# Appendix 2 – Biological Resources

The study area for this section includes those areas extending from mean high tide line seaward. The environmental setting is presented for the ocean area immediately offshore of SONGS, and includes general descriptions of fauna within the southern California bight where applicable.

## Plankton

Plankton refers to organisms that have limited or no swimming ability and drift or float along with ocean currents. The two broad categories of plankton are phytoplankton and zooplankton. Phytoplankton, or plant plankton, form the base of the food web by photosynthesizing organic matter from water, carbon dioxide, and light. They are usually unicellular or colonial algae and support zooplankton, fish, and through their decay, large quantities of marine bacteria. Zooplankton are essentially microscopic animal plankton. They are a primary link between phytoplankton and larger marine organisms in marine food webs.

Several important terms are used to further differentiate planktonic forms based on their life histories. Holoplankton are those organisms that spend their entire life as plankton, while meroplankton spend only a portion of their life cycle as plankton. For example, the larval stages of benthic invertebrates frequently fall into the category of meroplankton; they lead a planktonic existence until they mature, at which time they settle into to the bottom of the ocean to take up their adult life. Ichthyoplankton are a specialized category of zooplankton, comprised of the larval stages of fish.

Plankton distribution, abundance, and productivity are dependent on several environmental factors. Factors include light, nutrients, water quality, terrestrial runoff, and upwelling. Their distribution tends to be very patchy with high seasonal and inter-annual variability along the California coastline. Because phytoplankton are photosynthetic, they are generally limited to the photic zone while zooplankton can occur throughout the water column from surface to bottom.

Fish production is highly dependent on the growth and productivity of both phytoplankton and zooplankton (Ryther, 1969) and fishery yields increase exponentially with increasing primary production in marine environments (Hanson and Leggett, 1982; Nixon, 1988). A description of plankton communities along the southern California coast is provided in the following sections.

### Phytoplankton

The phytoplankton community off the California coast primarily consists of diatoms, dinoflagellates, silicoflagellates, and coccolithophores (USDOI, BLM, 1979). Standard measures for describing phytoplankton communities are productivity, standing crop, and species composition.

Data from several studies (e.g., Bolin and Abbott, 1963; Allen, 1945) indicated that the phytoplankton community is similar in species composition along the entire coast of California. The diatom *Chaetoceros* was the most abundant species found along the coast (Bolin and Abbott, 1963; Cupp, 1943). Other dominant species included the diatoms *Skeletonema*, *Nitzschia*, *Eucampia*, *Thalassionema*, *Rhizosolenia* and *Asterionella*, and the dinoflagellates *Ceratium*, *Peridinium*, *Noctiluca*, and *Gonyaulax* (Bolin and Abbott, 1963). Reid et al. (1978) found similar population structure when he studied the vertical distribution of plankton assemblages in the nearshore part of the SCB during March 1976. Out of the fifty-eight samples collected from between La Jolla and Santa Monica Bay, the 20 most abundant species collected during this survey are listed in Table Ap.2-1. They closely follow the previous studies' findings; however, the most abundant species within the chlorophyll maximum layer were *Exuviella* sp. and *Mesodinium rubrum.*

Table Ap.2-1.
Average First 20 Taxa of Phytoplankton Species Listed in Order of Average Abundance in 58 Samples (from Reid et al., 1978)

| | |
|---|---|
| *1.* | *Exuviaella* sp. |
| *2.* | *Scrippsiella* sp./*Peridinium trochoideum* (Stein) Lemm. |
| *3.* | *Skeletonema costatum* (Greve.) Cleve |
| *4.* | *Eucampia zodiacus* Ehrenberg |
| *5.* | *Prorocentrum gracile* Schutt |
| *6.* | *Calciosolenia murrayi* Schlauder |
| *7.* | *Thalassiothrix frauenfeldii* (Grun.) Grunow |
| *8.* | *Gymnodinium* sp. A |
| *9.* | *Gymnodinium splendens* Lebour |
| *10.* | *Mesodinum rubrum* Lohmann |
| *11.* | *Rhizosolenia fragilissima* Bergon (small form) |
| *12.* | *Eutrptiella gymnastica* Throndsen |
| *13.* | *Hemiaulus sinensis* Grev. |
| *14.* | *Ceriatium kofoidii* Jorgensen |
| *15.* | *Torodinium robustum* Kofoid and Swezy |
| *16.* | *Gymnodinium* sp. S |
| *17.* | *Leptocylindrus danicus* Cleve |
| *18.* | *Cochlodinium catenatum* Okamura |
| *19.* | *Peridinium minutum* Kofoid |
| *20.* | *Gonyaulax polyedra* Stein |

Productivity, which is a measure of growth or new plant material per unit time, is highly variable off the California coast (Owen, 1980). Generally, the highest productivity levels occur within about 50 km of the coastline (Owen, 1974), and tend to be the highest or about six times higher in upwelling areas than the open ocean (Riznyk, 1974). Oguri and Kanter (1971) reported that spring primary productivity levels were approximately 5 times higher than in summer and 10 times higher than in winter.

