3.8 Fish

3.8 FISH

3.8.1 Affected Environment

3.8.1.1 Introduction

3.8.1.1.1 Definition

This section describes the fish and fish assemblages 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.

3.8.1.1.2 Regional Setting

The offshore area is part of the Pacific Ocean region referred to as the Southern California Bight (SCB), and is directly affected by two ocean currents. The colder, northern California Current and the southern, warm-water Davidson Current 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 unusually diverse marine biota within the SCB region (Murray and Littler 1981).

In the coastal zone and waters of San Diego Bay, biological conditions mirror that of other southern California coastal bays and estuaries. San Diego Bay is located in an arid region of Mediterranean climate and is fed by small, seasonal rivers and streams. As a result, the fish assemblages are largely devoid of freshwater and anadromous species, and are dominated by estuarine resident and marine migrant fish (Allen et al. 2006 and VRG 2009). Unlike the majority of southern California bays and estuaries, San Diego Bay is comparatively large and displays considerable habitat diversity and develops environmental gradients, especially during the winter months when most rainfall occurs. The offshore portion of SSTC is adjacent to the mouth of San Diego Bay and is comprised of primarily sandy soft-bottom surf zone habitat, interspersed with low relief rocky cobble habitat within the coastal pelagic zone out to 328 feet.

The SSTC and San Diego Bay are situated within an urban area, where there is intense shore and water use—both current and historical. In proximity to a large Naval complex and California's second largest city, San Diego Bay receives waters and urban runoff from a watershed of 415 square miles, where 50 percent of the county's population lives or works. The legacy of historic dredging, filling, direct sewage delivery, and pollutants that still persist have modified the benthic environment that supports marine plants and invertebrates vital to the fish species during multiple life stages; thus, biological assemblages have changed in comparison to past marine communities. Due to this history and identified pollutants, San Diego Bay is listed as an impaired water body under Clean Water Act (CWA) Section 303[d] by the California State Water Resources Control Board (Regional Water Quality Control Board 2007). These pollutants influence the population dynamics of invertebrates living in San Diego Bay sediments. An added pressure on the marine communities is the depletion and modification of the habitats in the Region of Influence (ROI) from historic conditions. Compared to historic acreages, there has been a 70 percent loss of salt marsh, 84 percent loss of intertidal areas other than salt marsh, and a 42 percent loss of shallow subtidal waters. Conversely, since the San Diego Bay was first dredged in 1914, deep-water habitat has doubled. Also, available shoreline habitats have experienced physical alteration, with 74 percent of the shoreline now armored with artificial hard structures—a type of substrate not native to the ROI. Fresh water and sediment formerly delivered to the San Diego Bay by several rivers and creeks are now almost completely impounded by dams and replaced by storm water flows.

3.8.1.1.3 Region of Influence

The marine ROI can be partitioned into three zones: the bayside training zones within the San Diego Bay (sandy beaches, mudflats, and the nearshore environment); portions of the intertidal to nearshore (<0.5

nautical mile [nm]) ocean area off the southern beaches of Naval Air Station, North Island (NASNI); and the intertidal to nearshore (<3 nm) ocean area encompassing the training lanes at SSTC-North (SSTC-N) and SSTC-South (SSTC-S), and ocean anchorages. Fish species that occur in this area for any portion of their life cycle are discussed in this chapter.

3.8.1.2 Marine Fish Habitat

The aquatic marine environment within the ROI supports diverse fish assemblages that reflect the great variety of aquatic habitats that are available to fish. Aquatic habitat delineation is discussed in Section 3.7. This section describes what is known about fish populations in the ROI and functions performed by the waters of the ROI to support fish productivity. Within the aquatic portion of the ROI—waters below mean higher high water—a wide variety of fish habitat types are represented. Fish habitat is described in terms of depth and substrate (Allen et al. 2006 and VRG 2009); the type and amount of ecological information on fish are not equable among habitats or among species. What is known about fish habitat reflects various investigator interest, sampling logistics, and economic and political considerations.

Fish habitat types previously used to describe waters within the ROI are divided into those within San Diego Bay and those within coastal nearshore waters adjacent to the San Diego Bay, out to a depth of approximately 600 feet. San Diego Bay fish habitat types are segregated by depth (intertidal, shallow subtidal, moderately deep subtidal, and deep channel, Table 3.8-1), vegetation (vegetated versus unvegetated) and substrate (soft bottom, mudflat, rip rap, rocky reef) (Horn 1980; Horn and Allen 1981; Allen 1985, 1997, 2006, and VRG 2009) as previously presented in Section 3.7. The majority of this literature regarding fish habitat places San Diego Bay into a single category: bays and estuaries. Bays and estuaries of Southern California give way to smaller embayments where freshwater input is largely restricted to the winter months when rainfall is most prevalent.

Table 3.8-1: Submerged Habitat Types Based on Bathymetry within the San Diego Bay and SSTC Bay Training Areas

Habitat	Depth (ft – MLLW[1])	San Diego Bay (acres)	SSTC ROI (acres)
Salt Marsh[2]	> +2	823	-
Intertidal (excluding salt marsh)	+2 to -2	1,802	32
Salt Ponds	> +2.0	1,608	-
Shallow	-2 to -12	4,799	846
Moderately Deep	-12 to -20	2,219	983
Deep	< -20	4,443	22
Total		**15,694**	**1,883**

[1] Mean Lower Low Water

2 The salt marsh habitat is described in detail in Sections 3.7.1.3.1 and 3.11.1.2.

Near-coastal fish habitat is partitioned similarly into defined substrate and depth criteria; and it includes surf zone, coastal pelagic zone, and continental shelf representing soft substrata and rocky intertidal, rocky reefs, kelp beds, and deep rocky habitats representing hard substrata (Allen et al. 2006 and VRG 2009). Individual fish species are classified within specific habitat types, but realistically the majority of fish known to occur within the ROI transit between or through multiple habitats during some portion of their life or life stage. Several fish species documented to occur within the ROI make seasonal or diurnal movements through multiple habitat types when aggregating, foraging, and/or spawning. Estuarine and marine habitats within the ROI vary by depth (bathymetry), tidal inundation, bottom substrate, and whether they are vegetated or unvegetated as previously presented in Section 3.7. Figure 3.7-1 depicts tidal elevation of the habitats described in Section 3.7 and this section, and Table 3.8-1 shows the acreage of submerged habitat types and their respective depths below mean lower low water (MLLW) in the San Diego Bay and within the SSTC ROI. Figure 3.7-3 provides an overview of marine habitats based on vegetation and substrate within the ROI, and Figure 3.7-4 focuses on the SSTC Bay training areas.

3.8.1.2.1 Intertidal Zone

Intertidal areas in the ROI are between the high and low tide line, and are subject to varying degrees of tidal submergence. There are several subareas of intertidal habitat based on the dominant substrate type and associated biological communities. The intertidal zone is a highly dynamic area because of its variable exposure to air, extreme temperature fluctuations, and utilization by both aquatic and terrestrial organisms. Fish species residing or utilizing the intertidal zone must adapt to unique, extreme physical and biological conditions. The intertidal zone within the ROI contains several fish habitat types further described within this section.

Southern Coastal Salt Marsh

Southern coastal salt marsh is a unique and important habitat within San Diego Bay (Section 3.7.1.3.1 and 3.11.1.2). Fish use the areas of salt marsh still exposed to the tide when the tide is in, taking advantage of the abundant food resources. Topsmelt (*Atherinops affinis*), arrow goby (*Clevelandia ios*), California killifish (*Fundulus parvipinnis*), and longjaw mudsucker (*Gillichthys mirabilis*) are all expected in salt marshes, due to their prevalence at the Sweetwater Marsh (Johnson 1999). Young round stingray (*Urobatus halleri*) and California halibut (*Paralichthys californicus*) are expected during curtain times of the year as well.

Intertidal Habitat

As presented in Section 3.7.1.3.1, intertidal habitat of the San Diego Bay includes salt marshes, mudflats, sand flats and salt flats, and portions of artificial hard substrate that provide valuable habitat for a variety of flora and fauna.When the tide comes in, numerous fish, sharks, and rays move in to forage in the flats. While most common intertidal fish are tidal visitors, some remain at low tide in shallow drainage channels or are species that can live in the burrows of marine invertebrates (Moyle and Cech 1982). Resident intertidal fish include the California killfish, longjaw mudsucker and the arrow goby. Other fish common in intertidal habitats include estuarine resident fish such as bay pipefish (*Syngnathus leptorhynchus*), deepbody anchovy (*Anchoa compressa*), and spotted sand bass (*Paralabrax maculatofasciatus*). Additionally, marine migrant fish, either diurnal or seasonal visitors, California halibut, shiner perch (*Cymatogaster aggregata*), round stingray, and others make up the remainder of the fish species commonly found utilizing intertidal habitat.

Surf zone and sand flat fish habitat is constrained to the ocean portion of the ROI. The fish associated with intertidal surf zone/sand flat habitat live in a turbulent environment described as exposed coastal beaches. The turbulence and currents associated with intertidal sand flat habitat require high-energy expenditures by fish that live there; but turbulence provides a constant source of small, disoriented invertebrates that are exceptionally vulnerable to capture by fish. Common fish to intertidal areas of exposed coastal beaches are made up of a diverse group of fish including active plankton feeders :northern anchovy (*Engraulis mordax*); roving substrate feeders – California corbina (*Menticirrhus undulates*); flatfish – California halibut; migratory species – White seabass (*Atractoscion nobilis*); beach spawners – California grunion (*Leuresthes tenuis*); and piscovores – leopard shark (*Triakis semifasciata*), among others. Most species found in the intertidal surf zone/sandflat habitat are widely distributed in coastal habitats; few are found primarily in the surf (Moyle and Cech 1982, Allen et al. 2006).

Artificial Hard Substrate

Artificial hard substrate within the ROI consists of rip rap and quay wall constructed to stabilize shoreline areas and provides important diverse habitat, as discussed in Section 3.7.1.3.1. Natural hard substrate within San Diego Bay occurs on a very limited spatial extent based on National Oceanic and Atmospheric Administration charts. Davis et al. (2002) reported on average, intertidal riprap—and natural rocky habitats in wave-exposed environments—in southern California did not differ from each other in diversity, or community composition. The most common fish species, reported by Davis et al. (2002) during rip rap fish transects at each site, appeared directly related to the sites distance from the entrance of San Diego Bay. Open-coast rocky intertidal and rocky reef species; wooly sculpin (*Clinocottus analis*); opaleye (*Girella nigricans*); and black surfperch (*Embiotosa jacksoni*) were among the most abundant species during rip rap fish survey transects—with only the south San Diego Bay sites reporting any true estuarine resident fish species. Artificial hard substrate areas provide refuge and feeding areas for certain fish, such as perches, basses, sculpin, opaleye, and blennies that utilize rocky substrate that is of limited availability within San Diego Bay.

Salt Pond

Salt ponds are large, persistent, saline impoundments of estuarine, ocean and bay water that are, or were, managed for salt production. San Diego Bay has natural salt marshes, and the salt ponds are part of a 130-year old ecosystem, the majority of which are still utilized by the Western Salt Company Salt Works. No fish are documented to inhabit the salt ponds.

3.8.1.2.2 Shallow Subtidal

The shallow subtidal encompasses approximately half of San Diego Bay and is comprised of several habitat types. These habitat types were described in Section 3.7.1.3.1. The abundance and biomass of fish is much higher in shallow waters compared to deeper waters (Allen 1999, Allen et al. 2006). The majority of eelgrass (*Zostera marina*) in San Diego Bay is constrained to the tidal range defined by the shallow subtidal habitat; consequently eelgrass habitats represent a substantial portion of high-value fish habitat throughout the ROI. Shallow subtidal habitat within San Diego Bay is mostly represented in the south and south central bay. Allen (1999) reported that Slough anchovies (*Anchoa delicatissima*) ranked third overall in numerical abundance and sixth in biomass for the five-year period of the study; and that the slough anchovies occupied the midwaters of the intertidal, nearshore and channel subhabitats—mainly in the South and South Central areas of San Diego Bay.

Ecoregions of San Diego Bay

While the shallow subtidal habitat is divided into two habitat modifiers—vegetated versus unvegetated—the associated fish assemblages differ in composition and location. Allen (1999) found that similar numbers of fish were taken in the vegetated and unvegetated areas over all sampling methods. The distinction between the two shallow subtidal habitats is the vertical distribution of fish density. Analysis of fish sampling methods among gear types displayed marked differences in vegetated versus unvegetated habitat supporting the findings of Hoffman (1986) that fish catches were twice as large over eelgrass habitats, compared to unvegetated sites (Allen 1999).

Unvegetated Shallow Soft Bottom

As discussed in Section 3.7.1.3.1, underwater observations indicate that algal mats present in unvegetated shallows are an important microhabitat feature—they provide cover or refuge from predators for many species of motile invertebrates and fish, much like marsh vegetation does for birds. The living plant material and detritus constitute a primary food source for California killifish, as well as an ancillary food source for other fish (Macdonald et al. 1990).

Unvegetated shallow areas support assemblages of benthic invertebrates and demersal fish that are distinct from vegetated shallow areas (Kramer 1990, Takahashi 1992a, Allen 1997). Many of these invertebrates serve as a food source for the demersal fish that occur in these unvegetated shallow areas of soft sediment. Common species to unvegetated shallow soft bottom include marine migrants California halibut, round stingray (*Urolophus halleri*), and diamond turbot (*Hypsopsetta guttulata*).

Vegetated Shallow Soft Bottom

As discussed in Section 3.7.1.3.1, eelgrass, a native marine angiopserm, provides a critical benthic habitat in San Diego Bay. Table 3.8-2 displays the acreages of eelgrass present in SSTC bayside training lanes. Abundant algae and invertebrates that grow on the leaf blades provide primary and secondary productivity for consumption by larval and juvenile fish. Fish and invertebrates use eelgrass beds to escape from predators, as a food source, and as a nursery. The eelgrass beds provide surfaces for egg attachment and sheltered locations for juveniles to hide and feed. Eelgrass beds provide important habitat for several bay-estuarine fish species, including bay pipefish, barred pipefish (*Syngnathus auliscus*), shiner perch, and giant kelpfish (*Heterostichus rostratus*) (Allen et al. 2002).

Table 3.8-2: Eelgrass Areas of the SSTC ROI and Individual San Diego Bay Training Areas

Bayside Training Area	Square Kilometers	Acres
Alpha	0.0354	8.7
Bravo	0.0710	17.5
Charlie	0.0550	13.6
Delta-I	0.0940	23.2
Delta-II	0.2077	51.3
Delta-III	0.2616	64.7
Echo	0.1833	45.3
Foxtrot	0.4206	103.9
Golf	0.1108	27.4
Hotel	0.0342	8.5
Total	**1.4736**	**364.1**

Source: Composite data from 1994, 1999, 2004, and 2008 baywide eelgrass surveys.

3.8.1.2.3 Moderately Deep Subtidal

The moderately deep subtidal in San Diego Bay extends from the approximate lower depth of most eelgrass beds to the approximate edge of the shipping channel; it represents areas that have been dredged in the past, but are not maintained as navigational channels. The moderately deep subtidal in San Diego Bay is dominated by round stingray, spotted sand bass, California halibut, slough anchovy, and barred sand bass (*Paralabrax nebulifer*) (Allen 1998, Pondella et al. 2006).

3.8.1.2.4 Deep Subtidal

Deep subtidal habitat includes the surface water, water column and sediments for areas greater than 20 ft MLLW; it is associated with navigational channels. Except for a few areas in north bay that have no dredging record, all deep subtidal habitat has been dredged since the 1940s, with most of the dredging in the 1960s or more recently. Since very little of this habitat occurs in the ROI, it is not discussed further.

3.8.1.2.5 Nearshore Ocean and Surf Zone

This habitat includes the area offshore, or oceanside of SSTC-N and SSTC-S, and includes the marine waters off of the sandy beaches of NASNI, SSTC-N (including the yellow through orange boat lanes), and SSTC-S (including the white and purple boat lanes). Also included are the ocean anchorages that partially overlap the SSTC-N ocean boat lanes. These habitats were described in Section 3.7.1.3.1.

