). Zones of exposure were estimated for the different charge weights, charge depths, water depths, and seasons. These ZOI calculated ranges are shown in Table 3.9-9.

Shock Wave Generator (N1, Table 2-2) is a new activity under Alternative 1 that will take place within all boat training lanes and the San Diego Bay training areas. SWAG is a tool used to disarm enemy limpet mines, which have been attached to the hull of a ship. Under Alternative 1, SWAG is expected to occur up to 90 times a year in the San Diego Bay and nearshore waters of SSTC boat lanes.

UUV Neutralization (N3) is a new activity under Alternative 1 that would be conducted within SSTC Boat Lanes 1-14. Training consists of placing sequential charges consisting of a Seafox (3.3 pounds) or Archerfish (3.57 pounds) charge placed from depths of 10 feet to the bottom in water depths less than 72 feet.

AMNS (N7) is a new activity under Alternative 1 that would be conducted within SSTC Boat Lanes 1-14 (Table 2-2). 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 3.3 pound NEW charge (PBXN110) would be manually detonated.

Demolition Requalification and Training/Underwater Detonations (N9) is a new activity under Alternative 1 that would be conducted 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 placed from a depth of 20 feet to the bottom.

Table 3.9-9: Maximum Zone of Influence for Underwater Detonation Activities Under Alternative 1.

Underwater Detonation Operation	Charge Weight Used ¹	Season	Level B Harrassment	Level A Harrassment		Mortality
			Onset of TTS ² / Non-TTS ³ (yards)	Onset of slight lung injury (13.0 psi-msec) (yards)	50% TM rupture (205 dB re 1 μ Pa ² -sec) (yards)	Onset of extensive lung injury (30.5 psi-msec) (yards)
Mine Countermeasures	20	Warm	470	360	80	80
		Cold	450	160	80	80
Floating Mine	5	Warm	240	20	80	20
		Cold	260	20	80	20
SWAG	0.033	Warm	60	0	0	0
		Cold	40	0	0	0
Unmanned Underwater Vehicle Activities	15	Warm	440	360	80	80
		Cold	400	150	80	80
Marine Mammal Systems Activities (sequential)	29	Warm	420/740	360	140	90
		Cold	470/650	170	140	90
Marine Mammal Systems Activities (individual)	29	Warm	400	360	100	90
		Cold	490	170	100	90
Dive Platoon (sequential)	3.5	Warm	330/470	80	90	50
		Cold	370/560	90	90	50
Qual/Cert (sequential)	13.75	Warm	330/470	140	100	80
		Cold	370/530	140	100	80
Qual/Cert (individual)	25.5	Warm	420	300	90	90
		Cold	470	170	90	90
Mine Neutral (sequential)	3.5	Warm	330/470	80	90	50
		Cold	370/560	90	90	50
UUV Neutral (sequential)	3.57	Warm	220/260	80	60	50
		Cold	230/280	90	60	50
AMNS	3.5	Warm	220	80	40	40
		Cold	230	80	40	40

¹ Charge weights are listed in pounds

² Maximum ZOI based on greatest range from dual criteria (182 dB re 1 μ Pa²-sec or 23 psi)

³ Behavioral Disruption Non-TTS (listed only for (sequential detonations))

NSW Underwater Demolition Training (N11) is a new activity under Alternative 1 that 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.

Based on the modeling approach applied, as discussed in Section 3.9.2.4 and without consideration for mitigation measures, underwater detonations under Alternative 1 would result in the potential for noninjurious (Level B) harassment to cetaceans and pinnipeds, but there would be no potential for injurious (Level A) harassment or mortality. The modeled explosive exposure numbers by species are presented in Table 3.9-10. Specifically, 153 annual exposures to pressure from underwater detonations would result in TTS (Level B harassment). Of these 153 exposures, 98 annual exposures would result in TTS for bottlenose dolphins. Exposures of California sea lions comprise the remaining 55 annual exposures that would result in TTS. Exposures to grey whales and harbor seals are not anticipated due to low species density and the limited zone of influence of the proposed underwater detonations. These exposure modeling results are estimates of marine mammal underwater detonation sound exposures without consideration of standard mitigation and monitoring procedures.