Standing crop, or the amount of phytoplankton cells present in the water, is also highly variable and heterogeneous off the California coast. Owen (1974) reports highest standing crop values during the summer (range of 2.50 to 3.00 $mg/m^3$) and lowest values during the winter months (range of 0.30 to 0.40 $mg/m^3$). Palaez and McGowan (1986) reported high densities of phytoplankton in spring and summer that lessen in the fall and become the lowest in the late fall and early winter. They attributed the seasonal differences to ocean circulation patterns and the nutrient content of waters off the California coast. Nutrient-poor waters associated with winter currents and oceanic periods result in reduced phytoplankton biomass (Bolin and Abbott, 1963; Garrison, 1976).

Phytoplankton biomass have been reported to be higher near Point Conception than in southern or central California regions possibly due to greater upwelling off the Point (Owen, 1974). Biomass reached peak levels during summer (July to September) and decreased from October to December and with distance from shore. Highest biomass values were reported during August and in the upper 20 m of the water column (Owen and Sanchez, 1974).

## Zooplankton

Zooplankton are those animals that spend part (meroplankton) or all (holoplankton) of their life cycle as plankton. Zooplankton are often further categorized by size, i.e., their tendency to pass through (microzooplankton) or be retained (macrozooplankton) by a typically sized plankton net of (250-300um) (Dawson and Pieper, 1993). The temporal and spatial distributions of plankton are dependent on a number of factors including currents, water temperature, and phytoplankton abundance (Loeb et al., 1983). Spring blooms occur for both meroplankton and holoplankton while fall blooms tend to be restricted to the holoplankton. The meroplankton include the larvae of many commercial species of fish, lobster, and crabs. Like phytoplankton, spatial distribution of zooplankton is extremely patchy. However, a number of studies have established the importance of the nearshore ecosystem to the early development of fish.

Based on data collected by the California Cooperative Oceanic Fisheries Investigations (CalCOFI), McGowan and Miller (1980) reported a high degree of variability in species composition in offshore waters and that dominant species vary widely even from sample to sample. Fleminger (1964) reported 190 species and 65 genera of calanoid copepods. Kramer and Smith (1972), estimated that 546 invertebrate and 1,000 species of fish larvae occur in the California Current System. Major zooplankton groups off the California coast include copepods, euphausiids, chaetognaths, mollusks, thaliaceans, and fish larvae.

Roesler and Chelton (1987) concluded that zooplankton abundance in the southern area of the SCB was controlled by local biomass response to changes in the advective environment. In microzooplankton studies conducted off La Jolla, Beers and Stewart (1970) determined that biomass tends to decrease from onshore to offshore. Protozoans account for the greatest percentage of microzooplankton numerically, while the micrometazoans dominate the biomass (Beers and Stewart 1967, 1969, 1970). Beers and Stewart also found that protozoans, dominated by ciliates, accounted for 23-32% of the microzooplankton biomass, while copepod nauplii accounted for approximately 60% of the total metazoan organic carbon.

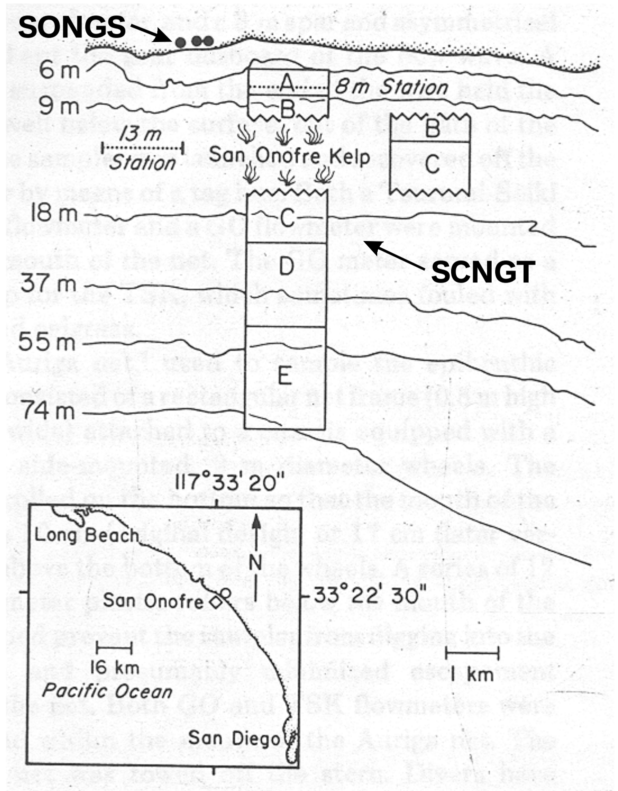
Dominant categories of zooplankton offshore of the SCB included the calanoid copepods *Calanus*, *Pleuromamma*, and *Metridia,* as well as Euphausiids and the pelagic phase of the red crab*, Pleuoncodes planipes*. Seasonal studies at Diablo Canyon indicate that zooplankton production is highest during June and July and in January and February. These periods coincided with upwelling periods with corresponding increases in phytoplankton (Icanberry and Warrick, 1978; Smith, 1974).