Habitats on the oceanside of the SSTC can be described by a combination of depth, substrate, and wave energy. The nearshore area is primarily soft bottom, and spans from exposed sandy beaches to the water column above the inner-shelf. The coastal nearshore areas are classified as surf zone and coastal pelagic zone up to 100 miles westward, as described by Allen et al. (2006). The high energy surf zone and shallow (water depth < 98 feet) areas dominated by sand and low lying (< 6.6 feet) rocky reef and cobble are illustrated in Figure 3.7-3. Utilizing the habitat classification system developed for San Diego Association of Governments and California Coastal Conservancy (Merkel & Associates, Inc. et al. 2002), the majority of the area is described as a Subtidal/Soft Bottom/Sand ecotype, with a low to moderate energy ecotype modifier, because of seasonal variability with respect to wave energy.

Higher abundances and species diversity of invertebrates are found on long, gently sloping beaches, while lower abundances and diversity are present on steep, coarse-grained beaches. Demersal fish, common in sandy beach habitat in San Diego County, include bat rays, round stingrays, leopard sharks, California halibut, and sole (Family Pleuronectidae).

3.8.1.2.6 San Diego Bay

Bays and estuaries are known to be important nursery and refuge areas for marine fish (Cronin and Mansueti 1971, Haedrich and Hall 1976). Bays and estuaries are recognized as important fish habitat, serving especially as spawning and nursery sites, migration routes, and areas naturally supporting large populations of certain coastal fish species (Elliot 2002). Estuaries are among the most productive areas on earth, and the fish biomass in this habitat rank with that of the marine regions of upwelling, coral reefs, and kelp beds (Allen et al. 2006). Principal estuarine residents in San Diego Bay include Pacific staghorn sculpin (*Leptocottus armatus*), bay pipefish, and arrow goby, which are all synonymous with large estuaries throughout California. Other common estuarine species are California killifish, slough anchovy, deep body anchovy, spotted sand bass, and several other species of goby. Marine migrant fish are a major component of the fish assemblages found in San Diego Bay and utilize different portions and habitats of the San Diego Bay at various life stages. Marine migrants are dominated by topsmelt, shiner perch (*Cymatogaster aggregate*), juvenile California halibut, and yellowfin croaker (*Umbrina roncador*), among others. Another important characteristic of the fish inhabiting southern California bays and estuaries, including San Diego Bay, is that they form distinct species assemblages found nowhere else (Horn 1980; Horn and Allen 1981; Allen 1985, 1997; Macdonald et al. 1990).

Over 100 species of native fish are documented in San Diego Bay (Macdonald et al. 1990; Allen 1999; Pondella et al. 2006). Pondella et al. (2006) collected 57 species from two quarterly surveys in 2005—studies not substantially different from Allen's study (1999), which collected species assemblage data over a much longer period. During 20 seasonal sampling periods (July 1994 to April 1999), Allen (1999) reported 78 species of fish from throughout San Diego Bay. This contrasts with 56 species in 1892 (Eigenmann 1892), and only 25 species between 1968 and 1979 (Ford 1968; Ford et al. 1971; Lockheed 1979), which correspond to a period when waters of the ROI were recovering from many decades of raw sewage delivery. Allen (1998) and the Pondella et al. (2006) employed an Ecological Index to identify fish species that dominate San Diego Bay based on abundance, biomass, and frequency of occurrence. This index is expressed as:

$$\text{Ecological Index} = \%N \times \%W \times \%F$$

Where N = Abundance, W = Biomass, and F = Frequency

This measure is a modification of the Index of Relative Importance, which is used extensively in studies considering prey species from the gut contents of fish (Pinkas et al. 1971). Pondella et al. (2006) repeated this analysis in 2005.

Sampling performed by Allen et al. (1999) and Pondella et al. (2006) integrated sampling designs to investigate various habitats within the San Diego Bay, providing insight to the partitioning of fish abundance within distinct ecoregions and defined habitat types. The bayside training areas are all located within the South Central Ecoregion and are composed of moderately deep, shallow subtidal, and intertidal habitat, both vegetated (eelgrass) and unvegetated.

With an average of data from all ecoregions and years, Allen et al. (1999) estimated the numerical density of fish in San Diego Bay to be 1.75 individuals per square meter. On average, San Diego Bay contains 85 million fish, based on the estimated surface area. Most individuals were made up of northern anchovies (42 million); but there were on average almost 18 million slough anchovies, 10 million topsmelt, 3 million sardines, three million arrow gobies, and nearly two million shiner perch (Allen et al. 1999). Common higher level carnivorous fish such as round stingray, spotted sand bass, and California halibut were estimated to number 280,000, 133,000, and 80,000, respectively (Allen et al. 1999). The best estimates of numerical density for the individual ecoregions were 2.03 individuals/m^2 for the North Ecoregion, 1.93 individuals/m^2 for the North Central Ecoregion, 0.81 individual/m^2 for the South Central Ecoregion, and 1.15 individuals/m^2 for the South Ecoregion (Allen et al. 1999). The 10 species considered to be most dominant by Allen (1998) and by Pondella et al. (2006) based on their Ecological Index values, are listed in Table 3.8-3. Seven of the 10 species listed by Allen (1999) were included in the top 10 ecological index species in the Pondella et al. (2006) study. Ranking order was similar in both studies and only the Pacific sardine was noticeably absent in the Pondella ecological index ranking table; it was replaced by the deepwater anchovy, a similar schooling baitfish.

Table 3.8-3: Ranking of Top 10 "Ecological Index" Fish Species for Two Survey Reports Using the Same Methods in San Diego Bay

Scientific name	Common name	Rank 1994-1999 (Allen et al. 1999)	Rank 2005 (Pondella et al. 2006)
Atherinops affinis	Topsmelt	1	2
Urobatus halleri	round stingray	2	1
Engraulis mordax	northern anchovy	3	7
Anchoa delicatissima	slough anchovy	4	3
Paralabrax maculatofasciatus	spotted sand bass	5	5
Paralabrax nebulifer	barred sand bass	6	10
Paralichthys californicus	California halibut	7	9
Cymatogaster aggregata	shiner surfperch	8	6
Sardinops sagax	Pacific sardine	9	48
Heterostichus rostratus	giant kelpfish	10	13
Anchoa compressa	deepbody anchovy	34	4
Myliobatis californica	bat ray	18	8

Results from Pondella et al. (2006) survey are similar to Allen et al. (2002) in which topsmelt, round stingray, northern anchovy (ranked 8th in 2005), slough anchovy and spotted sand bass were ranked first through fifth, respectively. The similarity suggests that these species are critical components of the trophic structure of San Diego Bay; and that they may serve as good proxy to the overall health of the fish in the San Diego Bay ecosystem (Pondella et al. 2006).

The dominant fish assemblages in San Diego Bay were associated with regional area and habitat type. Species that were found to be numerically dominant (e.g., northern anchovy, slough anchovy, and topsmelt) during previous surveys showed a greater affinity to the northern portion of San Diego Bay, while the South-Central Ecoregion provided important nursery habitat for young of the year (YOY) for a wide range of San Diego Bay resident and marine migrant fish species. However, Allen (1999) and Pondella et al. (2006) found that the South-Central Ecoregion contained the lowest density, biomass, and diversity of fish species among all the ecoregions of the San Diego Bay.

Fish species and assemblages are commonly partitioned by habitat. Species groups with wide spread distributions among major habitat types are referred to as generalists, while those with restricted distributions are specialists. Considering that San Diego Bay and the ROI contain both diverse and distinct habitat types, the fish utilizing these areas are made up of a mixture of both resident specialists (e.g., arrow gobies, bay pipefish) and generalists (e.g., spotted sand bass, northern anchovies). The total amount of submerged habitat within San Diego Bay is 15,694 acres (San Diego Bay Integrated Natural Resources Management Plan [INRMP] 2000). The ROI within San Diego Bay contains 1,883.6 acres of submerged fish habitat divided into four categories: 1) deep (< -20 feet MLLW), 2) moderately deep (-12 to -20 feet MLLW), 3) shallow (-2 to -12 feet MLLW), and 4) intertidal (+2 to -2 feet MLLW). This represents 12.7 percent of all available fish habitat within San Diego Bay.

Submerged fish habitat within the San Diego Bay portions of the ROI encompasses deep (22.3 acres), moderately deep (982.7 acres), shallow (846.2 acres), and intertidal (32.4 acres) habitat types (Table 3.7-3). The South-Central Ecoregion is unique in that the eastern portion of the ecoregion is nearly completely dominated by armored shoreline (piers and quay wall) adjacent to deep water and the western portion (the San Diego Bay portion of the ROI) is comprised of gradual sloping bathymetry ending in intertidal mudflats and beaches. The North and North-Central Ecoregions contain narrow bands of moderately deep habitat because the shorelines associated with these areas are steeply sloped. Conversely, the South Ecoregion is dominated by expansive eelgrass habitats and salt marsh (outside of the Bay portion of the ROI), with shorelines that are gently sloped terminating at deep dredged channels. The moderately deep habitat within the San Diego Bay portion of the ROI represents the greatest area and percentage with respect to other habitats, considering the regional partitioning of habitat.

Eelgrass habitats contain a wide variety of fish species and span areas from intertidal to moderately deep subtidal depending on differing regions of San Diego Bay. Hoffman (1986) compared abundance and biomass of fish utilizing eelgrass beds and adjacent unvegetated area in three sections of San Diego Bay. The study concluded that eelgrass sites supported nearly twice as many individual fish. Density estimates from square enclosures used to enumerate burrow-inhabiting fish species such as gobies found densities of approximately 3.6 ind/m^2 (Allen 1999). The higher catches—at vegetated sites in five of ten possible gear comparisons performed by Allen et al. (1999)—were consistent with previous studies and, considering gear limitations, likely understated fish densities within vegetated habitat.

3.8.1.2.7 Coastal Nearshore

The habitats and associated fish communities of the nearshore coastal areas within the ROI are classified as surf zone and coastal pelagic zone (Allen et al. 2006). The nearshore area that encompasses the ROI is primarily soft bottom and spans from exposed sandy beaches to the water column above the inner shelf, typical of much of the southern California coastline. The coastal nearshore habitat within the ROI is high energy surf zone and shallow (< 100 feet) nearshore areas dominated by sand and low lying (< 6.0 feet) rocky reef and cobble (as described in Section 3.7.1.3.1). The fish common to these areas occur over the more shallow portions of the shelf and the soft bottom surrounding rock reef and kelp bed environments.

The fish assemblages of this area tie all the shallow water habitats closely together (Allen 1985). Fish observations within the San Diego region have recently been described by Merkel & Associates Inc. et al. (2002). A bathymetric survey of the area immediately offshore of the Silver Strand confirmed substrate conditions (Tierra Data Inc. 2006). The understory algae associated with the cobble substrate is comprised of primarily fleshy red algae; and canopy-forming macroalgae are mostly absent or infrequent. Associated invertebrate and fish communities in the understory algae habitat are similar to those found in kelp beds. Fish species commonly found in southern California kelp beds include topsmelt, surfperch, northern anchovy, California sheephead (*Semicosiphus pulcher*), and several species of bass (*Paralabrax* spp) and rockfish (*Sebastes* spp.).

Considering the substantial overlap of surf zone soft bottom and coastal pelagic habitat, in conjunction with the proximity of rocky reef kelp forest habitat, the range of fish species likely to occur within the ROI is broad. Fish species associated with the surf zone soft bottom overlap considerably with San Diego Bay and estuarine species, as well as YOY of other coastal pelagic species. Most species in the surf zone occur in other coastal habitats, and a few species occur primarily in the surf (Allen et al. 2006). Common species in the southern California surf zone are listed in Table 3.8-4.

Table 3.8-4: Common Southern California Surf Zone Fish Species

Scientific Name	Common Name	Scientific Name	Common Name
Engraulis mordax	Northern anchovy	*Atherinopsis californiensis*	Jacksmelt
Atherinops affinis	Topsmelt	*Leuresthes tenuis*	California grunion
Hyperprosopon argenteum	Walleye surfperch	*Seriphus politus*	Queenfish
Anchoa compressa	Deepbody anchovy	*Amphistichus argenteus*	Barred surfperch
Menticurrhus undulates	California corbina	*Umbrina roncador*	Yellowfin croaker
Urobatus halleri	Round stingray	*Mustelus californicus*	Gray smoothhound
Roncador stearnsii	Spotfin croaker	*Triakis semifasciata*	Leopard shark
Micrometrus minimus	Dwarf perch	*Syngnathus exilis*	Barcheek pipefish
Heterostichus rostratus	Giant kelpfish		

Source: Pondella et al. 2006

Coastal pelagic species inhabit the open water environment over the inner shelf, but they usually occur within a few kilometers of shore. Species include planktivores, such as anchovies; roving stratum-feeders, such as croakers and California corbina (*Menticurrhus undulates)*; and piscivores, such as Pacific mackerel (*Scomber japonicas*), Pacific bonita (*Sarda chiliensis*), and California barracuda (*Sphyraena argentea*), among others. Upwelling—and the mechanisms that regulate primary production—affects the temporal and spatial variability of the multiple trophic levels represented by this group of fish.

Fish species associated with rocky reefs and kelp beds overlap with other nearshore habitat types; and although kelp and other macroalgae play a substantial role abundance and distribution of these species, the kelp and microalgae are only one of many factors that affect the distribution of these nearshore fish species. Recent estimates suggest that kelp forest habitat supports between 6 and 15 times the density of fish compared to a similar area of soft substrate (Bond et al. 1999). The complexity and type of structure (rock) play an important factor in the variation and density of rocky reef fish. The greater the complexity of the reef structure, the larger the surface area for encrusting invertebrates and attached algae; hence, the availability of food for associated fish species. In turn, the complexity and type of structure provide shelter for smaller fish and invertebrates, to protect them from higher-level predatory fish, increasing species diversity. Kelp bed and rocky reef fish overlap considerably with coastal pelagic, surf zone, and some deep rock habitat species. Because of the seasonal and diurnal nature of many fish species, the rocky reef/kelp forest habitats have a high-diversity of fish, invertebrate, and algal species. The most common rocky reef/kelp forest species are listed in Table 3.8-5.

Table 3.8-5: Common Reef Fish Species Not Including Coastal Pelagic or Surf Zone Species Previously Listed

Scientific Name	Common Name	Scientific Name	Common Name
Chromis punctipinnis	Blacksmith	*Medialuna californiensis*	Halfmoon
Brachyistius frenatus	Kelp surfperch	*Sebastes atrovirens*	Kelp rockfish
Oxyjulis californica	Senorita	*Rhacochilus toxotes*	Rubberlip surfperch
Xenistius californiensis	Salema	*Sebastes serriceps*	Treefish
Gymnothorax mordax	California moray	*Anisotremus davidsonnii*	Sargo
Pleuronichthys coenosus	CO turbot	*Heterodontus francisci*	California hornshark
Hypsypops rubicundus	Garabaldi	*Semicossyphus pulcher*	California sheephead
Paralabrax clathratus	Kelp bass	*Halichoeres semicinctus*	Rock wrasse
Stereolepis gigas	Giant black seabass	*Atractoscion nobilis*	White seabass
Caulolatilus princeps	Ocean whitefish	*Damalichthys vacca*	Pile perch
Embiotoca jacksoni	Black surfperch	*Hypsurus caryi*	Rainbow perch
Scorpaena guttata	California scopionfish	*Coryphopterus nicholsii*	Blackeye goby
Cephaloscyllium ventriosum	Swell shark	*Paralabrax nebulifer*	Barred sand bass
Cheilotrema saturnum	Black croaker		

Source: Pondella et al. 2006

The ROI is typical of much of the California coastline, encompassing a primarily soft sand bottom interspersed with variable hard substrate in conjunction with one of the few large bay and estuarine systems, San Diego Bay. Factors affecting the nearshore habitat and associated fish species include wave action, sediment transport, and influences from freshwater systems.

The Tijuana River, located just south of the action area, and San Diego Bay are substantial contributors of sediment, fresh water, and nutrients, and are major contributors in shaping the subtidal community dynamics of nearshore Silver Strand. Biological communities associated with the hard bottom substrate within the study area fluctuate in presence and density both seasonally and spatially due to the areas' exposure, depth, and proximity to sediment and freshwater sources.