Table 3.9-10: Modeled Estimates of Species Exposed to Underwater Detonations Without Implementation of Mitigation Measures under Alternative 1

Species			ALTERNATIVE 1: Season Average Mammals Exposure (All Sources)			
			Level B Behavior (MSE only)	Level B TTS	Level A Injury	Level A Mortality
			177 dB	182 dB / 23 psi	205 dB / 13.0 psi-ms	30.5 psi-ms
Cetaceans	Gray Whale	Warm	-	-	-	-
		Cold	0	0	0	0
	Coastal Bottlenose Dolphin	Warm	30	43	0	0
		Cold	40	55	0	0
Pinnipeds	California Sea Lion	Warm	4	4	0	0
		Cold	40	51	0	0
	Harbor Seal	Warm	0	0	0	0
		Cold	0	0	0	0
Total Exposures			114	153	0	0

In addition to possible exposures that could result in TTS, the modeling without consideration of mitigation measures indicates that detonations under Alternative 1 also would result in the potential for 114 nonphysiological behavioral exposures. While physiological impacts were calculated for all activities, non-physiological behavioral impacts were calculated only for those exercises which involved multiple detonations during a training scenario. Coastal bottlenose dolphins were predicted to have a similar number of non-physiological behavioral exposures in both the warm (30) and cold (40) seasons,

while California sea lions were predicted to have a higher number of non-physiological behavioral exposures during the cold season (40) than in the warm season (4). Modeling estimates indicate that no exposures of either coastal bottlenose dolphins or California sea lions exceeded injury criteria suggesting that risk of injury was low during a year of training at SSTC.

To reduce the potential for behavioral or physiological damage such as TTS or injury, a buffer zone would be established around each detonation area. As discussed in Section 3.9.3, the buffer zone for 24 to 72 feet of water depth would remain the same to accommodate the largest Level B behavioral harassment ZOI under Alternative 1 (MMS sequential detonations). The buffer zone for VSW underwater detonations (in zero to 24 feet of water), would also remain the same. Operations would not be conducted if marine mammals are sited in the buffer zone. This type of mitigation would likely prevent animals from being exposed to the loudest explosive effects that could potentially result in behavioral, TTS or PTS and more intense behavioral reactions. Implementation of current mitigation and monitoring procedures in the SSTC, as described in Section 3.9.1.7, would minimize the potential for marine mammal exposures to underwater detonations. With implementation of mitigation measures, it is anticipated that exposures will be primarily behavioral, and are highly unlikely to disrupt overall behavior patterns such as migrating, breeding, feeding and sheltering, of marine mammals in the ROI.

3.9.2.9.2 Aircraft Activities

Implementation of Alternative 1 would result in similar effects to marine mammals as previously described under the No Action Alternative. The types of air activities proposed for Alternative 1 are consistent with those described under the No Action Alternative, although the frequency would increase and five new activities would be conducted (N4-N8, Table 2-2). As presented in Chapter 2 (Table 2-2 and 2-3) and detailed in Appendix C, helicopter activities over San Diego Bay and ocean waters within the ROI would more than double under Alternative 1 as compared to the No Action Alternative. Helicopter activities would have the greatest impact because of the low flying and hovering at altitudes down to 100 feet. Disturbance of marine mammals from the noise, physical presence, or sea surface disturbance from aircraft within the ROI would be limited to animals utilizing the area immediately adjacent to the activity and likely only within upper-most section of the water column. Any temporary effect to marine mammals near the surface remains a low probability considering the temporal variability of both training actions and the potential for marine mammals to be present near the sea surface within a specific training area. It is likely that few animals would be in the area and those approaching the area would avoid it if aircraft activities are being conducted. Therefore, there would be minimal effects to marine mammals from aircraft activities as a result of implementation of Alternative 1 and these effects are highly unlikely to disrupt overall behavior patterns such as migrating, breeding, feeding and sheltering, of marine mammals in the ROI.