## Ichthyoplankton

Ichthyoplankton, or fish eggs and larvae, are an important component of the zooplankton community. With the exception of a few fish species (e.g., the embiotocidae or surfperches that bear live young), most fish that occur in southern California are present as larvae or eggs in the plankton community. The spatial and temporal distribution and composition of the ichthyoplankton are generally due to the spawning habits and the requirements of the adults. Seasonal patterns of ichthyoplankton in nearshore waters are influenced by the spawning cycles of demersal fish species and the northern anchovy, *Engraulis mordax*, while further offshore, composition is influenced by pelagic and migratory species such as hake and jack mackerel (Loeb et al., 1983). Like phytoplankton and zooplankton, the spatial distribution of ichthyoplankton is patchy and influenced by several environmental factors.

In CalCOFI samples collected offshore California, ichthyoplankton densities were found to be at the highest during January to March (Loeb et al., 1983). This was due to the peak spawning season for the northern anchovy, Pacific hake, Pacific mackerel, and the Pacific sardine. During this period, larvae of these species comprised up to 84 percent of the samples. Generally, they found that ichthyoplankton densities decreased from north to south and inshore to offshore.

Figure Ap.2-1 Locations of Ichthyoplankton Sampling Blocks




Ichthyoplankton entrainment surveys conducted for the San Onofre Nuclear Generating Station (SONGS) during the late 1970's further defined long-term average abundance patterns in the vertical and cross-shore dimensions at the project site.[1] Plankton sampling was conducted within five blocks (Figure Ap.2-1) on 57 occasions over a span of 21 months between January 1978 and September 1979. Separate samples were collected at the sea surface (neuston), within the water column, and within the epibenthic layer that lies immediately above the seafloor. Spatial patterns of 19 numerically dominant larval taxa were examined statistically. The larvae of fourteen taxa exhibited significant cross-shore differences in abundance. The populations of five of these taxa[2] were largely restricted to the very nearshore Blocks A and B. The more populous larvae of the remaining taxa tended to be more broadly distributed across the shelf, even though a couple of the taxa had their center of maximum population within Block E, located well offshore of the SCNGT site.[3]

Despite the widely varying differences in the spatial distribution of individual taxa, total ichthyoplankton density at the project site tends to be dominated by the presence of one taxon, the northern anchovy. Additionally, the study found that markedly higher densities of fish eggs are found in the mid-shelf neuston layer. Eggs tend to accumulate within the neuston layer because of their buoyancy.

In a summary of CalCOFI fish larvae data Ahlstrom (1965a) found that twelve taxa made up over 90 percent of the larvae collected. The most abundant was the northern anchovy, *Engraulis mordax*. Other common larval species were the Pacific hake, *Merluccius productus*; rockfish, *Sebastes* spp.; flatfish, *Citharichthys spp.*; and the California smoothtongue, *Leuroglossas stilbius*. Anchovy and rockfish larvae were abundant from the winter to spring seasons. Spawning varied by season with no discernible pattern within the California Current system (Kramer and Ahlstrom, 1968; Ahlstrom et al., 1978).

The early site-specific studies described above were followed by plankton investigations (Lavenberg et al., 1986, and SCE, 1982), that covered most of the nearshore coastal zone of the Southern California Bight. This database covered the time period from 1979 and 1984 and was used to assess the significance

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1 Barnett, A.M., A.E. Jahn, P.D. Sertic, W. Watson. 1980. Long term average spatial patterns of ichthyoplankton off San Onofre and their relationship to the position of the SONGS cooling system. Marine Ecological Consultants of Southern California, 533 Stevens Avenue, Solana Beach, California 92075. July 22, 1980.

2 The larvae of gobies, blennies, silversides, and two kinds of kelpfish were largely restricted to the very nearshore region, shoreward of the San Onofre Kelp Bed.

3 The larvae of rockfish and northern lampfish had significantly higher populations at offshore Blocks ***D*** and ***E***.

of intake losses at a number of coastal power plants. One of the cross-shore transects coincided with the site of the SONGS study described above. The entire dataset was used to estimate the magnitude of ichthyoplankton populations within the Southern California Bight.

Table Ap.2-2.
Average Ichthyoplankton Densities (#/100 m$^3$)
within the Southern California Bight

| | Isobath Depth (m) | | | |
|---|---|---|---|---|
| Species | 8 | 15 | 22 | 36 |
| Northern Anchovy | 215.0 | 218.0 | 523.9 | 519.0 |
| White Croaker | 87.7 | 169.9 | 103.6 | 68.4 |
| Queenfish | 17.7 | 18.1 | 11.7 | 3.8 |
| Kelp and Sand Bass | 0.6 | 2.0 | 3.2 | 1.8 |

Table Ap.2-2 shows cross-shore trends in average ichthyoplankton abundance within the Bight were consistent with the results of the earlier site-specific study. Specifically, the numerically dominant northern anchovy larvae were concentrated near the 22-m isobath and deeper. The population centers of the larvae of other species, such as white croaker and queenfish, were centered along shallower isobaths. Throughout the database, the larvae of northern anchovy always ranked highest in abundance except during 1984 when a strong El Niño altered the coastal environment. The abundance of northern anchovy larvae along the San Onofre transect was generally lower than the Bight-wide average.