Few studies have concentrated on evaluating the density and diversity of fish species of nearshore soft bottom habitat in contrast to investigations of kelp forests. In order to enumerate the abundance of fish within the ocean portions of the ROI, California Department of Fish and Game catch block data was analyzed for the years 2002-2005. Portions of catch blocks 860, 877, and 878 incorporate a portion of the ROI and thus were included in the analysis. Catch in pounds-per-year for all gear types and methods for the five most abundant targeted fish species and fish species likely to occur at least within a portion of the ROI are presented in Table 3.8-6. The most abundant species in terms of pounds caught were tuna (all species), white seabass, California sheephead, California halibut, swordfish (*Xiphias gladius*), and shark (all species), respectively. Use of these data in relationship to the ROI should take into consideration the fact that substantial portions of the catch blocks occur outside the ROI; and a majority of these fish species are captured using gill nets, which are restricted to beyond three miles of the mainland coast, also placing them well outside of the ROI. Additional species encompassed in the catch block data include several species known to occur within San Diego Bay during some life stage, as well as fish known to utilize nearshore surf zone areas for opportunistic foraging and/or spawning.

Table 3.8-6: Catch Data for the Five Most Abundant Fish Species and Fish Species Likely to Occur Within the ROI for the Years 2002-2005

Common Name	Gear Type	Total Pounds (2002-2005)
Tuna – all	All	94,925
Seabass – white	All	78,530
Sheephead - California	All	71,132
Halibut - California	All	46,064
Swordfish	All	39,843
Shark – all	All	35,590
Barracuda - California	All	17,233
Rockfish – all	All	14,745
Sardine - Pacific	All	4,741
Scorpionfish	All	4,696

Species listed in the catch block data are associated with hard bottom habitat such as California sheephead, scorpion fish (*Scorpaena guttata*), rockfish (all species), cabezon (*Scorpaenichthys marmoratus*), and lingcod (*Ophiodon elongatus*); these species only transit or forage within the ocean portions of the ROI on a limited basis, considering the proximity of primary hard bottom habitat to the north at Point Loma and south at Imperial Beach. Pelagic species including California barracuda, Pacific mackerel, Pacific sardines (*Sardinops sagax caerulea*), and Pacific bonita use the nearshore portion of the ROI to varying degrees depending on oceanographic conditions that affect primary production and food availability. Pelagic species use the upper portion of the water column and are considered seasonal migrants, not documented to inhabit surf zone areas for substantial time periods.

Considering the habitat contained with the coastal nearshore portions of the ROI the most likely species to frequent the surf zone areas shallower than 20 feet MLLW are perch, croaker, California grunion, topsmelt, YOY white seabass, and California halibut. All of these are well adapted to the physical rigors of the surf zone habitat and take advantage of suspended material for foraging. Love et al (1986) documented that queenfish (*Seriphus politus*), white croaker (*Genyonemus lineatus*), and northern anchovy had the greatest index of community importance for soft bottom habitat at 6 meters depth for three southern California beaches. California grunions are known to spawn on nearby Imperial Beach (United States Army Corps of Engineers 1995) and the Coronado Strand. California grunion spawn at night as the highest tides recede; after approximately two weeks the recently hatched fish larvae are swept out to sea during high tides. California grunion use the upper intertidal habitat of beaches for spawning from late February to early September; Grunion activity is expected to be concentrated from late March to early June.

3.8.1.3 Ichthyoplankton

Planktonic fish larvae are an important and distinctive mode of life considered a separate category of plankton called ichthyoplankton; they have been studied extensively in south San Diego Bay (Department of the Navy [DoN]/San Diego Unified Port District [SDUPD] 2000). It appears that ichthyoplankton species composition and abundance differ substantially from juvenile/adult fish composition and abundance of south San Diego Bay. This means the value of south San Diego Bay for juvenile and adult fish is different from its value for fish eggs and larvae—when data from Allen (1998) are compared with plankton data from south San Diego Bay. Studies cited in DoN/SDUPD 2000 describe a seasonal study in which conical net tows were taken at eight, south San Diego Bay stations every two to four weeks over a one-year period (1972–1973). The primary purposes of this research were to describe and evaluate the species composition and seasonal dynamics of larval fish in the area, and to assess possible effects from the South Bay Power Plant. Researchers identified the eggs and larvae of 18 species of fish from the study area, and found that the eggs of two species—the deepbody anchovy and the diamond turbot—accounted for over 97 percent of the planktonic eggs collected; however, juvenile and adults of these species were not common in fish catches (Allen 1998). One taxonomic group consisting of the larvae of arrow, cheekspot, and shadow gobies, accounted for over 87 percent of the fish larvae sampled during the one-year period. Atherinid larvae, consisting of the topsmelt and jacksmelt (*Atherinopsis californiensis*), accounted for 8.5 percent, while the remaining 4.5 percent included representatives of ten other species or higher taxa. Several of these species exhibited seasonal patterns of occurrence, and it was concluded that the ichthyoplankton assemblage of south San Diego Bay contained fewer species than occur in coastal waters along the Pacific coast of the United States.

3.8.1.4 Commercial and Recreational Fisheries

Fish in San Diego Bay taken by commercial or recreational fishing are listed in Table 3.8-7. Those species that support a commercial fishery are indicated with an asterisk. Commercial fishing no longer occurs in San Diego Bay: the last commercial fishery, for striped mullet (*Mugil cephalus*) in south San Diego Bay, ended in 1998. However, seven species inhabiting San Diego Bay support commercial fisheries elsewhere in southern California waters. The most important of these is the California halibut, The northern anchovy is taken commercially for use as live bait. In addition, the Pacific sardine is taken as part of this catch. Fish caught for live bait are brought and held in bait receivers located in north San Diego Bay, where they are sold to commercial and recreational fisherman. A much larger group of species are caught within the San Diego Bay by recreational fisherman and by those who fish for subsistence. At least 58 species are involved in the recreational catch.

3.8.1.5 Pacific Coast Groundfish Fishery Management Plan

The Pacific Coast Groundfish Fisheries Management Plan (FMP) manages 89 species over a large and ecologically diverse area (Pacific Fisheries Management Council [PFMC] 2004). These species occupy diverse habitats at all stages of their life histories—such as rockfish that have pelagic (open water) eggs and larvae. In contrast, some species may have a discrete or narrow Essential Fish Habitat (EFH, Section 3.7.1.3.2), such as adult rockfish showing strong affinities for specific locations/habitats. In addition, the FMP identifies seven composite EFHs including estuarine, rocky shelf, non-rocky shelf, canyon, continental slope/basin, neritic zone, and oceanic zone. The FMP also identifies both fishing-related and non-fishing-related activities that may cause adverse impacts to EFH. For example, non-fishing-related activities that potentially affect groundfish EFH include dredging, fill, excavation, mining, impoundment, discharge, water diversions, thermal actions, activities that contribute to non-point source pollution and sedimentation, and the introduction of potentially hazardous material (PFMC 2004).

Detailed life history information about federally protected fish in the groundfish management plan is available as an appendix to Amendment 19 of the Pacific Coast Groundfish FMP (PFMC 2005). These data are culled from fishing records where available, and from scientific literature about the species' preferences for certain latitudes, substrates, and depths. Based on this information, species for which the habitat in the ROI is at least 40 percent suitable for at least one life stage of the fish are listed in Table 3.8-8. Fish are also listed if previously identified in San Diego Bay (Merkel & Associates 2000; Allen 1999; Hoffman 1995). These fish are expected to occur in the ROI because of the highly suitable nature of the habitat for one or more stages of their life cycle. Habitat Suitability Probabilities for all fish in the Groundfish FMP are available in Appendix B to Amendment 19 of the FMP.

Table 3.8-7: Fish Species of San Diego Bay Taken by Recreational and Commercial Fishermen

Scientific Name	Common Name	Scientific Name	Common Name
Osteichthyes	bony fish	*Pleuronichthys ritteri*	spotted turbot
Atherinops affinis	Topsmelt	*Pleuronichthys verticalis*	hornyhead turbot
Atherinopsis californiensis	Jacksmelt	*Cheilotrema saturnum*	black croaker
Leuresthes tenuis	California grunion	*Atractoscion nobilis**	white seabass
Hippoglossina stomata	bigmouth sole	*Genyonemus lineatus*	white croaker
Xysteurys liolepis	fantail sole	*Menticurrhus undulates*	California corbina
Caranx caballus	green jack	*Roncador stearnsii*	spotfin croaker
Caranx hippos	crevalle jack	*Seriphus politus*	queenfish
Trachurus symmetricus	jack mackerel	*Umbrina roncador*	yellowfin croaker
Chanos chanos	milkfish	*Sarda chiliensis*	Pacific bonito
Clupea harengus pallasii	Pacific herring	*Scomber japonicas*	Pacific mackerel
*Sardinops sagax caeruleus**	Pacific sardine	*Scomberomorus sierra*	sierra
Scorpaena guttata	sculpin	*Medialuna californiensis*	halfmoon
Scorpaenichthys marmoratus	cabezon	*Morone saxatilis*	striped bass
Amphistichus argenteus	barred surfperch	*Paralabrax clathratus**	kelp bass
Cymatogaster aggregata	shiner surfperch	*Paralabrax maculatofasciatus*	spotted sand bass
Damalichthys vacca	pile surfperch	*Paralabrax nebulifer*	barred sand bass
Embiotoca jacksoni	black surfperch	*Sphyraena argentea*	California barracuda
Hyperprosopon argenteum	walleye surfperch	*Albula vulpes*	bonefish
Micrometrus minimus	dwarf surfperch	*Cynoscion parvipinnis*	shortfin corvine
Phanerodon furcatus	white surfperch	Chondrichthyes	sharks and rays
Rhacochilus toxotes	rubberlip surfperch	*Carcharhinus remotus*	narrowtooth shark
*Engraulis mordax**	northern anchovy	*Galeorhinus zyopterus*	soupfin shark
Girella nigricans	opaleye	*Mustelus californicus*	gray smoothhound
*Mugil cephalus**	striped mullet	*Mustelus henlei*	brown smoothhound
Hypsopsetta guttulata	diamond turbot	*Mustelus lunulatus*	sicklefin smoothhound
*Paralichthys californicus**	California halibut	*Prionace glauca*	blue shark
Platichthys stellatus	starry flounder	*Triakis semifasciata*	leopard shark
*Parophrys vetulus**	English sole	*Sphyma zygaena*	smooth hammerhead shark
Pleuronichthys coenosus	CO turbot	*Squalus acanthias*	spiny dogfish

Note: Asterisks indicate species of commercial importance in southern California waters

As well as designating EFH, the PFMC designates Habitat Areas of Particular Concern (HAPC). These are ecologically important, rare, or sensitive habitats that should be given special attention when evaluating the effects of non-fishing impacts. San Diego Bay meets two criteria for an HAPC: as an estuary and as an eelgrass habitat (3.7.1.3.2 Marine Plants and Invertebrate Community Overview).

The FMP for Coastal Pelagic Species (CPS) includes five species—four finfish and one invertebrate—including northern anchovy, jack mackerel (*Trachurus symmetricus*), Pacific sardine, Pacific (chub) mackerel (*Scomber japonicus*), and market squid (*Loligo opalescens*) (PFMC 1998). All but the market squid could be expected in the ROI. The remaining species have wide distributions throughout California, as well as in international waters outside of the U.S. Exclusive Economic Zone, and are taken directly or indirectly with a variety of fishing gear. Gear used to commercially harvest CPS by directed fishing methods include round-haul nets such as purse seines, drum seines, lampara nets, and dip nets (PFMC 1998). CPS can also be taken incidentally in midwater trawls, pelagic trawls, gill nets, trammel nets, trolls, pots, and hook-and-line techniques. Non-fishing-related activities that have the potential to harm groundfish species could also have the same effect on these pelagic species.

Table 3.8-8: Fish that Are Included in the Pacific Groundfish Fishery Management Plan that Could Be Expected to Appear in the Region of Interest

Scientific Name	Common Name
Triakis semifasciata	leopard shark
Raja binoculata	big skate
Raja inornata	California skate
Raja rhina	longnose skate
Ophiodon elongates	lingcod
Sebastes chrysomelas	black and yellow rockfish
Sebastes mystinus	blue rockfish
Sebastes paucispinis	bocaccio
Sebastes dallii	calico rockfish
Sebastes goodei	chilipepper
Sebastes carnatus	gopher rockfish
Sebastes rastrelliger	grass rockfish
Sebastes chlorostictus	greenspotted rockfish
Sebastes umbrosus	honeycomb rockfish
Sebastes atrovirens	kelp rockfish
Sebastes diploproa	splitnose rockfish
Sebastes saxicola	stripetail rockfish
Sebastes serriceps	treefish
Pleuronichthys decurrens	curlfin sole
Citharichthys sordidus	Pacific sanddab
Scorpaena guttata	California scorpionfish
Parophrys vetulus	English sole

3.8.1.6 Threatened and Endangered Species

No federally threatened or endangered fish are documented to utilize the waters of the ROI during any portion of their life cycle.

3.8.1.7 Current Management through Monitoring and Enhancement

All species groups are monitored through the San Diego Bay INRMP, including baseline inventory and regular monitoring. INRMPs are developed jointly by the Navy and fish and wildlife agencies such as the CDFG, USFWS, and other resource agencies as appropriate. Mutual agreement from these agencies is sought for the fish and wildlife component of natural resources management identified in the INRMP, and an annual review with the agencies discussing Navy-wide natural resources is mandatory. Terrestrial and marine aspects of natural resources management are addressed in the NBC INRMP. Marine aspects are also addressed in the San Diego Bay INRMP. INRMPs help installation commanders manage their natural resources in a manner that is consistent with sustainability of those resources and to ensure continued support of the military mission.

A portion of the fish species are also intermittently evaluated through the project site approval process. The most recent comprehensive San Diego Bay survey effort was in April and July 2005 (Pondella et al. 2006). Surveys identify and quantify San Diego Bay's utilization of fishery populations, identify habitats that support juvenile fish, and determine areas of San Diego Bay that support important populations of forage fish species. The INRMP and surveys are funded jointly by the U.S. Navy and the Port of San Diego.

The Navy is also in the process studying EFH throughout the San Diego Bay. As discussed in Section 3.7.1.3.2, this study will facilitate the valuation of EFH with special focus on the habitat types most likely to be impacted by Navy activities or be used to mitigate for potential Navy project impacts.

3.8.1.8 Current Mitigation Measures

No current mitigation measures are in place that address fish species specifically. Habitat mitigation for intertidal and subtidal areas (Section 3.7.1.5), including eelgrass, provide a degree of mitigation for fish species documented to reside within those habitats.

3.8.2 Environmental Consequences

This section presents the analysis of potential impacts to fish as a result of implementation of the project alternatives, including the No Action Alternative. The analysis of effects on fish concerns direct physical injury—the potential for death, injury, or reduced productivity due to disturbance. Two EFHs are located within the ROI: (1) Eelgrass EFH, and (2) Groundfish EFH. Groundfish EFH encompasses estuarine, rocky shelf, non-rocky shelf, canyon, and oceanic zone within the ROI. Alternatives 1 and 2, increase training tempo from baseline conditions, introduce new platforms and equipment into training, and decrease access restrictions and encumbrances on training. Implementation of any alternative other than the No Action Alternative will result in an increase in the number of training activities that are conducted in the ROI. Alternative 2 is identical to Alternative 1, except that the Navy would utilize all 7,000 yards of ocean beaches along SSTC-N and SSTC-S, and all bayside training beaches—except the Delta North and South California least tern nesting habitat (i.e., Alpha, Bravo, Charlie, Echo, Foxtrot, Golf, and Hotel) for continuous, year-round training. Activities analyzed in this section for all alternatives are 1-14, 16, 18, 20-30, 32-35, 37-42, 44-46, 49-53, 57, 66, 73, 77, and 78 and N1-N9 and N11 (Table 2-1 and 2-2). Marine vessel traffic in the SSTC—mainly support vessels for training activities—is analyzed for effect. Training activities in which interactions between personnel/craft and fish are anticipated to be rare—swimming, diving, or activities that utilize only non-motorized combat raiding rubber crafts (CRRCs) (Activities 54, 55, 56, 60, 64, 67, 69-71, and 73, Table 2-1)—are excluded from individual analysis as potential impacts from interactions would be minimal to non-existent. Training activities that occur exclusively on the land portion of SSTC are excluded from this analysis as they are not expected to impact fish that may be present adjacent to the SSTC beach or bayside training areas. (Activities 15, 17, 19, 31, 36, 43, 47, 48, 58, 59, 61-63, 65, 68, 72, and 74-76; and N10, Table 2-1 and 2-2). The U.S. Navy has conducted an EFH assessment to establish all potential EFH impacts and has consulted with the NMFS regarding potential effects to EFH. Results of potential impacts to EFHs are addressed in 3.7.5.