In addition, one new air activity utilizing helicopters with a mounted Light Detection and Ranging (LIDAR) blue-green laser used to detect, classify, and localized floating and near-surface mines in shallow water (N5) would be added under Alternative 1 (Table 2-2). Zorn et al. (1998) collected information about current laser safety standards and investigated retinal damage mechanisms for humans, and research on eye anatomy for humans, cetaceans, and pinnipeds in an attempt to determine laser safety thresholds for cetaceans and pinnipeds. Zorn et al. developed a sensitivity ratio to compare the human eye sensitivity to that of marine mammals and concluded that the human eye is more sensitive to laser radiation than either the cetacean eye or the pinniped eye.

Cetaceans and pinnipeds have adapted to living in bright sunlight and dark ocean waters. In bright light, a highly constricted pupil keeps the received energy levels down, while in darker conditions, a pupil can be fully opened to admit as much light as possible. It is unlikely an animal would have fully dilated pupils at the surface, especially during daylight hours. If marine mammals were directly illuminated by a LIDAR

source, this highly constricted pupil would further reduce the received energy, as Airborne Laser Mine Detection System activities are restricted to daylight hours. Although the likelihood that an oceanographic LIDAR's laser beam would directly contact a cetacean or pinniped eye is unknown, both cetaceans and pinnipeds spend a significant amount of time underwater and are widely scattered at sea. Large groupings at sea are easy to spot and would be avoided by helicopter operators. Combining this information with the low number of annual activities, temporal variability of training actions, lower sensitivity to laser radiation, low potential for marine mammals to be present near or at the sea surface within a specific training area, and the low probability of direct eye contact of a moving LIDAR laser, the use of LIDAR poses a minimal risk to marine mammals.

3.9.2.9.3 Marine Vessels

Marine vessels increase in use and scope under Alternative 1 compared to the No Action Alternative. Increases to on water activity by marine vessels in both ocean and San Diego Bay training areas would increase the probability of effect on marine mammals 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, SWAG (N1) and Surf Zone Test Detachment (N2), as well as increases to existing activities, SDV/ASDS Cert training and Barge Ferry/Causeway Coxswain training (Table 2-2).

3.9.2.9.4 Amphibious and Beach Activities

ELCAS/Pile Driving

Under Alternative 1, the number of ELCAS events will increase from two to four activities annually. The training locations, pile driver, and pile type and size would remain the same as in the No Action Alternative. As such, the ZOIs shown in Table 3.9-7 for pile driving would also be the same as in the No Action Alternative.

Based on assessments conducted (discussed in Section 3.9.2.5), and without consideration of current mitigation measures, activities under Alternative 1 are not expected to cause injury (Level A harassment) to marine mammals. However, ELCAS installation could result in behavioral (Level B) harassment to 60 cetaceans and pinnipeds (40 bottlenose dolphins and 20 California sea lions, Table 3.9-11). Also, pile removal activities could result in behavioral (Level B) harassment to 288 cetaceans and pinnipeds (6 gray whales, 168 bottlenose dolphins, 102 California sea lions, and 12 harbor seals). As mentioned previously, these exposure modeling results are estimates of marine mammal ELCAS sound exposures without consideration of standard mitigation and monitoring procedures.

The available scientific literature suggest that introduction of pile driving into the marine environment could result in short term behavioral and/or physiological marine mammal impacts such as: altered headings; increased swimming rates; changes in dive, surfacing, respiration, feeding, and vocalization patterns; masking; and hormonal stress production (Southall et al., 2007); however, some field studies also suggest marine mammals do not observably respond to construction type sounds such as drilling (e.g., Richardson et al. 1995; Moulton et al., 2005). Individual animal responses are likely to be highly variable depending on situational state, and prior experience or habituation. Southall et al. 2007 point out that careful distinction must be made of brief minor, biologically unimportant reactions as compared to profound, sustained or biologically meaningful responses related to growth, survival, and reproduction. Populations of bottlenose dolphins, California sea lions, and harbor seals in and adjacent to San Diego Bay and SSTC have likely been historically exposed and potentially habituated to multiple regional anthropogenic underwater noise sources (i.e., commercial shipping, recreational boating, in-water construction, aircraft overflights, etc.).