## Fish

The fish resources in the off the coast of southern California are comprised of over 480 species (Horn, 1974) including both year-round residents and seasonal migrants. Large numbers of shellfish and other invertebrate species also occur in the area with the most important being crabs, shrimp, bivalves, and squid. The high level of diversity is reflective of the complex hydrographic, physical, and geologic conditions of the region that provide a wide variety of habitats for fish resources. The distribution of fishes in the area fluctuates on a daily, seasonal, and annual basis for many reasons including food availability, environmental conditions, and migration (USDOI, 1996a).

The offshore environment can generally be divided into several zones. For fishes in the area, these zones include the benthic or shelf and pelagic zones. Demersal species are those that live on or near the sea floor while pelagic fish species occur in the water column. Information on species composition, abundance, and distribution of demersal and pelagic fish communities in the project area are described below.

### Demersal Fish

The benthic environment offshore the project area generally consists of sandy, or muddy substrates. Fish species common to the area in deeper water beyond the tidal and wave zone that are important commercially or recreationally include flatfishes, bocaccio, cabezon, and sea bass. In shallower waters that are affected by waves and tides, common fish species are the perches, smelts, skates, rays, and flatfishes. Several researchers have reported that demersal fish species distributions are based on depth or depth-related factors (e.g., Bence et al., 1992; Wakefield, 1990; Caillet et al., 1992). Fish densities on the shelf between 50 and 200 m water depth are generally high, with flatfish densities being highest for species such as Pacific sanddabs and various types of sole.

Quarterly bottom trawls conducted in 2003 offshore San Onofre encountered 37 species of fish (SONGS, 2003). Trawls were conducted along three nearshore isobaths (20, 40, and 60 ft. depths) directly offshore SONGS and at two nearby reference areas. Table Ap.2-3 summarizes depth distributions for the 26 species of trawl caught fish collected off the San Onofre transect during the 2003 survey. The trawls were dominated by queenfish, northern anchovy, and white croaker. At the shallowest depth (20 ft.), queenfish accounted for 53% of the catch, while northern anchovy and white croaker accounted for 21% and 19% respectively. Flatfishes such as Pacific sanddab and various sole species constitute an increasing proportion of the catch from north to south and from surf zone to the outer shelf (Love et al., 1986; M. J. Allen, 1982). These findings are supported by the SONGS data; further offshore, speckled sanddabs were the most abundant demersal species encountered, compromising 67% of the catch at the 60 ft. depth.

Table Ap.2-3.
Relative Abundance of Fish Caught in Bottom Trawls at San Onofre (adapted from SONGS, 2003)

| Species | | Abundance at Isobath Depth (ft.) | | | Total |
|---|---|---|---|---|---|
| | | 20 | 40 | 60 | |
| *Seriphus politus* | queenfish | 432 | 9 | 0 | 441 |
| *Engraulis mordax* | northern anchovy | 175 | 11 | 2 | 188 |
| *Genyonemus lineatus* | white croaker | 158 | 19 | 0 | 177 |
| *Citharichthys stigmaeus* | speckled sanddab | 0 | 55 | 110 | 165 |
| *Citharichthys xanthostigma* | longfin sanddab | 0 | 0 | 24 | 24 |
| *Hyperprosopon argenteum* | walleye surfperch | 23 | 1 | 0 | 24 |
| *Menticirrhus undulatus* | California corbina | 16 | 0 | 0 | 16 |
| *Paralichthys californicus* | California halibut | 1 | 2 | 11 | 14 |
| *Cymatogaster aggregata* | shiner surfperch | 0 | 5 | 6 | 11 |
| *Phanerodon furcatus* | white seaperch | 0 | 6 | 4 | 10 |
| *Embiotica jacksoni* | black surfperch | 0 | 7 | 0 | 7 |
| *Heterostichus rostratus* | giant kelpfish | 1 | 3 | 0 | 4 |
| *Xystreurys Iolepis* | fantail sole | 0 | 3 | 1 | 4 |
| *Pleuronichthys ritteri* | spotted turbot | 0 | 1 | 2 | 3 |
| *Syngnathus californiensis* | kelp pipefish | 3 | 0 | 0 | 3 |
| *Anchoa compressa* | deep-bodied anchovy | 2 | 0 | 0 | 2 |
| *Atherinopsis californiensis* | jacksmelt | 2 | 0 | 0 | 2 |
| *Atractoscion nobilis* | white sea bass | 2 | 0 | 0 | 2 |
| *Paralabrax clathratus* | kelp bass | 0 | 2 | 0 | 2 |
| *Raja binoculata* | big skate | 0 | 0 | 2 | 2 |
| *Cheilotrema saturnum* | black croaker | 0 | 1 | 0 | 1 |
| *Gymnura marmorata* | butterfly ray | 1 | 0 | 0 | 1 |
| *Myliobatis californica* | bat ray | 1 | 0 | 0 | 1 |
| *Pleuronichthys verticalis* | hornyhead turbot | 0 | 0 | 1 | 1 |
| *Synodus lucioceps* | California lizardfish | 0 | 0 | 1 | 1 |
| *Triakis semifasciata* | leopard shark | 1 | 0 | 0 | 1 |
| **Totals** | | **818** | **125** | **164** | **1107** |