3.8.2.1 Approach to Analysis

To assess the impact of training activities on fishery resources in the ROI, training activities were divided into constituent activities that have potential to impact the environment. These activities occur in a defined manner and space; therefore their effect on the environment can be assessed. A literature review on potential effects common to most activities is presented and includes shock waves, acoustic effects (noise), disturbance, and habitat modification.

Effects on fish, and the distances at which behavioral effects can occur, depend on the nature of the disturbance, the sensitivity of the fish, and species-specific behavioral responses. Changes in fish behavior can reduce their catch ability. The following methods were used to assess potential effects on fish: Received stimuli that correspond to the various types of effects on fish; and effects to fish including physical damage to fish, short-term behavioral reactions, long-term behavioral reactions, and changes in distribution.

The relative abundance of fish species present within the effect area was estimated. Whether there was an effect within each effect area was then determined. If there was an effect, it was described in terms of relative numbers affected versus total relative population on the range. The no effect determination included cases where there were no effects on fish; or there were inconsequential changes in their behavior.

Whereas baseline conditions describe the relative abundance of fish as estimated from density or fisheries data, estimates of the absolute abundance of fish for the nearshore coastal areas of interest are not available. There are few available estimates of abundance for the shallow areas of SSTC-N and SSTC-S. Thus, effects on fish in the nearshore coastal area are expressed in relative terms.

There are two types of sound sources that are of concern to fish and fisheries. 1) Strong underwater shock pulses that can cause physical damage to fish. 2) Underwater sounds that could cause disturbance to fish and affect their biology or catch ability by fishermen. Both types of sound can cause changes in fish distribution and/or behavior. This assessment focuses on these potential effects on fish.

Disturbance of fish and/or modification of fish habitat from activities are evaluated based on the area the individual action encompasses, and the value and type of habitat known to occur within the specific area. The activity descriptions provided below (Sections 3.8.2.2 and 3.8.2.3) define the general location and manner in which the activity occurs, which can then determine how resources are affected that are not evenly distributed across the environment.

The data obtained on effects of sound and shock waves on fish are very limited—in terms of number of well-controlled studies and in number of species tested. There are limits in the range of data available for any particular type of sound source. Additionally, available data focused on fish habitat modification or disturbances related to behavioral changes in fish movement or activity from aircraft and marine vessels are limited or absent. Considering the sources of shockwaves, sound, and habitat modification associated with the activities described in Chapter 2, effects pertaining to fish are grouped by action in the following alternatives analysis.

3.8.2.1.1 Effects of Shock Waves

Underwater explosions can affect fishes in two basic ways: they can be physically injured and killed or their behavior could be altered in a manner that reduces their survival. This section discusses underwater detonations and the metrics used to describe them, and summarizes information on the susceptibility of fishes to these detonations.

An underwater detonation produces a pressure wave that radiates quickly from the detonation site. The strength of this wave depends on the type and amount of explosive, the location of the detonation in the water column (near the bottom versus near the surface), distance from the detonation site (the strength of the pressure wave dissipates with distance), and the location of the fish in the water column. The typical pressure wave from an explosion consists of an instantaneous increase to the peak pressure, followed by a slower (but still very rapid) logarithmic decrease to ambient pressure (SAIC 2000). The pressure wave can be displayed as a waveform that describes the pressure-time history, where time is measured in seconds, while pressure is measured in micropascals (μPa).

The principal mechanism by which pressure waves from blasts cause physical injuries to organisms is through oscillations in body tissues. Most blast injuries in marine animals involve damage to air- or gas-containing organs (Yelverton 1981). For example, fish with swim bladders are vulnerable to the effects of explosives, while fish without swim bladders (flatfish, sharks, and rays) and invertebrates are much more resistant (Yelverton 1981, Young 1991). During exposure to shock waves, the swim bladder oscillates and may rupture, in turn causing hemorrhages in nearby organs. Fish that have thick-walled swim bladders that are close to the body wall and away from the kidneys are more resistant to blast injury than are fish with thin-walled swim bladders that touch the kidneys. Studies suggest that larger fish are generally less susceptible to death or injury than small fish at the same distance from the source (Yelverton et al. 1975); elongated forms that are round in cross-section are less at risk than deep-bodied forms; and orientation of fish relative to the shock wave may affect the extent of injury. Research has focused on the effects on the swim bladder from underwater detonations but not the ears of fish (Edds-Walton and Finneran 2006). The results of most studies are dependent upon specific biological, environmental, explosive, and data recording factors. One of the real problems with these studies is that they are highly variable and so extrapolation from one study to another, or to other sources, such as those used by the Navy, creates challenges.

Based upon currently available data it is possible to predict specific effects of Navy impulsive sources on fish. There are several results that are at least suggestive of potential effects that result in death or damage. First, there are data from impulsive sources such as pile driving and seismic airguns that indicate that any mortality declines with distance, presumably because of lower signal levels. Second, there is also evidence from studies of explosives (Yelverton et al. 1975) that smaller animals are more affected than larger animals. Finally, there is also some evidence that fish without an air bubble, such as flatfish and sharks and rays, are less likely to be affected by explosives and other sources than are fish with a swim bladder.

For underwater demolition training, the effects on fish from a given amount of explosive depend on location, season, and many other factors. O'Keeffe and Young (1984) provides charts that allow estimation of the potential effect on swim bladder fish using a damage prediction method developed by Goertner (1984). O'Keeffe's parameters include the size of the fish and its location relative to the explosive source, but are independent of environmental conditions (e.g., depth of fish, explosive shot, and frequency content). Richardson et al. (1995) and Yelverton (1981) have also developed a methodology for estimating impacts; however these methods are based on a deep-water scenario, while the sites used in the SSTC have water depths typically no greater than 70 ft (21m). For a given charge weight, injury distances are often greater in shallow water than in deep water, because the impulse pressure changes are increased by reflections off the seafloor. On the other hand, impulse magnitude is lower the closer the receptor is to the surface, and in shallow water fish tend to be closer to the surface than in deep water. Young (1991) developed a method for estimating fish injuries from blasts in shallow water that typically calculates somewhat greater injury distances than Yelverton's method, which simulate a deep-water scenario:

$$R = 95\ W_f^{-0.13}\ W_e^{-0.28}\ (DOB)^{0.22}$$

In this equation, R is the distance in feet from blast to fish, W_f is the weight of the fish in pounds, W_e is the weight of the explosive in pounds, and DOB is the depth of the blast in feet. The fish are assumed to be in "shallow" water. This equation calculates the 90 percent survival range, and some injury and mortality could occur at greater distances. Table 3.8-9 lists the estimated 90% survival distance using Young's 1991 method for a range of fish sizes, depths, and explosive charges.

Table 3.8-9: Estimated 90% Survival Distances (Feet) for a Range of Fish Weights, Charge Sizes, and Charge Depths*

Fish Weight (lbs)	Depth (ft)	Explosive Charge (Pounds)				
		3.5	5	10	20	29
0.1	20	352	389	472	573	636
	40	410	453	550	668	741
	60	448	495	601	730	810
0.5	20	285	315	383	465	516
	40	332	367	446	542	601
	60	363	402	488	592	657
1	20	261	288	350	425	471
	40	304	336	408	495	549
	60	332	367	446	541	600
5	20	212	234	284	345	382
	40	246	272	331	401	445
	60	269	298	361	439	487
10	20	193	214	259	315	349
	40	225	249	302	367	407
	60	246	272	330	401	445

*Based on Young 1991 and applies to fishes with swim bladders.

Underwater explosive testing was performed near SSTC-N at Naval Amphibious Base (NAB) in very shallow water (VSW) (15 feet) for similar conditions to the ROI (Naval Surface Warfare Center [NSWC]/Anteon Corp., Inc. 2005) to investigate the potential effect to marine mammals and turtles (discussed in Section 3.9.2.4.3). Pressure waves were measured at various radii for 2- and 15-pound explosions located on the bottom, mid-water, and on the surface. At NAB peak pressure (psi), values recorded for off-bottom charges were approximately 50 percent greater at both the mid and far range sensors than for the same sized charges placed on the bottom. For most of the test shots reported in the NSWC/Anteon Corp., Inc. (2005) testing the deepest gages showed the least pressure. This is contrary to typical detonations in the middle and upper part of the deeper water column that usually produce an increase in pressure and energy near the bottom at distance—because of combinations of direct and bottom-reflected pressure waves and refraction. In the very shallow water environment, the bottom slopes away moving into deeper water. Bottom or near bottom detonations may create a shadow zone along the bottom at distance—because of the general linear property of ray-paths. Given the non-linear degradation of impulse waves through sea water and the variability of bottom substrate and depth of the explosions, it is difficult to estimate the distance of no effect for all the possible ranges of detonations.

An effects distance can be determined for fish of similar size to species known to occur within the ROI by integrating impulse and peak pressure results from the underwater explosive testing performed by NSWC/Anteon Corp., Inc. (2005)—with effects criteria derived from Yelverton's (1981) empirical equation (Table 3.8-9). Goertner (1994) performed tests on fish with and without swim bladders: hogchokers (*Trinectes maculatus*) and summer flounder (*Paralichthys dentatus*). In the fish without swim bladders, the report shows that hogchokers, exposed to 10-pound underwater detonations at 30 feet, all sustained critical injury—severe hemorrhaging throughout body cavity, and/or gross kidney damage—or death. If it is assumed that the type of underwater detonation utilized in the Goertner study was similar to those tested in the NSWC/Anteon Corp., Inc. (2005) investigation, a peak pressure of approximately 1,000 psi can be estimated at the 30 feet distance for a 10-pound underwater detonation. With the severity of the injuries to fish exposed to 1,000 psi peak pressure without swim bladders, it can be assumed that at least 50 percent mortality would result. Summer flounder—fish without swim bladders—were also tested in the Goertner study; they sustained no injuries from the same 10-pound underwater detonations at distances as close as 6 feet. In contrast, Goertner (1994) reported results from a similar study performed on fish with swim bladders and determined that fish with swim bladders were susceptible to impulse effects 100 times greater than fish without swim bladders. Effects to fish from underwater detonations are dependent on species, weight, and impulse level.

3.8.2.1.2 Acoustic Effects of Underwater Sounds to Fish

Sensitivity of Fish to Acoustic Energy

Fish have a variety of different sensory systems that enable them to gather information from the world around them (volumes by Atema et al. 1988 and by Collin and Marshall 2003 for thorough reviews of fish sensory systems). While each of the sensory systems may have some overlap in providing a fish with information about a particular stimulus, such as when an animal might see and hear a predator, different sensory systems may be most appropriate to serve an animal in a particular situation. Thus, vision is often most useful when a fish is close to the source of the signal in daylight, and when the water is clear. However, vision does not work well at night, or in deep waters. Fish can use chemical signals to indicate danger. However, chemical signals travel slowly in water: diffusion of the chemicals depends upon currents; further, chemical signals are not directional and may diffuse quickly to a non-detectable level. As a consequence, chemical signals may not be effective over long distances.

In contrast, an acoustic signal in water travels very rapidly, it travels great distances without substantially attenuating (declining in level) in open water, and its travel is highly directional. Thus, acoustic signals provide the potential for two distant animals to communicate quickly (reviewed in Zelick et al. 1999; Popper et al. 2003).

Since sound is a good way to gather information and communicate, fish have evolved two sensory systems to detect acoustic signals (Zelick et al. 1999 for review). The two systems are the ear, for detection of sound above 20 hertz (Hz) to 1 kilohertz (kHz) or more, and the lateral line for detection of hydrodynamic signals (water motion) from less than 1 Hz to 100 or 200 Hz. The inner ear in fish functions very much like the ear found in all other vertebrates, including mammals. The lateral line, in contrast, is only found in fish and a few amphibian (frogs) species. It consists of a series of receptors along the body of the fish. Together, the ear and lateral line are often referred to as the octavolateralis system.

Sound in Water

The physical principles of sound in water are the same as sound in air (see Rogers and Cox 1988; Kalmijn 1988, Kalmijn1989). Any sound source produces both pressure waves and actual motion of the medium particles. However, whereas in air the actual particle motion attenuates very rapidly and is often inconsequential even a few centimeters from a sound source, particle motion travels (propagates) much further in water due to the greater density of water than air. In the literature on fish hearing, the terms "acoustic near field" and the "acoustic far field" can be found, with the former referring to the particle motion component of the sound and the latter the pressure. There is often the misconception that the near field component is only present close to the source. However, all propagating sound in water has both pressure and particle motion components; but after some distance, often defined as the point at a distance of wavelength of the sound divided by 2 pi ($\lambda/2\pi$), the pressure component of the signal dominates, though particle motion is still present and potentially important for fish (e.g., Rogers and Cox 1988, Kalmijn 1988, Kalmijn 1989). For a 500 Hz signal, this point is about 0.5 m from the source.

The critical point to note is that fish detect both pressure and particle motion, whereas terrestrial vertebrates only detect pressure. Fish directly detect particle motion using the inner ear. However, pressure signals are initially detected by the gas-filled swim bladder or other bubble of air in the body. The air bubble then vibrates and serves as a small sound source which reradiates or resends the signal to the inner ear as a near field particle motion. The ear can only detect particle motion directly, and it needs the air bubble to produce particle motion from the pressure component of the signal.

If a fish is able to only detect particle motion, it is most sensitive to sounds when the source is nearby, due to the substantial attenuation of the particle motion signal as it propagates away from the sound source. As the signal level gets lower and further from the source, the signal ultimately goes below the minimum level detectable by the ear, the threshold. Fish that detect both particle motion and pressure are more sensitive to sound than are fish that only detect particle motion: the pressure component of the signal attenuates much less over distance than does the particle motion; although, both particle motion and pressure are always present in the signal as it propagates from the source.

One critical difference between particle motion and pressure is that fish pressure signals are not directional. Thus, for fish pressure does not appear to come from any direction (Popper et al. 2003, Fay 2005). In contrast, particle motion is highly directional and is detectable by the ear. Accordingly, fish appear to use the particle motion component of a sound field to gather information about sound source direction. This makes particle motion an extremely important signal to fish.

As both pressure and particle motion are important to fish, it becomes critical that in design of experiments to test the effects of sound on fish and fish hearing, the signal must be understood not only in pressure levels, but also in its particle motion component. This has not been done in most experiments on effects of human-generated sound to date, with the exception of one study on effects of seismic airguns on fish (Popper et al. 2005).

What do Fish Hear?

Based on current knowledge, all fish are able to perceive lower frequency sounds, from below 50 Hz to 1,500 Hz, whereas some fish have developed accessory hearing structures enabling them to detect higher frequencies over 3,000 Hz (Fay 1988; Ramcharitar and Popper 2004). A select few are able to detect sounds over 120 kHz (Mann et al. 2001). Broadly, fish can be categorized as hearing specialists or hearing generalists (Scholik and Yan 2002).

Fish in the hearing specialist category, such as carp, catfish, and mormyrids, have a broad hearing frequency range with a low auditory threshold due to a mechanical connection between an air-filled cavity, such as a swim bladder, and the inner ear. Specialists detect both the particle motion and pressure components of sound and can hear at levels well above 1,000 Hz, whereas generalists are limited to detection of the particle motion component of low-frequency sounds at high sound intensities (Amoser and Ladich 2005). The best hearing sensitivity of many hearing generalists is at or around 300 Hz (Popper 2003).

Hearing specializations are most often found in freshwater species, while in marine species specializations are quite rare (Amoser and Ladich 2005). It can be argued that the evolution of hearing specializations was facilitated by low ambient noise levels found in lakes, slowly flowing waters, and the deep sea (Amoser and Ladich 2005; Ladich and Bass 2003; Popper 1980). This evolution most likely came about due to the essential need to detect abiotic noise, avoid approaching predators and detect prey, and to a much lesser degree, communicate acoustically (Amoser and Ladich 2005; Fay and Popper 2000).

If the sound is loud enough and within the range of frequencies a fish can hear, a sound will be detected by a fish at some distance from the source. Because of the variable hearing thresholds summarized above, this distance varies among species. Theoretically, a yellowfin tuna (*Thunnus albacores*) would need to be much closer than an Atlantic cod (*Gadus morhua*) to hear a low-frequency sound at a given energy level.

Studies in reference to effects on hearing have been of two types. In one set of studies, the investigators exposed fish to long-term increases in background noise to determine if there are changes in hearing, growth, or survival of the fish (Wysocki and Ladich 2005). While data are limited to a few freshwater species, it appears that some increase in ambient noise level, even to above 170 dB re 1 µPa does not permanently alter the hearing ability of the hearing generalist species studied, even if the increase in sound level is for an extended period of time. However, this may not be the case for all hearing generalists, though it is likely that any temporary hearing loss in such species would be considerably less than for specialists receiving the same noise exposure.