Table 3.9-11: Estimates of Exposed Species to ELCAS Activities Without Implementation of Mitigation Measures under Alternative 1

Species			Annual Estimated Mammals Exposure			
			Level B (Continuous)	Level B (Impulse)	Level A (Cetaceans)	Level A (Pinnipeds)
			120 dB RMS	160 dB RMS	180 dB RMS	190 dB RMS
Cetaceans	Gray Whale	Installation	N/A	0	0	0
		Removal	6	N/A	0	0
	Coastal Bottlenose Dolphin	Installation	N/A	40	0	0
		Removal	168	N/A	0	0
Pinnipeds	California Sea Lion	Installation	N/A	20	0	0
		Removal	102	N/A	0	0
	Harbor Seal	Installation	N/A	0	0	0
		Removal	12	N/A	0	0
Total Exposures			288	60	0	0

The implementation of the current mitigation and monitoring procedures in the SSTC, as described in Section 3.9.2.7, will minimize the potential for impacts to individual marine mammals or marine mammal stocks from ELCAS activities.

3.9.2.9.5 Other Acoustic Sources

Two activities are proposed under Alternative 1 that introduce an additional source of high-frequency noise into the marine environment. UUV Neutralization and AN/AQS-20 Mine Hunting (N3 and N4) introduce high-frequency sidescan sonars, which are operated at frequencies greater than 200 kHz. It is important to note that, as a group, marine mammals have functional hearing ranging from 10 Hertz (Hz) to 180 kHz; however, their best hearing sensitivities are well below that level. Since sonar sources operating at 180 kHz or higher attenuate rapidly and are at or outside the upper frequency limit of even the ultrasonic species of marine mammals, further consideration and modeling of these higher frequency acoustic sources are not warranted.

3.9.2.10 Alternative 2

Implementation of Alternative 2 would increase the total operational training tempo to the same levels as presented for Alternative 1 (Table 2-2 and 2-3). Similar to Alternative 1, Alternative 2 would 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 oceanside beach training areas would be available for use, regardless of time of year. Since the differences between Alternative 1 and Alternative 2 are terrestrial, the impacts associated with Alternative 2 would be the same as those described above for Alternative 1.

3.9.3 Proposed Mitigation Measures

Given implementation of the current mitigation measures for SSTC activities (described in detail in Section 3.9.1.7), there would be minimal impacts to marine mammals under any of the alternative actions considered in this EIS.

Mitigation measures for oceanside underwater detonations would remain the same as described in Section 3.9.1.7.

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. Mitigation measures for SWAG detonation training are described below. Similar to existing mitigation measures, the physical topography, the lack of protected species on the range, and the type of Navy training routines allow for exceptionally reliable and effective mitigation procedures. Marine mammal species can be detected within a radius that extends out to the distance at which only the lowest degree of TTS would be expected to occur. That is, the procedures described in this section mitigate the potential for Level A harassment by injury and Level B harassment associated with TTS since explosives are not detonated when protected species are in the area associated with those effects. Mysticetes and large odontocetes are rarely, if ever, present in the shallow offshore waters of the SSTC. Were large marine mammals to approach the area—even far beyond the buffer zone—they would be immediately obvious to the shore or safety-boat observers. The SSTC ROI is not known to be a preferred feeding site for small marine mammals. Thus, the principal concern is for protection of small odontocetes (dolphins and small whales) and carnivora (sea lions) that only occasionally transit though the site. It follows that the buffer zones, to be described below, are determined by modeled estimates of the propagated peak-pressure and energy.

The following mitigation measures are consistent with existing training objectives and activities as well as established human safety procedures. In case of unanticipated conflict, human safety considerations will take precedence and such conflicts are always used to make incremental improvements in the procedures used in subsequent activities.