## Pelagic Fish

Pelagic fish are those species associated with the ocean surface or the water column. Distribution of pelagic fish is generally governed by water depth, distance from shore, and other environmental factors. Oceanic waters up to depths of approximately 200 m are referred to as the epipelagic zone. Epipelagic zone waters are typically well lighted, well mixed, and support photosynthetic algal communities. Water depths from 200 to approximately 1,000 m are referred to as the mesopelagic zone, while depths greater than 1,000 m are considered the bathypelagic zone. With increasing depths, light, temperature, and dissolved oxygen concentrations decrease as pressure increases. Hence, the bathypelagic zone, is characterized by complete darkness, low temperature, low oxygen concentrations, and high pressure. Each zone is distinguished by characteristic fish assemblages (Moyle and Cech, 1988). Generally, epipelagic fishes are relatively large, active, fast growing, long-lived fishes that reproduce early and repeatedly. Mesopelagic fishes are relatively small, slow growing, long-lived fishes that reproduce early and frequently. Bathypelagic fishes are relatively large, sluggish, rapid-growing, slightly shorter-lived fishes that reproduce late and maybe only once during their lifetime (Childress et al., 1980)

Pelagic fishes in the project area are a mix of year-round residents and migrants from several different habitats. Species include large predators (e.g., tunas, sharks, swordfish) and forage fish (e.g., northern anchovy and Pacific sardine). The distributional ranges for pelagic fishes are generally quite extensive and cover much of the coastal California region. Many fish in the pelagic zone such as albacore tuna migrate over vast areas in the Pacific.

Common epipelagic fish in the region include planktivorous schooling fishes such as Pacific mackerel, and northern anchovy; predatory schooling fishes such as Pacific bonito (*Sarda chiliensis)* and yellowtail; and large solitary predatory fishes such as blue shark (*Prionace glauca*) and swordfish (*Siphias gladius*) (Mais 1974, 1977; Squire 1983, Bedford and Hagerman 1983, Cailliet and Bedford 1983).

There are few published studies on pelagic fish assemblages in the neritic zone (within approximately 20 km of the coast) of the SCB. However, northern anchovy is the most abundant species (>80% of all fishes caught) caught within 3 km of the coast, with queenfish, white croaker (*Genyobnemus lineatus*),Pacific butterfish (*Peprilus simillimus*) and three types of silversides (Antherinidae) also being common. Except for northern anchovy, whose abundance increases during the summer due to recruitment of juveniles), there is little seasonal variation in total catch (L. G. Allen and DeMarini 1983).

The composition of fish assemblages on the mainland shelf and slope changes with depth and latitude, although trends with depth are more dramatic than trends with latitude (M. J. Allen, 1982). Faunal turnover is most rapid from the surf zone out to about 25 m in depth, and again between 100 and 150 m depth (J. Cross unpubl. data). Schooling water column fishes dominate just outside the surf zone throughout the SCB. This is confirmed by impingement studies performed at SONGS which indicate a diverse composition of nearshore fishes (Table Ap.2-4) heavily dominated by schooling forage fish such as northern anchovy, queenfish, and Pacific sardine.

Sharks and rays, also epipelagic fish, occur in the general project area. Since its inception in 1983, seventeen shark species have been reported in the Southern California Bight area by the CDFG shark tagging program.[4] The most common species encountered and tagged by this program, are the blue shark *Prionace glauca,* and the shortfin mako shark, *Isurus oxyrinchus*. Correspondingly, these sharks represent a large portion of the recreational shark fishery in California waters. The waters of the SCB,

4 http://www.sharktagger.com/program.html

Table Ap.2-4.
Relative Estimated Annual Fish Impingement Counts at SONGS in 2003
(adapted from SONGS, 2003)