There is a small group of studies that discusses effects of high intensity sound on fish, where fish were exposed to short duration but high intensity signals, such as might be found near underwater detonations, pile driving, or seismic air gun surveys. The investigators in such studies were examining whether there was not only hearing loss and other long-term effects, but also short-term effects that could result in death to the exposed fish. However, as discussed in Hastings and Popper (2005), much of this literature has not been peer reviewed, and there are substantial issues with regard to the actual effects of high intensity sounds on fish. Popper et al. (2005) examined the effects of exposure to a seismic air gun array on three species of fish found in the Mackenzie River Delta near Inuvik, Northwest Territories, Canada. The species included a hearing specialist, the lake chub (*Couesius plumbeus*), and two hearing generalists, the northern pike (*Esox lucius*), and the broad whitefish (*Coregonus nasus*) (a salmonid). In this study, fish in cages were exposed to 5 or 20 shots from a 730 cubic inch calibrated air gun array. Received Exposure Levels (RL) were determined for root-mean-square (RMS) sound pressure level, peak sound levels and SELs (e.g., average mean peak SPL 207 dB re 1 µPa RL; mean RMS sound level 197 dB re 1 µPa RL; mean SEL 177 dB re 1 µPa^{2}s).

The results showed a temporary hearing loss for both lake chub and northern pike, but not for the broad whitefish, to both 5 and 20 air gun shots. Hearing loss was on the order of 20 to 25 dB at some frequencies for both the northern pike and lake chub, and full recovery of hearing took place within 18 hours after sound exposure. While a full pathological study was not conducted, fish of all three species survived the sound exposure and were alive more than 24 hours after exposure. Those fish of all three species had intact swim bladders and there was no apparent external or internal damage to other body tissues (e.g., no bleeding or grossly damaged tissues), although it is important to note that the observer in this case was not a trained pathologist. Recent examination of the ear tissues by an expert pathologist showed no damage to sensory hair cells in any of the fish exposed to sound (Song et al. submitted).

A critical result of this study was that it demonstrated differences in the effects of air guns on the hearing thresholds of different species. In effect, these results substantiate the argument made by Hastings et al. (1996) and McCauley et al. (2003) that it is difficult to extrapolate between species with regard to the effects of intense sounds.

There have been a number of studies that suggest that the sounds from pile driving, and particularly from driving of larger piles, kill fish that are very close to the source. The source levels in such cases often exceed 230 dB re 1 µPa (peak) and there is some evidence of tissue damage accompanying exposure (e.g., Caltrans 2001, 2004; reviewed in Hastings and Popper 2005). However, there is reason for concern in analysis of such data since in many cases the only dead fish observed were those that came to the surface. It is not clear whether fish that did not come to the surface survived the exposure to the sounds, or died and were carried away by currents. The Fisheries Hydroacoustic Working Group (2008) developed an interim criteria for injury to fish from pile driving activities. The criteria identify sound pressure levels of 206 dB peak and 187 dB accumulated sound pressure level (SEL) for all listed fish except those that are less than 2 grams. In that case, the accumulated SEL will be 183 dB.

In summary, the lethal and sublethal effects of noise on fish is variable among species and the source of noise, and considering the limited availability of pertinent literature and the absence of specific investigations on species known to occur within the ROI, use of sound levels (dB re 1 µPa RL) should be carefully utilized when accessing potential effects.

3.8.2.1.3 Disturbance- Behavioral Responses to Acoustic Energy

Underwater sounds have been used by fishermen to guide herring and other schooling fish to their nets (Yelverton 1981), or to exclude fish from water intakes (Haymes and Patrick 1986). The noises made by fishing boats can scare some target fish. Sudden changes in noise level can cause fish to dive or to avoid the sound by changing direction. Time of year, whether the fish have eaten, and the nature of the sound signal may all influence how fish will respond to it.

Short, sharp sounds can startle herring. In one study, the fish changed direction and moved away from the 80–92 Hz source, but schooling behavior was not affected (Blaxter et al. 1981). Schwarz and Greer (1984) studied the responses of penned herring to sounds. The experimental pen was 3.3 meters long on each side. The following responses were noted (Schwarz and Greer 1984):

- Avoidance - fish moved slowly away from the sound source.
- Alarm - the school packed, fled at high speed, dove repeatedly, and quickly changed directions.
- Startle - fish flexed their bodies powerfully and then swam at high speed without changing direction, or shuddered with each blast (the last noted by Pearson et al. 1992).

The low-frequency (<2 kHz) sounds of large vessels or accelerating small vessels usually caused an initial avoidance response among herring. The startle response was observed occasionally. Avoidance ended within 10 seconds of the “departure” of the vessel. After the initial response, 25 percent of the fish groups habituated to the sound of the large vessel and 75 percent of the responsive fish groups habituated to the sound of the small boat. Chapman and Hawkins (1969) also noted that fish adjust rapidly to high underwater sound levels.

Pearson et al. (1992) conducted a controlled experiment to determine effects of low-frequency (mostly <500 Hz), strong noise pulses on several species of rockfish off the California coast. They used an air gun with a source level of 223 dB re 1 µPa. They noted:

- Startle responses at received levels 200 to 205 dB re 1 µPa and above for two sensitive fish species (olive and black rockfish), but not for two other species exposed to levels up to 207 dB.
- Alarm responses at 177 to 180 dB for the two sensitive species, and at 186–199 dB for other species.
- An overall threshold for the above behavioral response at ~180 dB.
- An extrapolated threshold of approximately 161 dB for subtle changes in the behavior of rockfish that included reduced catch ability in a hook and line fishery (Skalski et al. 1992).
- A return to pre-exposure behavior types within the 20 to 60 minute exposure period.

Popper et al. (2005) exposed three freshwater fish species (northern pike, broad whitefish, and lake chub) to 20 air gun shots over 15 minutes at peak received levels >205 dB re 1 µPa. There were no apparent physical effects, and a temporary shift in hearing sensitivity (Temporary Threshold Shift, TTS) was found in only two of the species, with recovery within 24 hours of exposure.

Experiments conducted by Skalski et al. (1992), Dalen and Raknes (1985), Dalen and Knutsen (1986), and Engas et al. (1996) demonstrated that some fish were forced to the bottom and others driven from the area in response to low-frequency air gun noise. The authors speculated that catch per unit effort would return to normal quickly in their experimental area because behavior of the fish returned to normal minutes after the sounds ceased.

Aircraft overflights occur within the ROI on a daily basis and helicopter activities below 1,000 feet above ground level. Sound does not transmit well from air to water. The sound levels resulting from an HH-60 helicopter flying at 1,000 feet flying at 100 feet, and hovering at 10 feet were 110, 129, and 143 dB re 1 µPa, respectively, directly under the helicopter at a depth of 1 foot (USAF 1999). Sound levels decline at increasing lateral distances from the aircraft's track or location and with increasing depth in the water. The underwater sounds originating from the aircraft decline rapidly after the aircraft has passed. It is unlikely that these sound levels cause physical damage or even behavioral effects in fish, based on the sound levels that have been found to cause such effects. Effects of underwater noise attributed to aircraft overflights on fish would be minimal.

In summary, fish often react to sounds, especially continuous strong and/or intermittent sounds of low frequency (<1 kHz) at received levels of 160 dB re 1 µPa and higher. The Fisheries Hydroacoustic Working Group (2008) developed an interim criteria for behavioral disturbance to fish from pile driving activities, which listed the behavioral disturbance threshold at 150 dB RMS. Low-frequency pulses at levels of 180 dB may cause noticeable changes in behavior, such as an alarm response and lowered catch ability (Chapman and Hawkins 1969; Pearson et al. 1992; Skalski et al. 1992). These sounds are 80 to 100 dB over and above the fish's hearing threshold. It appears that fish often habituate to repeated strong sounds rather rapidly, on time scales of minutes to an hour or so. However, the habituation does not endure, and resumption of the disturbing activity may again elicit disturbance responses from the same fish. However, while behavior modification of fish from mechanically propelled vessels may occur, the level of disturbance is primarily categorized as avoidance (Schwarz and Greer 1984).

The Glacier Bay Underwater Noise – Interim Report investigated sources of underwater noise and sound levels of all types of ships and/or small craft transiting Glacier Bay, Alaska. The types of vessels categorized in the NSWC study were similar to those utilized for SSTC actions within the ROI. The study reported that only about one percent of noise samples collected contained marine vessel noise levels exceeding 120 dB and no vessel noise levels exceeded 130 dB at the hydrophone (NSWF, 2002). Expected noise levels of vessels used in the ROI would be less than those shown to provoke strong behavioral responses. Sound events resulting in avoidance behavior are not expected to have a long-term adverse impact on health or survival or a lasting disruption of behavioral patterns (such breeding, feeding, or sheltering) from such temporary and transitory sound events.

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 µPa-m and these high frequency sounds attenuate rapidly in seawater, which is below the behavioral threshold. 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. Additionally, 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 fish, 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, while pingers and recall devices are utilized under all alternatives, no impacts are expected from their use and will not be carried forward in this EIS analysis.

3.8.2.1.4 Habitat Modification

Natural disturbances are important agents of change in ecosystems. Various characteristics, such as spatial scale and time of disturbance, result in differential abilities of species (and ecosystems) to respond (Allen et al. 2006). In the context of activities taking place within the ROI and their potential to physically modify fish habitat both short and long term, the area of disturbance (i.e. habitat) is critical when evaluating effect. The partitioning and terminology used to define waters within the ROI are important in order to describe the region as well as the areas of potential effect within both the bayside and oceanside training areas. The oceanographic term nearshore describes a regional area from the land/sea interface to deeper waters over the continental shelf out to approximately 1,000 feet in depth. While the ROI encompasses both San Diego Bay and nearshore ocean waters the majority of potential effects from activities are focused on shallow areas described as intertidal areas, mudflats, or surf zone. In order to discuss interactions between these areas and activities the term surf zone will refer to the land/sea interface within the ocean training areas out to approximately -10 feet MLLW and mudflats, intertidal areas, or eelgrass will refer to areas within San Diego Bay from -10 feet MLLW to the high tide mark. Surf zone habitat is constantly changing to some degree based on longshore sand transport and wave action; the fish species residing there have adapted to habitat modification and take advantage of opportunities. In contrast, mudflats and eelgrass habitat within the San Diego Bay is in a somewhat steady state in comparison to the surf zone; several fish species occupy small home ranges and depend on the persistence of eelgrass to maintain their existence. Specific studies investigating bottom disturbance from watercraft operating near or landing on sandy beaches, intertidal areas, mudflats, or eelgrass are not available; thus, affects analyses can only be estimated in relative terms based on the size of the marine vessels accessing these areas and the duration of the activity.

Fish habitat in the near coastal marine environment is segregated based on depth, type, and complexity of the substrate fish associate with. Fish species associated with hard bottom/rocky reef areas have smaller home ranges and defined habitat criteria than species associated with soft bottom areas. Effects on fish with regard to habitat modification within soft bottom (sand) areas of southern California are not comprehensive and studies have primarily focused on habitat modification within kelp forests or rock reef areas. The majority of studies evaluated changes in macroalgae cover or density and the relationship to effects on fish densities and species diversity. Studies investigating habitat modification with regard to vessel anchoring or mooring have focused on coral reef environments. Thus, potential effects from SSTC activities within the nearshore coastal marine environment related to fish habitat modification will be centered on the type of interaction the activity has with the bottom substrate and the type and complexity of that substrate. Potential effects to fish assemblages will be based on the fish species common to that substrate and densities or relative abundances documented for that area.

3.8.2.2 No Action Alternative

The No Action Alternative would maintain the current level and types of training that occur in the ROI. Current mitigation measures would remain unchanged. This section focuses on only groups of activities that have the potential to result in an impact to specified fish species (As discussed previously, similar types of activities are grouped together to facilitate effects analysis). Types of activities that could affect fish include aircraft activities (related to sound propagation into the water column), marine vessel activities, underwater detonations, and amphibious activities. In addition, beach and inland activities have minimal or no potential for impact to fish in areas within the SSTC study area, as these areas are removed from aquatic habitats.

3.8.2.2.1 Air Activities

Air activities consist of Unmanned Aircraft System training, as well as, helicopter take offs, landings, and activity practice. Under the No Action Alternative, there are 10 activities that involve aircraft training. Many of the training activities utilize helicopters to transport and deploy equipment and individuals into the water, where personnel either swim to shore or perform activities in the water. While the majority of helicopter activities occur at distances too far above the water to influence fish communities, a proportion of activities occur in close proximity (less than 300 feet above ground level.) to the water's surface.

Helicopters deploy personnel and equipment in oceanside training lanes (Activities 4, 6, 7, 12, 16, 25, 26, 28, 29, 30, 35, 37, 64, Table 2-1). Helicopter activities would have the greatest impact when flying low and hovering at altitudes down to 100 feet. Noise modeling indicates that the predicted SEL at a depth of 1 foot resulting from the overflight of an HH-60 helicopter at 100 feet would be approximately 100 to 118 dB re 1 μPa (frequencies of 20 Hz and 5 kHz) with peak sound levels potentially reaching 129 dB re 1 μPa (USAF, 1999). Low elevation hovering during these activities would not have physical effects on fish under the surface of the water based on these sound levels and effects criteria. Effects criteria developed in the previous Section 3.8.2.1.2 suggest that some behavior modifications related to noise may occur but are unlikely, as underwater hearing ability of fish is not considered sensitive enough to detect the noise associated with helicopter overflights and hovering and behavioral studies have indicated that response thresholds are extremely high, greater than 180 dBA.

Any physical or behavioral effect, however infrequent, would be temporary and infrequent based on the variability of fish residing near the water's surface in SSTC-N and SSTC-S and the number of activities performed per year. Aircraft landings on shore within bayside training areas would have localized disturbance and habitat modification potentially affecting fish foraging within eelgrass habitat. Effects from San Diego Bay landings would be temporary and localized considering the dynamic nature of the intertidal habitat, the short duration the action takes place within the habitat, and the probability that fish would be present at the time of the action. Disturbance of fish from the noise, physical presence, or sea surface disturbance from aircraft within the ROI would be limited to fish utilizing the area immediately adjacent to the action and likely only within the uppermost section of the water column. Reduced foraging success or behavior modification attributed to air actions is not likely to occur according to findings previously presented. Any temporary effect to fish near the surface remains a low probability considering the temporal variability of both training actions and the potential for fish to be present near the sea surface within a specific training area.

3.8.2.2.2 Marine Vessel Activities

Marine vessel use in the ROI consists of non-mechanically propelled boats, propeller surface craft, and water jet driven craft. Non-mechanically propelled craft are used by trainees to navigate in San Diego Bay and ocean waters, as well as, for transportation to shore for training activities. Interactions between personnel/craft and fish, which are anticipated to be rare and innocuous, such as swimming or activities that utilize only non-motorized CRRCs, are excluded from individual activity analysis as potential impacts from interactions would be minimal to non-existent. 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). Potential effects from these activities on EFH are detailed in Section 3.7.2.2.

Propeller surface craft are used for a variety of purposes in the ROI. Propeller surface craft are used in entirely water-based activities, where trainees practice navigation, mock boat attacks, and boarding drills.

These craft are also used to transport people or equipment to shore for raids or activities, as safety support for swimmers during physical fitness training, and to transport marine mammals for training. Under the No Action Alternative, training activities involve propeller- and jet-driven surface craft of various size and speed. Activities occur in both San Diego Bay and oceanside training lanes and to varying degrees involve landing on beaches in both areas.

Effects on fish from marine vessels either mechanically driven or self-propelled operating within the ROI include physical impacts, sound, visual disturbance, and habitat modification. Because of the variable hearing thresholds among fish species the distance at which they are affected can vary. Sudden changes in noise level can cause fish to dive or to avoid the sound by changing direction. The density of the water column (water, temperature, turbidity), time of year, whether the fish have eaten, and the nature of the sound signal may all influence how fish respond to sound or movement (Schwarz and Green 1984). Marine vessels utilized during various training activities land on beaches and San Diego Bay shorelines that support fish assemblages. The modification of intertidal habitat depends on the size of the marine vessel, the frequency of the landings within the area, and whether the propulsion system creates scouring during the landing activity.