For SWAG charges laid bayside on SSTC at the locations described:

1. A buffer zone of 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 marine mammals 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 marine mammal prey.
3. Divers placing charges on mines and dive support vessels will check the area immediately around the mine location for marine mammals.
4. If a marine mammal 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 and marine mammals for at least 10 minutes.
5. Immediately following the detonation, visual monitoring for marine mammals within the buffer zone will continue for 10 minutes. Any animals appearing will be observed for signs of injury. Injured marine mammals will be reported to the CNRSW Environmental Director, the PACFLT Environmental Office, and NMFS.

Mitigation for ELCAS/Pile Driving Activities on SSTC oceanside:

The Navy proposes, under the associated SSTC marine mammal monitoring plan, to conduct underwater acoustic propagation monitoring during the first available ELCAS deployment at the SSTC under the Incidental Harassment Authorization application. This acoustic monitoring would provide empirical field data on ELCAS pile driving and removal underwater source levels, and propagation specific to ELCAS training at the SSTC. These results will be used to either confirm or refine the Navy's exposure predictions.

3.9.4 Impacts to Marine Mammal Species or Stocks

Overall, the conclusions in this analysis find that impacts to marine mammal species and stocks would be negligible for the following reasons:

- Acoustic harassments are within the non-injurious temporary threshold shift (TTS) or behavioral effects zones (Level B harassment). There are no exposures to sound levels or pressure that could cause permanent threshold shift (PTS)/injury (Level A harassment) resulting from the summation of the modeling.
- Although the numbers presented for the No Action Alternative (Table 3.9-6 and 3.9-8), Alternative 1 and Alternative 2 (Table 3.9-10 and 3.9-11) represent estimated harassment under the Marine Mammal Protection Act (MMPA), as described above, they are likely overestimates of harassment, primarily by behavioral disturbance. In addition, the model calculates harassment without taking into consideration standard mitigation measures, and is not indicative of a likelihood of either injury or harm.
- Additionally, the mitigation measures described in Section 3.9.1.7 and Section 3.9.3 are designed to reduce sound exposure of marine mammals to levels below those that may cause "behavioral disruptions" and to achieve the least practicable adverse effect on marine mammal species or stocks.

Consideration of negligible impact is required for NMFS to authorize incidental take of marine mammals. By definition, an activity has a "negligible impact" on a species or stock when it is determined that the total taking is not likely to reduce annual rates of adult survival or recruitment (i.e., offspring survival, birth rates). Using each species' life history information, the expected behavioral patterns in the SSTC training and exercise locations, and an analysis of the behavioral disturbance levels in comparison to the overall population presented for each species, these species-specific analyses support the conclusion that proposed SSTC training events would have a negligible impact on marine mammal populations.

3.9.5 Unavoidable Adverse Environmental Effects

There are no unavoidable adverse environmental effects on marine mammals. Implementation of protective measures minimizes any adverse impacts associated with SSTC training activities.

3.9.6 Summary of Effects

Modeling estimates for the No Action Alternative indicate that no exposures would result in slight injury, severe injury, or mortality of any marine mammal. Without implementation of current mitigation measures, 78 annual exposures to pressure from underwater detonations could result in TTS and 68 annual exposures could result in nonphysiological behavioral exposures (Level B harassments). In addition, 30 annual exposures (20 bottlenose dolphins, 10 harbor seals) from pile installation activities and 144 annual exposures (3 gray whales, 84 bottlenose dolphins, 51 California sea lions, and 6 harbor seals) pile removal activities could result in Level B harassment. However, implementation of the current mitigation measures will minimize the potential impacts to marine mammal species in the SSTC and the remaining potential impacts are highly unlikely to disrupt overall behavior patterns such as migrating, breeding, feeding and sheltering, of marine mammals in the ROI.

Modeling estimates for Alternatives 1 and 2 indicate that without implementation of current mitigation measures, 153 annual exposures to pressure from underwater detonations could result in TTS and 114 annual exposures could result in nonphysiological behavioral exposures (Level B harassments). In addition, 60 annual exposures (30 bottlenose dolphins, 20 harbor seals) from pile installation activities and 288 annual exposures (6 gray whales, 168 bottlenose dolphins, 102 California sea lions, and 12 harbor seals) pile removal activities could result in Level B harassment. No exposures would result in slight injury, severe injury, or mortality. However, implementation of the current mitigation measures will minimize the potential impacts to marine mammal species in the SSTC.