| Common Name | Unit 2 | Unit 3 | Total |
|---|---|---|---|
| northern anchovy | 883,575 | 2,281,516 | 3,165,091 |
| queenfish | 81,747 | 191,879 | 273,626 |
| Pacific sardine | 12,742 | 50,597 | 63,339 |
| Pacific pompano | 4,419 | 22,163 | 26,582 |
| jacksmelt | 2,077 | 5,672 | 7,749 |
| white seaperch | —* | 3,624 | 3,624 |
| walleye surfperch | 1,551 | 1,877 | 3,428 |
| shiner perch | 1,401 | 1,836 | 3,237 |
| white croaker | 727 | 2,025 | 2,752 |
| bocaccio | 762 | 1,661 | 2,423 |
| jack mackerel | 830 | 492 | 1,322 |
| salema | 1,004 | — | 1,004 |
| sargo | — | 864 | 864 |
| specklefin midshipman | — | 822 | 822 |
| black perch | — | 607 | 607 |
| topsmelt | 603 | — | 603 |
| yellowfin croaker | 526 | — | 526 |
| deep body anchovy | — | 488 | 488 |
| cabezon | 480 | — | 480 |
| California grunion | 372 | — | 372 |
| **Totals of top 15 species** | **992,816** | **2,566,123** | **3,558,939** |
| **Totals of all species** | **995,398** | **2,569,039** | **3,564,437** |

* Fish count for species was not in top 15 for this unit

in particular, are believed to be a nursery area for these two species. The prey species of the blue shark, which is found worldwide in temperate and subtropical seas, includes various fish species such as the slender sole *Lyopsetta exilis*, cuskeels, sanddabs, and squid (Love, 1991). The diet of the mako consists mainly of bony fishes such as mackerels, tunas, bonitos and swordfish. Consequently, mako are frequently caught as by-catch by commercial fisheries for these fish species.

White sharks, *Carcharondon carcharias,* are another familiar resident of the SCB. Over the past several years, both juvenile and adult white sharks have been noted in the nearshore waters off the coast of San Onofre and in the immediate vicinity of SONGS.[5] Although adults are commonly known to feed on larger marine mammals[6] such as elephant seals, juvenile white sharks prey on small sharks and bony fishes, such as grunion, *Leuresthes tenuis*, which come ashore to spawn on sandy beaches throughout southern California from early March through September.[7] On 20 August 2004, a juvenile great white is believed to have been responsible for an attack on a surfer in nearby San Clemente[8] that took place when bait fish were present in large quantities.

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5 http://www.signonsandiego.com/news/northcounty/20030824-0123-shark.html

6 http://swfsc.nmfs.noaa.gov/frd/HMS/Large%20Pelagics/Sharks/food%20habits/food%20habits.htm

7 http://www.dfg.ca.gov/mrd/grnindx3.html

8 http://www.surfpulse.com/sharks.shtml

## Endangered and Threatened Fish Species

One rockfish species, *Sebastes paucispinis* or bocaccio, has been listed as a Species of Concern by NOAA since 1999. In January 2001, it was petitioned for listing under the Endangered Species Act (ESA). A formal status review required by the ESA was initiated in June of 2001 by the National Marine Fisheries Service (NMFS). This review indicated that the southern population of bocaccio was at 3.6 percent of its pre-exploitation biomass, or approximately 1.6 million fish. The decline to this low level is due to a combination of overfishing and poor recruitment of young bocaccio into the population. However, based on the review, NMFS determined that listing was not warranted (67 FR 69704, November 19, 2002) provided certain management measures were implemented to protect the remaining population.[9] A more recent stock assessment conducted in 2003, indicates that the current long-term risk of further decline is very low. During 2003, bocaccio were the tenth most common species entrained at SONGS, with 2,423 returned to the sea alive (Tables Ap.2-4 and Ap.2-5)

Table Ap.2-5. Species of Special Interest Entrained at SONGS in 2003 (SONGS, 2003)

| Species | Reason for Concern | Number of Impinged Fish Returned Alive |
|---|---|---|
| California Halibut | Important sport and commercial fish | 13 |
| Cabezon | Species of Special Concern* | 649 |
| Bocaccio | Species of Special Concern | 2423 |
| Giant Sea Bass | Protected in California | 15 |
| Kelp Bass | Important recreational fish | 78 |
| White Sea Bass | Important sport and commercial fish | 194 |
| California Sea Lion | Marine Mammal Protection Act | 39 |
| Harbor Seal | Marine Mammal Protection Act | 21 |
| Green Sea Turtle | Endangered Species Act | 0 |

* Cabezon is no longer listed as a species of concern by NOAA.

Cabezon, *Scorpaenichthys marmoratus*, is the largest member of the cottid family. Ranging from Alaska to Baja California, cabezon are prized by sport divers for their edibility, size, and ease of capture. They are found on hard bottoms in shallow water to depths of 250 feet. Increased commercial fishing pressures, particularly from the live fish market, have created concern for the viability of this species in nearshore coastal waters. After bocaccio, they were the most frequently entrained species of special interest encountered at SONGS during 2003 (Table Ap.2-5).

## Marine Mammals

Bonnell and Dailey (1993) list a total of 36 marine mammal species known to occur in the Southern California Bight from sightings and strandings, and an additional three species that may be possible visitors to the area. The marine mammal species reported can be grouped into the following three categories: (1) migrants that pass through the area on their way to calving or feeding grounds, (2) seasonal visitors that remain for a few weeks to feed on a particular food source, or (3) year-round residents of the area. Of the 39 species listed, 32 were cetaceans (i.e., whales, dolphins, and porpoises), six were pinnipeds (i.e., seals and sea lions), and one was a fissiped (the sea otter). A listing of these species and their abundance and status is provided in Table Ap.2-6.