Effects on fish species from noise, physical interaction, or habitat modification attributed to small marine vessels (<40 feet) operating within the ROI would be minimal. Small mechanically driven vessels do not emit noise levels documented to cause substantive behavioral or physiological effects nor does the water intake associated with the engine utilize sufficient water to entrain adult fish or detrimental quantities of fish larvae or eggs. Behavior modification of fish species interacting with small marine vessels both mechanically driven and self-propelled would be minimal considering the low population densities of fish within the training areas, 0.81 individuals/m^2 for the South-Central portion of San Diego Bay (Allen 1999), compared to the regional setting (1.75 individuals/m^2 for all regions of San Diego Bay) and the temporal and spatial variability of fish species and individual activities. Reduced foraging success, disturbance from behavior modification, or habitat modification attributed to self-propelled or small mechanically driven vessel activities are not likely to occur, based on the effects criteria presented in Section 3.8.2.1 (Approach to Analysis) and the short duration and spatial extent of activities within sensitive intertidal habitat. Activities involving small marine vessel used in support of diving, swimming or training which do not come in contact with marine substrates (Activities 2, 3, 5 - 12, 14, 18, 21, 23, 26, 28, 34, 35, 57, 77, or 78, Table 2-1) are anticipated to have little to no effect on fish species present based on effects criteria discussed in Section 3.8.2.1 regarding noise effects, behavioral modifications, or physical injuries.

Effects on fish species from noise, physical interaction, or habitat modification attributed to large mechanically driven vessels operating over open water within the ROI would be minimal based on effects criteria in the approach to analysis. However, large mechanically driven craft operating under power during landing activities may have effects on fish when landing activities occur within the San Diego Bay over eelgrass beds. For instance, a Landing Craft Air Cushion (LCAC) is a large craft powered by four gas turbine engines that uses fans to hover above the water. Its footprint includes its physical structure plus the area surrounding it, which is affected by the strong wind it produces. An LCAC approaches the beach and comes ashore up near the crest of the beach. Hovercraft were recorded in the frequency ranges of 80 to 630 Hz with source level of up to approximately 110 dB re 1 μPa and 50 to 2,000 Hz with a source level up to 121 re 1 μPa (Richardson et al. 1995). Recordings of a Griffon 2000TD hovercraft passing a hydrophone at full power in Prudhoe Bay, Alaska indicated broadband (10-10,000 Hz) levels reaching 133 dB re 1 μPa (Blackwell and Greene 2005), with most spectral energy centered around 87 Hz. The noise associated with LCAC activities is below those associated with behavioral disturbance thresholds in fish, but still possesses the potential for localized disturbance effects to fish.

Other direct effects to fish species from LCACs are similar to other marine surface vessels, as described below, but are reduced due to the relative infrequency of the activity (four per year). Designed to land on beaches, LCAC training activities are concentrated at oceanside training areas of SSTC. Previous bathymetric and biological surveys performed within the nearshore waters off Imperial Beach describe a physically disturbed area that oscillates between ephemeral kelp bed and sand/cobble bottom. The habitat contained within the offshore training lanes where LCAC activities take place is dominated by sand/cobble bottom. LCACs hover above the water and produce a large surface disturbance. However, LCACs likely only have a direct effect on fish immediately below the LCAC or in extremely shallow water. LCAC activities have minimal effect to fish and their associated subtidal habitat.

Jets and propellers for other marine vessels operating continuously over a sustained time period may excavate fish burrows and alter foraging and behavior of resident fish species. Large boat landings, primarily Landing Craft, Utility and Landing Craft, Mechanized are constrained to landing (beaching) to SSTC-N and SSTC-S boat and beach lanes and Bravo within the bay training areas. Effects from crushing during large vessel landings may have localized effects, although it's probable that both excavation and crushing effects from large vessel landings would be localized and overall species assemblages unaffected considering the spatial extent of adjacent habitat and infrequent (less than 200 activity days/year within all defined landing areas) nature of the activities. Behavior modifications of fish species interacting with large mechanically driven vessels would be minimal considering the habits and movement patterns of the most abundant fish within the training areas (northern anchovies, slough anchovies and top smelt) compared to the regional setting and the temporal and spatial variability of the individual large ship activities. Reduced foraging success or behavior modification attributed to large mechanically driven vessel activities is not likely to occur based the lack of disturbance effects and the short duration and spatial extent of activities within the intertidal habitat. Marine vessel activities in the SSTC ROI do not physically disrupt behavior or migration patterns of fish species. Marine vessel activities in the SSTC ROI would not measurably alter the water or sediment quality from debris or discharge sufficient to impact EFH. Based on the extent, duration, and magnitude of potential impacts from SSTC marine vessel training activities, there be an adverse impact of eelgrass habitat in San Diego Bay. The Navy currently maintains a signed agreement with the Army Corps of Engineers and NOAA Fisheries (i.e., Banking Instrument; N00242-080624-X42-MOA; DoN 2008) to mitigate or compensate impacts to eelgrass habitat, and any impacts to eelgrass within the designated training lane within Bravo training area will be offset by the NEMS, as discussed in Section 3.7.1.5.

3.8.2.2.3 Underwater Detonations

Underwater detonations taking place under the No Action Alternative are detailed below (Table 3.8-10). Training activities involving their use are described in Chapter 2 (Activities 6, 7, 10, 11, 12, Table 2-1). Under the No Action Alternative, all detonations occur in the oceanside training lanes within designated boat lanes 1-14. Detonations occur in water depths ranging from 0 to 72 feet depending on the activity.

The effect to fish species within a ZOI from detonations can only be evaluated in general terms due to the diversity of species that may occur within lethal impulse distances and the unknown density and probability of each species occurring within the ROI. While fish assemblages, occurrences, and density is documented for the San Diego Bay (Allen 1999, Allen et al. 2006 and Pondella et al. 2006), and likely fish assemblages identified for the coastal surf and pelagic zones adjacent to SSTC (Allen et al. 2006), the exact densities of fish within the water column in the oceanside portion of the SSTC ROI is less well documented. Most fish are relatively mobile in their distribution over short time and space scales. Fish movement and occurrence is affected by a number of factors including, but not limited to, tidal conditions, long and short-term oceanographic variations, seasonal variations, species specific life history variations, etc.

The threshold for 1% mortality from an underwater detonation varies by fish species (Table 3.8-9). It is estimated to be at the point where impulse waves measure below 69 Pa·s (10 psi-ms) for gobies and 116 Pa·s (16.8 psi-ms) for Pacific sardines, the most impulse sensitive fish species within the ROI. Other species have impulse thresholds greater than 145 Pa-s (21.0 psi-ms).

Modeling was conducted to determine potential effects of underwater detonations on marine mammals (Section 3.9.2.4 for a detailed discussion of the modeling effort). The modeling calculated the zone of influence (ZOI) from each SSTC underwater detonation to the onset of severe lung injury in marine mammals, which is a received pressure of 13.0 psi-ms (Table 3.9-5). The maximum ZOI to the 13.0 psi-ms threshold for the largest charge (20 lbs mine countermeasure charge) is 360 yards. Combining the static nature of underwater detonations and the high mobility and variability of fish species within the nearshore coastal area of the ROI, the magnitude of the detonation would be the greatest factor affecting the area of potential effect.

Table 3.8-10: Underwater Explosive Activities Conducted during the No Action Alternative

Activity Number	Underwater Detonation	NEW[1] (lb)	Number of Detonations	Water Depth	Charge Depth	Tempo	Location
5	MCM[2]	10 to 20	1/ op	≤ 72	Mid-water	16 ops/yr	Boat Lanes 1 - 14
5	MCM	10 to 20	1/op	≤ 72	Bottom	16 ops/yr	Boat Lanes 1 - 14
6	Floating Mine	≤ 5	1/op	≤ 72	Surface (< 5 feet)	25 ops/yr	Boat Lanes 1 - 14
7	Dive Platoon*	3.5	8/op	10 – 72	Mid-water to Bottom	8 ops/yr	Boat Lanes 1 - 14
9	VSW MCM	0.1 to 20	1/op	≤ 24	Bottom	60 ops/yr	Boat Lanes 1 - 14
10	UUV[3] Ops	10 to 15	1/op	10 ≤ 72	Bottom to 10 feet from surface	4 ops/yr	Boat Lanes 1 - 14
11	MMS[4] Ops	13	2/op	10 ≤ 72	Bottom	8 ops/yr	Boat Lanes 1 - 14
11	MMS Ops	13	1/op	24 ≤ 72	Bottom to 20 feet from surface	8 ops/yr	Boat Lanes 1 - 14
12	Mine Neutral*	3.5	8/op	30 – 72	Bottom	4 ops/yr	Boat Lanes 1 - 14
37	SDV/ASDS	< 10	1/op	≤ 24	Bottom to Mid-water	14 ops/yr	Boat Lanes 1 - 14

Charges and are presented in terms of NEW in pounds.

[1]NEW: Net Explosive Weight; [2]MCM: Mine Counter Measures; [3] UUV: Unmanned Underwater Vehicle; [4] MMS: Marine Mammal Systems;

* Note - Most training events are a single detonation (i.e., 1/op) per event. However, several training activities involve sequential charges during the same training event. Unless otherwise specified, all sequential charges are conducted either less than 10-seconds apart or greater than 30-minute apart.

For purposes of this analysis, fish density within the nearshore ocean coastal areas of SSTC was assumed as similar to be similar to the lowest density ecoregion of San Diego Bay (0.08 /square feet) (Allen 1999, Allen et al. 2006). Based on this assumption, a total of 80 fish could reside within 1,000 square feet of near-coastal habitat. The degree of impact for each fish species can be estimated to some extent using reasonable assumptions of the blast effects radius for various detonation sizes, and the number and type of fish likely to be present within defined habitat types. However, the majority of detonations occur in habitats in the SSTC oceanside boat lanes that are lower in quality than those in the San Diego Bay. Combined with the population sizes and dispersed nature of potentially affected fish populations in the oceanside boat lanes, it is likely that this assumption overestimates the density of fish that would be in the area, possible by an order of magnitude, and thus calculations on zones of impact are used in this assessment, rather than assumed fish densities. In summary, small fish with swim bladders (< 0.5 pounds) in close proximity to underwater detonations would sustain lethal impact 1 percent of the time (LD 1) when exposed to greater than 116 Pa·s (16.8 psi-ms) impulse according to Yelverton (1981).

The variable impact to fish is species dependent (swim bladder versus no swim bladder), and it is conservative to assume that small fish (i.e. Pacific sardines < 0.5 pounds) within 360 yards (1080 feet) of the largest underwater detonation would suffer 1 percent mortality, according to effects criteria defined in Table 3.8-9 and in Section 3.8.2.1.1. Realistically it can be assumed that nearly half the fish in the area surrounding an underwater detonation do not have swim bladders and would not likely be affected outside of immediate area of the blast (30 ft), based on Goertner (1994) and a substantial portion of the fish would be greater than 0.5 pounds and would be effected to a much lesser degree.

Fishes known to reside and transit the nearshore ocean portion of the ROI utilized for underwater detonations (waters contained within boat lanes less than 72 feet MLLW) are variable in both time and space. Fish most susceptible to impulse injuries from SSTC underwater detonations (pacific sardines, northern anchovies, and top smelt) are extremely abundant (Allen 1999 estimated that 42 million northern anchovy reside in San Diego Bay) vary seasonally and inhabit a large geographic area that extends from Canada to Mexico. Resident and diurnal transients such as California halibut, croakers, bass, and various elasmobranches (sharks and rays) are not documented to be present in high densities within the ocean portions of the ROI and due to their size would be less susceptible to injury. For example, a 9 pound kelp bass would have an LD 1 of approximately one third the distance from the center of the same detonation as a Pacific sardine, resulting in an effect area of only one tenth that of smaller fish.

Overall impacts to specific fish species and assemblages under the No Action Alternative would remain temporary and localized considering the expansive nature of the adjacent habitat, the population size and dispersed nature of potentially effected fish populations, and the frequency of the largest underwater detonation activities (less than 32 20 lb detonations per year). In addition, underwater detonation activities in the SSTC ROI would not measurably disrupt behavior or migration patterns of fish species so as to impact populations of fish species.

As discussed in Section 3.7.2.2.2, underwater detonation activities in the SSTC ROI would not measurably alter the water or sediment quality from debris or discharge sufficient to impact EFH. Modifications to benthic habitat from detonations placed on the bottom occur infrequently and only within the SSTC ocean training lanes. Benthic habitat within the SSTC ocean training lanes is dominated by a physically dynamic sandy/cobble bottom that is both expansive and limited in EFH value. Adverse effects to EFH and to fish in general from underwater detonations activities would be temporary, localized, and minimal, there would be no lasting effects to populations, prey availability, or the food web. As a result of the analysis presented above as well as in Section 3.7, no adverse affects to EFH are anticipated.

3.8.2.2.4 Amphibious and Beach Activities

Training activities encompassed in this section included amphibious vehicles, Elevated Causeway System (ELCAS), and fluid transfer systems. Training activities include the use of training areas within both San Diego Bay and the nearshore environment. Potential effects from these activities include vehicle transit within ROI waters, noise, and habitat modification similar to those described in Section 3.8.2.2.2, Marine Vessel Activities. Potential effects from these activities on EFH are detailed in Section 3.7.2.2.

Amphibious Activities

Amphibious vehicles utilized during various training activities (Amphibious Assault Vehicle [AAV] and others) land on beaches and San Diego Bay shorelines that support fish assemblages. The modification of that shoreline depends on the size of the amphibious vehicle, the frequency of the landings within the area, and whether the propulsion system creates scouring during the landing activity. Amphibious activities analyzed in this section focus on the interaction the vehicle or training activity has within the landing area and, to a lesser extent, the waters adjacent to the landing areas.

Amphibious Vehicles

Amphibious vehicles, specifically AAV's, are involved in activities that perform landings in beach side training lanes in SSTC-N and SSTC-S. The surf zone habitat within the beach side training lanes is comprised of primarily coarse sand and supports transient fish. Amphibious vehicle landings interface with the bottom substrate at various levels depending on the tide but would not be expected to adversely impact fish habitat or fish. The surf zone habitat of the beach side training lanes is exposed to the predominant wind and wave direction and sediment in continually redistributed on both a daily and seasonal bases. Considering the limit draft (< 5 feet) of the AAV and small size (< 30 foot length) of the vehicles in conjunction with the steep slope of the beach throughout the SSTC-N and SSTC-S, bottom disturbance would be limited and not expected to adversely impact fish habitat. Fish utilizing the landing areas would not be expected to encounter adverse effects attributed to disturbance and would more likely take advantage of the sediment displaced or suspended by the vehicles for opportunistic feeding of liberated invertebrates.

Elevated Causeway System

During ELCAS training (Activity 42, Table 2-1) a temporary pier is erected using floating causeway sections and a pile driver that drives 24-inch hollow steel piles into the surf zone to secure the piles in place. After conclusion of the activity, the pier is deconstructed and the pilings are removed by vibrating the piles to loosen, and then extract them. Causeway activities occur primarily on SSTC-N oceanside boat training areas 1-10, but also periodically in the bayside training area Bravo. This activity occurs during two separate training events per year annually, up to 14 days per event under the No Action Alternative. Activities involve accessing beach areas through the surf zone using floating and land-based heavy equipment. The ELCAS pier is typically 1,200 feet in length at SSTC due to bathymetry and depth requirement of ships docking alongside the pier. ELCAS pier piles are driven every 40 feet with the exception of the first and last causeway sections where four piles are utilized rather than two piles.

Shock pulses from pile driving have the potential to affect fish in the immediate area and could have lethal effects if fish venture in close proximity. Depending on the level of the sound and shock waves produced by piling driving activities and the distance individual fish species are in proximity to the pile, various lethal and sublethal effects may occur. Previous studies discussed earlier in this section place lethal levels at above 230 dB and other deep water studies identify 180 dB as the disturbance effects level for rockfish. Considering the complexity and magnitude of associated logistical aspects of ELCAS, the majority of fish species within the activity area are likely to be displaced prior to pile driving activity. In some cases, specific opportunistic surf zone fish species (e.g., perch, topsmelt) may be attracted to the suspension of particulate matter and entrained food items liberated by the large vessels and heavy equipment used during ELCAS activities and would likely be susceptible to a greater degree of effect from the pile driving.