Based on the above analysis, the Navy has submitted an application for an Incidental Harassment Authorization to NMFS per the requirements of MMPA for proposed training activities that have the potential to incidentally take marine mammals as listed above. The Navy received comments from NMFS on the IHA request on September 9, 2010 and submitted the Final IHA request to NMFS on September 15, 2010. The Notice of Receipt of the IHA application was published in the Federal Register by NMFS on October 19, 2010. After consideration of public comments on the IHA application, NMFS may grant the authorization to take small numbers of marine mammals by harassment if it finds that the taking will have a negligible impact on the species or stock(s) on subsistence uses (where relevant). NMFS will identify appropriate mitigation, monitoring and reporting requirements. Chapter 6 provides a full description of the IHA process and Appendix G provides a list of the Silver Strand Training Complex (SSTC) IHA documentation. Agency correspondence and supporting documentation can be found on the SSTC EIS website at www.silverstrandtrainingcomplexeis.com.

Table 3.9-12 presents a summary of effects and mitigation measures for the No Action Alternative, Alternative 1, and Alternative 2.

Table 3.9-12: Summary of Effects

Alternative	Effects
No Action Alternative	<ul style="list-style-type: none"> • Modeling estimates for the No Action Alternative indicate that exposures are not expected to result in slight injury, severe injury, or mortality of marine mammals. Without implementation of current mitigation measures, underwater detonations could result in behavioral and TTS (Level B) harassment exposures. 78 annual exposures to pressure from underwater detonations could result in TTS and 68 annual exposures could result in nonphysiological behavioral exposures (Level B harassments). In addition, 30 annual exposures (20 bottlenose dolphins, 10 harbor seals) from pile installation activities and 144 annual exposures (3 gray whales, 84 bottlenose dolphins, 51 California sea lions, and 6 harbor seals) pile removal activities could result in Level B harassment. No exposures are expected to result in injury, severe injury, or mortality. • Implementation of current mitigation measures minimizes potential impacts to marine mammal species in the SSTC ROI. • Ship collisions are unlikely due to the low density of marine mammals in the area.
Alternative 1	<ul style="list-style-type: none"> • Modeling estimates for Alternative 1 indicate that without implementation of current mitigation measures, an increased tempo of underwater detonations and could result in an increase of behavioral and TTS (Level B) harassment. 153 annual exposures to pressure from underwater detonations could result in TTS and 114 annual exposures could result in nonphysiological behavioral exposures (Level B harassments). In addition, 60 annual exposures (30 bottlenose dolphins, 20 harbor seals) from pile installation activities and 288 annual exposures (6 gray whales, 168 bottlenose dolphins, 102 California sea lions, and 12 harbor seals) pile removal activities could result in Level B harassment. No exposures are expected to result in slight injury, severe injury, or mortality. • Implementation of current mitigation measures would minimize potential impacts to marine mammal species in the SSTC ROI. • Ship collisions are unlikely due to the low density of marine mammals in the area. • Effects from other activities are the same as described under the No Action Alternative.
Alternative 2	<ul style="list-style-type: none"> • With implementation of current mitigation measures, effects are the same as described under Alternative 1.
Mitigation	<p>Mitigation measures for very shallow water (VSW) underwater detonations on SSTC oceanside (0-24 feet):</p> <ul style="list-style-type: none"> • 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.