9 http://www.nmfs.noaa.gov/pr/species/concern/profiles/bocaccio.pdf

Table Ap.2-6.
Cetaceans of the Eastern North Pacific and Their Status off Southern California
(Adapted from Bonnell and Dailey, 1993)

| Common Name | Scientific Name | Abundance | Status |
|---|---|---|---|
| Baleen Whales (Suborder Mysticeti) | | | |
| Blue whale | *Balaeoptera musculus* | Rare. Migratory population peaks in summer due to northward migration | E* |
| Fin whale | *B. physalus* | Rare. Migratory population with peak abundance in summer. | E |
| Sei whale | *B. borealis* | Rare. Seen only during summer months during migration. Primarily offshore | E |
| Bryde's whale | *B. edeni* | Rare. Single sighting occurred near San Diego | NA |
| Minke whale | *B. acutorostrata* | Common. Migratory population with peak abundance during spring and summer | NA |
| Humpback whale | *Megaptera novaeangliae* | Uncommon. Migratory population with peak abundance during summer and autumn | E |
| Gray whale | *Eschrichtius robustus* | Common during migration in winter and spring | NA |
| Northern right whale | *Eubalaena glacialis* | Rare. Only two sightings in southern California | E |
| Toothed Whales (Suborder Odontoceti) | | | |
| Sperm whale | *Physeter macrocephalus* | Uncommon. Primarily in offshore waters. Occasional visitor. | E |
| Common dolphin | *Delphinus delphis* | Common. Year-round resident | NA |
| Northern right-whale dolphin | *Lissodelphis borealis* | Common in the winter and spring | NA |
| Pacific white-sided dolphin | *Lagenorhynchus obliquidens* | Common. Year-round resident | NA |
| Risso's dolphin | *Grampus griseus* | Common. Year-round resident with peak population in summer and autumn | NA |
| Dall's porpoise | *Phocoenoides dalli* | Common. Year-round resident with peak population in autumn and winter | NA |
| Bottlenose dolphin | *Tursiops truncatus* | Common. Year-round resident | NA |
| Harbor porpoise | *Phocoena phocoena* | Rare. Occasional visitor to area from northern latitudes | NA |
| Short-finned pilot whale | *Globicephala macrorhynchus* | Small year-round population with increases during winter | NA |
| Killer whale | *Orcinus orca* | Uncommon. Occasional visitor to area from northern latitudes during summer and winter | NA |
| False killer whale | *Pseudorca crassidens* | Rare. Occurs primarily in tropical to warm temperate waters. Occasional visitor to area | NA |
| Cuvier's beaked whale | *Ziphius cavirostris* | Uncommon. Occasional visitor known from sightings and strandings. Primarily offshore. | NA |
| Baird' beaked whale | *Berardius bairdii* | Rare. Endemic to Arctic and cool temperate waters | NA |
| Hubb's beaked whale | *Mesoplodon carhubbsi* | Uncommon. Known primarily from stranding records. | NA |
| Ginkgo-toothed beaked whale | *M. ginkgodens* | Rare. Known from a single stranding record | NA |
| Hector's beaked whale | *M. hectori* | Rare. Known primarily from stranding records | NA |
| Blainville's beaked whale | *M. densirostris* | Rare. Possible visitor to area from northern waters | NA |
| Bering Sea beaked whale | *M. stejnegeri* | Rare. Possible visitor to area from northern waters | NA |
| Dwarf sperm whale | *Kogia simus* | Possible visitor. Known from strandings in central California and Mexico | NA |
| Pygmy sperm whale | *K. breviceps* | Rare. Occurs in tropical and warm temperate waters. Known from strandings | NA |

Table Ap.2-6.
Cetaceans of the Eastern North Pacific and Their Status off Southern California
(Adapted from Bonnell and Dailey, 1993)

| Common Name | Scientific Name | Abundance | Status |
|---|---|---|---|
| Striped dolphin | *Stenella coeruleoalba* | Rare. Occasional visitor to area. Known from sightings and strandings | NA |
| Spinner dolphin | *S. longirostris* | Occurs in tropical waters; possible visitor to area | NA |
| Spotted dolphin | *S. attenuata* | Occurs in tropical waters; possible visitor to area | NA |
| Rough-toothed dolphin | *Steno bredanensis* | Occurs in tropical waters; possible visitor to area | NA |

NA = Not Applicable; E = Endangered; T = Threatened

Generally, marine mammals are characterized by extensive distributional ranges (Gaskin, 1982). In this context the SCB represents a region of overlap. It is an area where populations of marine mammals having different biogeographic affinities intermingle (Dohl et al., 1983a). Several marine mammal species reach the southern limit of their ranges in the SCB while other species are at their northern range limits (Hubbs, 1960; Bonnell and Daily, 1993).