Sound impulses generated by pile driving attenuate at various rates depending on the depth, type of substrate, and size of the piling being driven. Hastings and Popper (2005) provide a brief summary of numerous measurements in the San Francisco Bay Area. Large diameter cast-in-steel-shell (CISS) piles driven with impact hydraulic hammers result in the greatest sound exposure. Timber piles that are driven with small hammers produce low amplitude sound pressure levels of less than 180 dB re 1 µPa (peak) at 33 feet from the pile. Twenty-four-inch concrete piles produced peak sound pressures of about 188 dB re 1 µPa, also at 33 feet from the pile. The larger CISS piles (i.e., 30-inch diameter or greater) produce much greater sound pressures. For instance, 30-inch diameter CISS piles driven with a diesel impact hammer produce 208 dB re 1 µPa (peak) at 33 feet from the pile and very large (96-inch diameter) CISS piles produce levels in excess of 220 dB re 1 µPa (peak) within 33 feet of the pile. Close to CISS piles, the RMS (impulse) is about 10 to 15 dB lower than the peak and the SEL is about 24 to 28 dB lower than the peak. Assuming the use of a 24-inch steel pile, shockwaves and peak pressures generated from ELCAS pile driving activities would be below the interim injury criteria and could be expected to be between 180 and 200 dB re 1 μPa^2-s within 30 ft of pile driving, the upper limits of which reach behavioral disturbance threshold levels and mortality for some small fish possessing swim bladders (Goertner 1994, Yelverton 1981).

ELCAS activities within San Diego Bay at Bravo beach have a greater potential for effect to fish species because eelgrass habitat is known to occur within and adjacent to the activity area. Fish identified to inhabit eelgrass habitat vary widely but several species (gobies, pipefish) inhabit burrows or maintain defined home ranges within specific areas. Effects from ELCAS activities including sound, shock waves, habitat modification, and increased turbidity would have lethal and sub lethal effects to some fish species in the eelgrass areas. Suspended material from pile driving or vibratory pile removal within the oceanside training areas would not substantially modify the surf zone or nearshore clarity to a degree expected to affect fish behavior or foraging. In contrast, increased turbidity and the potential redistribution of sediment from pile driving or vibratory pile removal may have adverse effects to eelgrass habitat from smothering within Bravo bayside training lane.

Considering the infrequency of these activities and the duration between driving piles within a high-energy surf zone, effects to fish within the offshore boat lanes would be temporary and localized. Effects to fish species within Bravo can be more precisely defined based on fish densities known to occur within that ecoregion as well as eelgrass habitat. Using the density of 0.08 fish per square foot published by Allen (1999) and assuming that each pile being driven affects a 30 ft radius around each pile, based on a 24" steel pile and 180 dB re 1 μPa^2-s, a total of 2,826 fish could be temporarily displaced or affected during each pile driven. Approximately 100 piles are driven for a 1,200 ft ELCAS pier. Considering the overall length of the ELCAS pier only a small percentage of all piles driven would occur within the narrow band of eelgrass habitat in Bravo (Figure 3.7-3). Fish documented to frequent deep and moderately deep habitat are comprised of fish known to inhabit large areas and make behavior modifications to avoid disturbance, concentrating effects to fish to primarily within eelgrass habitat. Caution should be used in extrapolating the total number of fish potentially affected from an ELCAS event since effects determinations were calculated for the most impulse susceptible fish (small fish < 0.5 lbs with swim bladders).

Small fish with swim bladders are numerically dominant in Allen (1999) density calculations for the South Central San Diego bay because they represent multiple sampling methodologies. The fish likely to be present with the effects area are represented by primarily schooling fish (northern anchovies, slough anchovies, and top smelt) that can easily avoid detrimental impulse and the remaining fish (predominantly gobies and pipefish) do not have swim bladders and are substantially (100 times less according to Goertner 1994) less susceptible to the same impulse levels. In summary, ELCAS activities are performed infrequently (twice per year) and, in most cases, within an already physically challenging surf zone habitat. Effects to fish species would be concentrated within close proximity to pile driving activities and most notably within eelgrass habitat. Considering the extent of adjacent habitat and the quantities of fish known to exist within that habitat, effects to fish populations from ELCAS activities would be temporary and localized. Lethal and sublethal effects to fish species would be localized to the immediate pile driving area and intertidal area containing eelgrass for the bayside training events. Effects to individual fish species would be minimal and no adverse effects would be anticipated for overall fish assemblages or populations.

The initiation of the ELCAS activity (movement of boats and barges, positioning of pile before driving, etc.) likely displaces many of the resident fish reducing the potential for lethal effect. Similar habitat is extensive to the north and south of the training areas, which provides adequate habitat for fish to relocate due to disturbance. Depending on the time of year, several other species may be locally displaced; however, no long-term effect to individual populations is anticipated. Any effects to fish species would be considered below measurable thresholds, outside of eelgrass habitat.

As described in Section 3.7.2.2.3, amphibious and beach activities in the SSTC ROI would not measurably alter the water or sediment quality from debris or discharge sufficient to impact EFH. Adverse modifications to benthic habitat resulting in effects to EFH occur on a limited basis during amphibious landing and beach construction activities within eelgrass habitat. Amphibious landing and beach construction activities within eelgrass habitat are constrained to training lane Bravo and impacts to EFH are offset by replacement of affected eelgrass habitat addressed in Section 3.7.1.5.

Beach Activities

Beach activities covered in this section involve activities that transfer fuel (simulated) or water from vessels on the water to beaches within training areas (Activities 38, 39, 50, Table 2-1). The focus of the analysis for the applicable activities is concentrated on the type of medium being transferred and the nearshore waters or intertidal areas that may be effected by equipment movement or positioning. Effects from marine vessel movements or landings are address in Section 3.8.2.2.2. Fluid transfer training events involve two activities; (1) the simulation of fueling transfers from ship-to-ship and shore-to-ship utilizing seawater and (2) the intake of seawater for desalination and the discharge of hypersaline brine back into San Diego Bay. Fluid transfer activities consist of transferring salt water to simulate fuel transfer (Activity 38, Offshore Petroleum Discharge System [OPDS]) and Activity 39 Amphibious Bulk Liquid Transfer System [ABLTS], and bringing saltwater ashore for desalinization (Activity 50, Reverse Osmosis Water Purification Unit [ROWPU]).

During an OPDS activity, a fuel transport conduit is towed ashore and anchored in between. During ABLTS training, the conduit floats on the water surface. Water is pumped to a unit on shore to simulate fueling and returned to the ocean with a hose. OPDS and ABLTS training occurs six and four times annually under the No Action Alternative, respectively. During the construction and installation of conduit needed for OPDS activity conduit is placed along the intertidal substrate where it has the potential to adversely affect eelgrass and other intertidal habitat by crushing or scouring during placement. Within the oceanside training lanes of SSTC-N and SSTC-S activities are performed infrequently, in most cases, within an already physically challenging surf zone habitat. The OPDS conduit is 8 inches in diameter and is anchored to the bottom with the remaining portion of the conduit resting in the intertidal habitat. Scouring from vessels performing conduit installation is addressed in Section 3.8.2.2.2 Marine Vessel Activities and would be limited to eelgrass habitat with Bravo. Effects to fish species would be concentrated within close proximity to conduit activities and most notably within eelgrass habitat and be limited to temporary displacement. Considering the extent of adjacent habitat and the quantities of fish known to exist within that habitat, effects to fish assemblages from OPDS activities would be temporary and localized. Sublethal effects to fish species would be limited to burrowing species in the immediate conduit area containing eelgrass for the bayside training events and recolonization would likely occur rapidly from adjacent fish populations. Effects to individual fish species would be minimal and no adverse effects would be anticipated for overall fish assemblages or populations.

Simulated fueling transfer poses minimal risk to fish species due to its localized nature and infrequent use. The intake of sea water from the ocean has a potential to remove larval fish and YOY that are in the close proximity ocean water intake. Depending on the time of year, depth, and velocity of the intake pipe, certain species are more susceptible than others. Impingement on the end of the pipe could affect larger fish but considering the activity only occurs 10 times per year minimal effect to fish populations are anticipated.

During ROWPU training, salt water is brought ashore and desalinized. Hypersaline water is then stored in a bladder and transported offsite for sewerage or mixed with potable water and discharged back into the sea at nearly the same salinity as the source ocean water and quantities are not likely to affect fish, considering the dissolution factor and physical mixing that occurs within the surf zone and nearshore waters where activities occur. Any physical effects to fish would be temporary and localized as training activities occur infrequently (4 times per year). For the limited instances that these transfer activities take place within Bravo the greatest potential for effect to fish species is from the interface of the conduit and/or equipment lying within intertidal habitat possesses the greatest potential for effect to fish species. Fish identified to inhabit intertidal mudflats and eelgrass habitat vary widely but several species (gobies, pipefish) either build burrows or maintain defined home ranges within specific areas. Effects from fluid transfer activities including sound, shock waves, habitat modification, and effects to turbidity would have lethal and sublethal effects to fish species in those areas. Water intake during activities in Bravo likely to occur in deep or moderately deep water could entrain adult and juvenile fish as well as eggs and larvae to some extent, but since the intake water is returned to San Diego Bay lethal effects would be limited if any. In summary, no long-term adverse effects would occur from fluid transfer activities and any effect to individual fish species would be localized and temporary. Amphibious and Beach activities in the SSTC ROI do not physically disrupt behavior or migration patterns of fish species.

3.8.2.3 Alternative 1 (Preferred Alternative)

Alternative 1 increases the current level and types of training that occur in the ROI. Current management and mitigation measures would remain unchanged (Section 3.8.1.7 and 3.8.1.8). This section focuses on only groups of activities that have the potential to result in an impact to specified fish species. As discussed previously, similar types of activities are grouped together to facilitate effects analysis.

3.8.2.3.1 Air Activities

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 (Activities N4–N8, Table 2-2). As presented in Chapter 2 (Table 2-1 and 2-2), helicopter activities over San Diego Bay and ocean waters within the ROI would more than double under Alternative 1 in comparison to the No Action Alternative. As described in Section 3.8.2.2.1, air activities are expected to have a minimal effect on fish, and the change in the numbers of activities would not change those predictions.

The use of helicopters within the ROI will be consistent with previously described activities and effects attributed to this activity would be of the same type and magnitude. Disturbance of fish from the noise, physical presence, or sea surface disturbance from aircraft within the ROI would be limited to fish utilizing the area immediately adjacent to the action and likely only within the uppermost section of the water column. Reduced foraging success or behavior modification attributed to air actions is not likely to occur according to findings previously presented. Any temporary effect to fish near the surface remains a low probability considering the temporal variability of both training actions and the potential for fish to be present near the sea surface within a specific training area.

Increases to air activities under Alternative 1 would not measurably change the effect to fish species from the No Action Alternative. Considering effects to fish species from air activities are isolated to noise and movement disturbance, the increase would not measurably change the potential effect to fish species or their populations.

3.8.2.3.2 Marine Vessel Activities

Marine vessels, self propelled, propeller and water-jet driven, or towed, would increase in use and scope under Alternative 1 compared to the No Action Alternative. The greatest increases to marine vessel activities would be attributed to new activities; Surf Zone Test Detachment, and Shock Wave Action Generator (SWAG) as well as increases to existing activities. Increases to on-water activity by marine vessels in both oceanside and the San Diego Bay training areas would increase the possibility of effect to fish species from noise and disturbance, most notably from large marine vessels, but would not measurably reduce fish species' capacity to persist unaffected. As the types of small marine vessels are expected to remain the same, even large increases of the use of small marine vessels will have little to no effect on fish species present. As such, activities involving small marine vessels used in support of diving, swimming or training which do not come in contact with marine substrates (Activities 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 14, 18, 21, 23, 26, 28, 34, 35, 57, 77, 78, N4, N6, N7, Table 2-1 and 2-2) are anticipated to have little to no effect on fish species present based on effects criteria discussed in Section 3.8.2.1 regarding noise effects, behavioral modifications, or physical injuries. Vessels remain on the surface and only occasionally land on beaches and mudflats where burrowing fish may be affected from crushing. Continued use of delineated training areas and avoidance of eelgrass beds and mudflats would reduce potential harmful effects to sensitive habitat.

New activities under Alternative 1 that will take place within all boat training lanes and bayside training areas (Activities N1, N2, N4, N6-N9, N11, Table 2-2) involve the use of both large and small mechanically driven vessels that are used to support training activities within boat lanes and San Diego Bay training locations. Potential effects from these activities on EFH are detailed in Section 3.7.2.3. Sound levels from transiting vessels and would not have physical effects on fish based on documented sound levels and effects criteria. The use of both large and small mechanically driven vehicles in the ROI will be consistent with previously described activities and effects attributed to this activity would be of the same type and magnitude.

3.8.2.3.3 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 below (Table 3.8-11), 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: SWAG and UUV Neutralization, Airborne Mine Neutralization System, Demolition Requalification and Training/Underwater Detonations, and NSW Underwater Demolition Training (N1, N3, N7, N9, and N11, respectively, Table 2-2) and the footprint of activities would be expanded to include SWAG detonations of up to 15 grams NEW within San Diego Bay. Potential effects from these activities on EFH are detailed in Section 3.7.2.3.

As described in Section 3.8.2.2.3 the impulse generated from underwater detonations and the size and species of fish present with the effect area directly correlates to the area of effect. The threshold for 1% mortality from an underwater detonation is estimated to be at the point where impulse waves measure below 69 Pa·s (10 psi-ms) for gobies and 116 Pa·s (16.8 psi-ms) for Pacific sardines, the most impulse

Table 3.8.11: Underwater Explosive Activities Conducted during Alternatives 1 and 2

Activity Number	Underwater Detonation Operation	NEW[1] (pounds)	Number of Detonations	Water Depth (feet)	Charge Depth	Tempo	Location
5	MCM[2]	10 to 20	1/operation (op)	≤ 72	Mid-water	29 ops/yr	Boat Lanes 1 - 14
5	MCM	10 to 20	1/op	≤ 72	Bottom	29 ops/yr	Boat Lanes 1 - 14
6	Floating Mine	≤ 5	1/op	≤ 72	Surface (< 5 feet)	53 ops/yr	Boat Lanes 1 - 14
7	Dive Platoon*	3.5	8/op	30 – 72	Bottom	8 ops/yr	Boat Lanes 1 - 14
9	VSW MCM	0.1 to 20	1/op	≤ 24	Bottom	60 ops/yr	Boat Lanes 1 - 14
10	UUV[3] Ops	10 to 15	1/op	10 ≤ 72	Bottom to 10 feet from surface	4 ops/yr	Boat Lanes 1 - 14
11	MMS[4] Ops	13 & 29	2/op	10 ≤ 72	Bottom	8 ops/yr	Boat Lanes 1 - 14
11	MMS Ops	13 & 29	1/op	24 ≤ 72	Bottom to 20 feet from surface	8 ops/yr	Boat Lanes 1 - 14
12	Mine Neutral*	3.5	8/op	30 – 72	Bottom	4 ops/yr	Boat Lanes 1 - 14
N1	SWAG	0.033	1/op	10 – 20	Mid-water	74 ops/yr	Echo
N1	SWAG	0.033	1/op	10 – 20	Mid-water	16 ops/yr	Boat Lanes 1 - 14
N2	Surf Zone T&E	Up to 20	1/op	≤ 24	Bottom	2 ops/yr	Boat Lanes 1 - 14
N3	UUV Neutral	3.3 & 3.57	2/op	10 – 72	Bottom to 10 feet from surface	4 ops/yr	Boat Lanes 1 - 14
N7	AMNS	3.53	1/op	40 – 72	Mid-water to Bottom	10 ops/yr	Boat Lanes 1 - 14
N9	Qual/Cert[5]	12.5 – 13.75	2/op	10 – 72	Bottom	8 ops/yr	Boat Lanes 1 - 14
N9	Qual/Cert	25.5	1/op	40 – 72	Bottom to 20 feet from surface	4 ops/yr	Boat Lanes 1 - 14
N11	NSW Demolition Training	≤ 10	1/op	≤ 24	Bottom	4 ops/yr	Boat Lanes 1 - 14
N11	NSW Demolition Training	≤ 3.6	1/op	≤ 24	Surface	8 ops/yr	Boat Lanes 1 - 14
37	SDV/ASDS	≤ 10	1/op	≤ 24	Bottom to Mid-water	40 ops/yr	Boat Lanes 1 - 14

[1]NEW: Net Explosive Weight. [2] MCM: Mine Counter Measures, [3] UUV: Unmanned Underwater Vehicle, [4] MMS: Marine Mammal Systems, [5] Qual/Cert: Qualification or Certification trials,

* Most training events are a single detonation (i.e., 1/op) per event. However, several training activities involve sequential charges during the same training event. Unless otherwise specified, all sequential charges are conducted either less than 10-seconds apart or greater than 30-minute apart.

sensitive fish species within the ROI. Other species have impulse thresholds greater than 145 Pa-s (21.0 psi-ms).