Table 3.9-12: Summary of Effects (Continued)

Alternative	Effects
<p>Mitigation (Continued)</p>	<ul style="list-style-type: none"> • 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 marine mammals. 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 marine mammals after 10 or more minutes of continuous observation with no marine mammals 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 marine mammal has been seen in the zone and, together, both search the surface within and beyond the mitigation zone for marine mammals (and other protected species such as sea turtles). • The observers (boat and shore based) will indicate that the area is not clear any time a marine mammal is sighted in the mitigation zone or moving toward it and, subsequently, indicate that the area is clear of marine mammals when the animal is out and moving away and no other marine mammals have been sighted. • Initiation of the detonation sequence will only begin on final receipt of an indication from the shore observer that the area is clear of marine mammals and will be postponed on receipt of an indication from that any observer that the area is not clear of marine mammals. • Following the detonation, visual monitoring of the mitigation zone continues for 30 minutes for the appearance of any marine mammal in the zone. Any marine mammal appearing in the area will be observed for signs of possible injury. • Any marine mammal observed after an 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.

Table 3.9-12: Summary of Effects (Continued)

Alternative	Effects
Mitigation (Continued)	<p>Mitigation measures for shallow water underwater detonations on SSTC oceanside (24-72 feet):</p> <ul style="list-style-type: none"> • 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). • 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 marine mammals 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 marine mammals (and other protected species such as sea turtles). • If a marine mammal is sighted within the 1,500 foot or 500 yard mitigation zone or moving towards it, underwater detonation events will be suspended until the marine mammal has voluntarily left the area and the area is clear of marine mammals for at least 30 minutes. • Immediately following the detonation, visual monitoring for marine mammals within the mitigation zone will continue for 30 minutes. Any marine mammal 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 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. <p>Mitigation for ELCAS/Pile Driving Activities on SSTC oceanside:</p> <ul style="list-style-type: none"> • A mitigation zone will be established at 150 feet or 50 yards from ELCAS pile driving and pile removal events. This mitigation zone is base on the predicted range to Level A harassment (180 dB RMS) for cetaceans, and is being applied conservatively to both cetaceans and pinnipeds. • Monitoring will be conducted within the 150 foot or 50 yard mitigation zone surrounding ELCAS pile driving and removal events for the presence of marine mammals (and other protected species such as sea turtles) before, during, and after pile driving and removal events • If marine mammals are found within the 150 foot or 50 yard mitigation zone, pile removal events will be halted until the marine mammals (or sea turtles) have voluntarily left the mitigation zone.

Table 3.9-12: Summary of Effects (Continued)

Alternative	Effects
Mitigation (Continued)	<ul style="list-style-type: none"> • Monitoring for marine mammals (or 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 marine mammals. • Monitoring observer(s) will implement shut-down/delay procedures when applicable by calling for shut-down to the hammer operator when marine mammals (or sea turtles) are sighted within the mitigation zone. • Soft Start - Providing additional protection for marine mammals (and 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 marine mammals 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 marine mammals 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. <p>For underwater detonations on SSTC oceanside under Alternative 1 and 2:</p> <ul style="list-style-type: none"> • 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. <p>For SWAG charges laid bayside on SSTC under Alternative 1 and 2:</p> <ul style="list-style-type: none"> • A buffer zone of 180 feet will be established around each SWAG detonation point. • Observer(s) with binoculars and small craft will survey the detonation area and the buffer zone for marine mammals 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 marine mammal prey. • Divers placing charges on mines and dive support vessels will check the area immediately around the mine location for marine mammals. • If a marine mammal 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 and marine mammals for at least 10 minutes.

Table 3.9-12: Summary of Effects (Continued)

Alternative	Effects
Mitigation (Continued)	<ul style="list-style-type: none"> • Immediately following the detonation, visual monitoring for marine mammals within the buffer zone will continue for 10 minutes. Any animals appearing will be observed for signs of injury. Injured marine mammals will be reported to the CNRSW Environmental Director, the PACFLT Environmental Office, and NMFS. <p>Mitigation for ELCAS/Pile Driving Activities on SSTC oceanside:</p> <ul style="list-style-type: none"> • The Navy proposes, under the associated SSTC marine mammal monitoring plan, to conduct underwater acoustic propagation monitoring during the first available ELCAS deployment at the SSTC under the Incidental Harassment Authorization application. This acoustic monitoring would provide empirical field data on ELCAS pile driving and removal underwater source levels, and propagation specific to ELCAS training at the SSTC. These results will be used to either confirm or refine the Navy's exposure predictions.