Utilizing the modeled distance to a received pressure of 13.0 psi·ms as a conservative estimate instead of the 16.82 psi·ms value, NUWC modeled ZOIs can be used. The ZOIs for the 13.0 psi-ms impulse threshold for Alternative 1 are shown in Table 3.9-7. For a 29 lb charge used during marine mammals systems training, the ZOI to the 13.0 psi-ms threshold is 360 yards (Section 3.9 for a detailed explanation of acoustic modeling) The variable impact to fish is species and size dependent (swim bladder versus no swim bladder), and it is conservative to assume that small fish (i.e. Pacific sardines < 0.5 pounds) within 360 yards (1080 feet) of the largest underwater detonation would suffer 1 percent mortality, according to effects criteria defined in Table 3.8-9 and in Section 3.8.2.1.1 as defined by Goertner (1994). Considering the common fish species documented to inhabit surf zone of Southern California, primarily large transient predators(sharks, rays, halibut, etc), roving substratum feeders (perch, corbina, croakers, etc) or schooling baitfish (top smelt, anchovy, etc). (Allen et al. 2006) it can be assumed that significant portion of the fish in the area surrounding an underwater detonation are either large in size (> 3 lbs) or do not have swim bladders. These factors greatly reduce the probability that specific fish species or assemblages would be adversely affected outside of the immediate area of the blast (30 ft), based on Goertner (1994) effects criteria. Overall impacts to specific fish species and assemblages would remain temporary and localized considering the expansive nature of the adjacent habitat, the population size and dispersed nature of potentially effected fish populations, and the frequency of the largest underwater detonation activities (less than sixteen 29 lb detonations per year).

Effects to fish from underwater detonations within waters of the ROI are based on modeling and tests performed by various institutions. The radius of lethal and sublethal effect to fish is solely based on interpolation of those modeling and test results and the maximum size of the detonation known to take place for each activity. Considering that nearly all SSTC underwater detonations occur in nearshore boat lanes 1-14 over mostly sand bottom, documented to harbor low fish densities compared to nearby rocky/kelp forest habitat, effects to fish assemblages would be localized and temporary. In summary, fish known to reside and transit the nearshore ocean portion of the ROI utilized for underwater detonations (waters contained within boat lanes less than 72 ft MLLW) are variable in both time and space.

Fish most susceptible to impulse injuries from SSTC underwater detonations (pacific sardines, northern anchovies, and top smelt) are extremely abundant (Allen 1999 estimated that 42 million northern anchovy reside in San Diego Bay) vary seasonally and inhabit a large geographic area that extends from Canada to Mexico. Resident and diurnal transients such as California halibut, croakers, bass, and various elasmobranches (sharks and rays) are not documented to be present in high densities within the ocean portions of the ROI and due to their size would be less susceptible to injury. For example, a 9 pound kelp bass would have an LD 1 of approximately one third the distance from the center of the same detonation as a Pacific sardine, resulting in an effect area of only one tenth that of smaller fish. Overall impacts to specific fish species and assemblages would remain temporary and localized considering the expansive nature of the adjacent habitat, the population size and dispersed nature of potentially effected fish populations, and the frequency of the largest underwater detonation activities. The increased detonations on the oceanside of SSTC-N under Alternative 1 are more likely to affect free-floating and infaunal invertebrates, as described in Section 3.7.2.3.3; however, due to low densities and short recovery times, this difference is also negligible and the effects to EFH would be similar to that described under the No Action Alternative.

3.8.2.3.4 Amphibious and Beach Activities

Amphibious Activities

Amphibious vehicles, specifically AAVs and Expeditionary Fighting Vehicles (EFVs), would be involved in activities that perform landings in beach side training lanes in SSTC-N and SSTC-S and increase in activity frequency from 3 to 18 times per year. Amphibious vehicle landings interface with the bottom substrate at various levels depending on the tide but would not be expected to adversely impact fish habitat or fish. The surf zone habitat of the beach side training lanes is exposed to the predominant wind and wave direction and sediment in continually redistributed on both a daily and seasonal bases. Considering the limit draft (< 5 feet) of the AAV and EFV and small size (< 30 feet length) of the vehicles in conjunction with the steep slope of the beach throughout the SSTC-N and SSTC-S, bottom disturbance would be limited and not expected to adversely impact fish habitat. Fish utilizing the landing areas would not be expected to suffer from adverse effects attributed to disturbance and would more likely take advantage of the sediment displaced or suspended by the vehicles for opportunistic feeding of liberated invertebrates.

ELCAS training activities would increase from three to four activities under Alternative 1 compared to the No Action Alternative and would remain within the same training area as the No Action Alternative. As described in Section 3.8.2.2.4, ELCAS activities are expected to have lethal and sublethal effects to fish species within areas sustaining greater than 180 dB re 1µPa depending on the type of fish within the effects radius at the time of the activity. Increases in the frequency of the shock waves attributed to pile driving will subsequently increase the frequency of the lethal and sublethal effects to fish species within the defined effects radius. However, the overall effects to individual fish species, assemblages, and EFH are expected to be temporary and localized considering the expansive nature of the adjacent habitat, population of the potentially effected species, and the frequency of piling driving activities. Effects to individual fish species would range from lethal to no effect; however, no adverse effects would be anticipated for overall fish assemblages or populations.

Beach Activities

Increases in beach activities not discharging byproducts or interfacing with the nearshore or San Diego Bay waters have no potential to affect fish species or assemblages and thus are not analyzed in this section as stated previously in Section 3.8.2, Environmental Consequences. The total number of activities with the potential to affect fish species increases from four to five from the No Action Alternative to Alternative 1, and is limited to Amphibious Bulk Liquid Transfer System (ABLTS) activities.

ABLTS is expected to have a minimal effect on fish, and incremental change in the numbers of activities would not change those predictions. Surface coverage by conduit is not sufficient to affect behavior of fish species, and bottom substrate disturbance or modification within the surf zone or intertidal areas attributed to equipment or sand movement occurs within an already physically disturbed zone in the case of beach areas and could only be quantified within San Diego Bay by the loss of eelgrass habitat. Any effect to fish within the boat lanes would be below measurable thresholds and would be only anticipated to occur within San Diego Bay if eelgrass habitat was modified or destroyed (Section 3.7.3.3).

The expected increased risk of habitat modification and invasive species introduction with increased waste associated with new activities or increases in activities in Alternative 1 would not constitute a measurable difference between Alternative 1 and the No Action Alternative; there is no documented correlation between any activity and trash or solid waste.

3.8.2.4 Alternative 2

Implementation of Alternative 2 would increase the total operational training tempo to the same levels as presented for Alternative 1 (Table 2-1 and 2-2). Implementation of Alternative 2 would also include the introduction of new types of training; conducting existing routine training at additional locations within SSTC established training areas, like Alternative 1. 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 not marine related, the impacts associated with Alternative 2 are expected to be the same as those described above for Alternative 1.

3.8.3 Proposed Mitigation Measures

Since most of the local marine environment consists of soft-bottom habitat with few rocky habitats and the local fish populations are not robust, most Navy activities will not affect fish populations within the ROI. The largest expected impact to fish species and assemblages comes from underwater detonations and the modification or destruction of eelgrass habitat within Bravo training area. The mitigation for 1.13 acres of lost eelgrass habitat discussed in Section 3.7 would provide additional habitat for fish species potentially lost or displaced from eelgrass by activities described in this section, thus partially mitigating effects to fish. Additionally, restriction of the public from accessing some sections of the training areas during some training for public safety and security reasons affords fish resources within those areas a certain level of refuge from recreational fishing pressure and disturbance. Furthermore the set aside of undeveloped shoreline for training offsets effects from training activities and assures that high value eelgrass and salt marsh habitat remains available to fish for foraging and reproduction.

As a result of the EFH consultation with the NMFS, the Navy will conduct a new bottom habitat mapping survey to more accurately detail potential habitat types (ex., sand, cobble, rocks) within the oceanside SSTC boat lanes. This effort, scheduled to begin in 2011, is designed to update bottom type classification at finer resolution and spatial scales than previous California State funded surveys from 2002. The goal from this Navy funded survey would be to provide information to NMFS on habitat types within SSTC, and to Navy commands conducting underwater detonations at SSTC for consideration in selection of appropriate bottom-laid detonation sites. Similar to the measures used to avoid sensitive habitats when selecting underwater explosive device detonation sites, the nearshore habitat survey data will also be used to ensure the OPDS system is not placed within any sensitive habitats.

The Navy will conduct April to May pre-event surveys for grunion prior to SSTC training events that could to disturb intertidal beach areas. From Table 2-1, events identified for grunion pre-event surveys include 41- Causeway Pier Insertion and Retraction training (max. of 10 per year), and 42-ELCAS (max. of four per year). These training events generally occur within only a few boat/beach lanes in SSTC-N and can occur throughout the year. For events that have a requirement to occur in April and May, the Navy will use predicted grunion spawning periods obtained from the California Department of Fish and Game (http://www.dfg.ca.gov/marine/grunionschedule.asp) to anticipate times to survey 10-14 days prior to the next ELCAS or Causeway Pier Insertion and Retraction.

This survey will identify if grunion spawning occurred or did not occur on the beach area scheduled for training. If grunion spawning is documented, then a determination on the spatial extent of spawn across the planned training area and magnitude of spawning (on the standard grunion 0-5 spawning scale) will be made. If a significant spawning run is observed (4 or 5 on the spawning scale) coincidental with and at the same location as the beach-impacting training event, the Navy will attempt to delay the event or move to a training area of lower density spawning or an area of no spawning. If such a shift cannot be done due to schedule conflict over multiple SSTC boat and beach lanes, logistic requirements to use a specific lane or area within a lane that precludes a shift, or safety considerations (ex., weather conditions, sea state), then the Navy will inform NMFS Southwest Region that training was conducted on that site for the specified reason.

Under the NMFS Incidental Harassment Authorization (IHA) consultation, there will likely be annual SSTC-specific reporting requirements on the quantities (number of detonations) and types (charge weight) of individual explosive used. The Navy is already building a data collection process for this information in anticipation of the NMFS requirement. While spatial display and quantification of some Navy training including detonation locations is classified, as a minimum, annual underwater detonation quantities used will be released to NMFS Office of Protected Resources in a classified report, similar to current reports the Navy provides for other range complexes. In addition, also as part of the IHA monitoring requirement, the Navy will be conducting representative mitigation monitoring for a sub-set of the total underwater detonations authorized by NMFS. This is approximately 4-16 individual detonation training events. During this monitoring, civilian marine biologists will independently observe the oceanside detonation site for marine mammals and sea turtles to ensure and document that the correct protective measures are applied. Under the EFH consultation, these biologists will also document the extent and quantity of any fish morality (or lack of mortality). This information will be included in the Navy's annual monitoring report to NMFS.

3.8.4 Unavoidable Adverse Environmental Effects

There are no unavoidable adverse effects to fish as a result of implementation of any alternatives.

3.8.5 Summary of Effects

Fish species and assemblages within estuaries and the nearshore ocean environments of the ROI are well adapted to physical changes in the environment and modify their activities based on stimuli within their immediate area. Most fish species potentially affected by activities of both the No Action Alternative and Alternatives 1 and 2 would likely actively move away from potentially harmful training activities, but some individual fish species will suffer lethal and sublethal effects do to their proximity to underwater detonations or pile driving activities Table 3.8-12 presents a summary of effects and mitigation measures for the No Action Alternative, Alternative 1, and Alternative 2.

The EFHA concludes that based on the extent, duration, and magnitude of potential impacts from SSTC training and testing, that there could be an adverse impact of up to 1.13 acres (0.46 hectares) of eelgrass habitat in San Diego Bay. The Navy currently maintains a signed agreement with the Army Corps of Engineers and NOAA Fisheries (i.e., Banking Instrument; N00242-080624-X42-MOA; DoN 2008) to mitigate or compensate impacts to eelgrass habitat, and any impacts to eelgrass within the designated training lane within Bravo training area will be offset by the NEMS.

Adverse effects to EFH and to fish in general from underwater detonations and certain select beach activities would be temporary, localized, and minimal, there would be no lasting effects to populations, prey availability, or the food web. Any potential effects would be further reduced with the proposed protective measures including bottom mapping of sensitive habitat. Therefore no adverse effect to EFH for the four major FMPs and their associated managed species are anticipated.

A full description of the EFHA consultation process is provided in Chapter 6 and Appendix G provides a list of the Silver Strand Training Complex (SSTC) EFHA consultation documentation. Agency correspondence and supporting documentation can be found on the SSTC EIS website at www.silverstrandtrainingcomplexeis.com.

Table 3.8-12: Summary of Effects

Alternative	Effects
No Action Alternative	• Small numbers of fish would be killed by shock waves from underwater detonations associated with the SSTC. However, underwater detonations would occur primarily in low-use habitats. • Noise associated with marine vessels is unlikely to affect fish as source levels from these sources are below those known to cause injury. Noise associated with pile driving would have some lethal and sublethal effects to fish but impacts would be localized due to the nature of the activity. • Groundfish are unlikely to be affected by activities in shallow waters. • With the current protective measures, no adverse effect to EFH and their associated managed species are anticipated.
Alternative 1	• Increases in pile driving and underwater detonation activities would increase the lethal and sublethal effect to fish species but fish assemblages would not be expected to be affected. • With the proposed protective measures, no adverse effect to EFH and their associated managed species are anticipated.
Alternative 2	• Increases in pile driving and underwater detonation activities would increase the lethal and sublethal effect to fish species but fish assemblages would not be expected to be affected. • With the proposed protective measures, no adverse effect to EFH and their associated managed species are anticipated.
Mitigation	• Habitat mitigation for intertidal and subtidal areas (Section 3.7), including eelgrass, provide a degree of mitigation for fish species documented to reside within those habitats. • The mitigation for 1.13 acres of lost eelgrass habitat discussed in Section 3.7 would provide alternative habitat for fish species potentially lost or displaced from eelgrass by activities described in this section, thus mitigating effects to fish. • As a result of the EFH consultation with the NMFS, the Navy will conduct a new bottom habitat mapping survey to more accurately detail potential habitat types (ex., sand, cobble, rocks) within the oceanside SSTC boat lanes. Similar to the measures used to avoid sensitive habitats when selecting underwater explosive device detonation sites, the nearshore habitat survey data will also be used to ensure the OPDS system is not placed within any sensitive habitats. • The Navy will conduct April to May pre-event surveys for grunion prior to SSTC training events that could to disturb intertidal beach areas. For events that have a requirement to occur in April and May, the Navy will use predicted grunion spawning periods obtained from the California Department of Fish and Game (http://www.dfg.ca.gov/marine/grunionschedule.asp) to anticipate times to survey 10-14 days prior to the next ELCAS or Causeway Pier Insertion and Retraction. This survey will identify if grunion spawning occurred or did not occur on the beach area scheduled for training. For cases in which a significant spawning run is observed coincidental with and at the same location as a planning training event, the Navy will attempt to delay the event or move to a training area of lower density spawning or an area of no spawning. If such a shift cannot be done due to schedule conflict over multiple SSTC boat and beach lanes, logistic requirements to use a specific lane or area within a lane that precludes a shift, or safety considerations (ex., weather conditions, sea state), then the Navy will inform NMFS Southwest Region that training was conducted on that site for the specified reason.

Table 3.8-12: Summary of Effects (Continued)

Alternative	Effects
Mitigation	• Under the NMFS Incidental Harassment Authorization (IHA) consultation, there will likely be annual SSTC-specific reporting requirements on the quantities (number of detonations) and types (charge weight) of individual explosive used. In addition, also as part of the IHA monitoring requirement, the Navy will be conducting representative mitigation monitoring for a sub-set of the total underwater detonations authorized by NMFS. This is approximately 4-16 individual detonation training events. During this monitoring, civilian marine biologists will independently observe the oceanside detonation site for marine mammals and sea turtles to ensure and document that the correct protective measures are applied. Under the EFH consultation, these biologists will also document the extent and quantity of any fish morality (or lack of mortality). This information will be included in the Navy's annual monitoring report to NMFS.

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