Boreal species, which are marine mammals found in the cooler waters of the North Pacific occur in central California during winter through early summer. They are found in areas of coastal upwelling and in the coolest waters of the California current. Examples of boreal species present within the SCB include Dall's porpoises, harbor porpoises, and the northern fur seals.

Conversely, the Bight waters frequently represent the northern bounds of marine mammals that are commonly found in warmer or subtropical waters to the south. Examples of these species include California sea lions and northern elephant seals, bottlenose dolphins and pilot whales.

Some species, for example the southern sea otter, are endemic to coastal central California and occur year-round at the northern fringes of the SCB, but are rarely seen south of Point Conception. Several additional species are largely restricted to the waters of the California Current, and occur in high numbers off of southern and central California. These species include the California sea lion, northern elephant seal, and during its migration, the California gray whale (Dohl et al., 1983a).

## Cetaceans

Although the numbers and species vary from season to season and from year to year, cetaceans (whales, dolphins, and porpoises) occur in the waters off of southern California year-round. Cetacean population levels are generally at their lowest in summer and are at their highest levels during the winter and spring when the bulk of the gray whale population passes through during the annual migration between their feeding grounds in the north Pacific, and their calving grounds in lagoons off the outer coast of Baja California.

Numerically, baleen whales are not a major component of the area's cetacean fauna. Although eight species have been reported within the SCB, only six occur with any frequency: the California gray whale (*Eschrichtius robustus)*, the humpback whale (*Megaptera novaeangliae)*, the blue whale (*Balaenoptera musculus)*, sei whale (*B. borealis*), mink whale (*B. edeni*), and the fin whale (*B. physalus)* (Bonnell and Dailey 1993). The majority of these whales use the coastal waters as migratory routes twice a year, pausing often to feed along the coast during their journey. The California gray whale is the most common baleen whale, and passes through the area twice on their annual migration. Most of the world population of this species make the biannual trip along the California coastline, and the majority are found close to shore over continental shelf waters (Herzing and Mate, 1984; Reilly, 1984; Rice et al., 1984; Rugh, 1984; Dohl et al., 1983a; Sund and O'Connor, 1974). The gray whale population off the coast of California ranges between 19,000 and 23,000 individuals, although during 1998, the population reached a peak of 26,000 individuals.

Peak periods of abundance of baleen whales occur during the winter and spring migration seasons. However, as overall populations of certain species increase (e.g., gray whales and humpback), larger numbers are becoming resident to areas offshore California (Dohl et al., 1983a). Both species have historically appeared off southern California as they migrate through the area to winter off of Baja California. Blue, fin, and sei whales have also been observed off southern California, though they typically remain well offshore.

Table Ap.2-7.
Seasonal Distribution of Cetaceans Within 3 Miles of Shore on the Continental Shelf
(Adapted from Bonnell and Dailey, 1993)

| Winter | Spring | Summer | Autumn |
|---|---|---|---|
| Gray whale | Gray whale | Risso's dolphin | Risso's dolphin |
| Bottlenose dolphin | Bottlenose dolphin | Bottlenose dolphin | Bottlenose dolphin |
| Common dolphin | Common dolphin | Common dolphin | Common dolphin |
| | Pacific White-sided dolphin | Pacific White-sided dolphin | Pilot whale |
| | | Pilot whale | |

Four species of porpoises represent the major year-round cetacean fauna found off of southern California in the project area. They are the Pacific white-sided dolphin (*Lagenorhynchus obliquidens)*, the bottlenose dolphin (*Tursiops truncatus)*, Risso's dolphin (*Grampus griseus)*, and the common dolphin (*Delphinus delphis)*. These species vary in their patterns of usage of the area and periods of peak abundances (Table Ap.2-7). Overall, however, the common dolphin is the most abundant cetacean species in the Southern California Bight, accounting for 57-84% of the total seasonal cetacean population in the area.[10] Between 15,000 and 57,000 common dolphins reside or pass through the SCB each year (Table Ap.2-8). They exhibit a strong seasonal distribution pattern with the greatest abundance in the SCB occurring in the summer and autumn months (Bonnell and Dailey 1993).

Table Ap.2-8. Estimated Annual Populations of Selected Cetaceans
Occurring within the Southern California Bight
(Adapted from Bonnell and Dailey, 1993)

| Species | Annual SCB Population |
|---|---|
| Common dolphin | 15,000-57,000 |
| Gray whale | 21,000 |
| Pacific White-sided dolphin | 6,000 |
| Risso's dolphin | 1,400 |
| Bottlenose dolphin | 160- 620 |
| Pilot whale | 370 |

10 Dahl et.al. 1981.

The most abundant cetacean species that occur within the three-mile boundary of the coast are provided in Tables Ap.2-8 and Ap.2-9. The number of species and individuals on the shelf within three miles from shore are substantially lower than those found in deeper waters on the shelf and slope (Dohl et al., 1983a). Within the SCB, the highest numbers of cetaceans are observed during the summer and autumn seasons when common, bottlenose, and Pacific white-sided dolphins are most abundant. In contrast, the numbers of gray whales peak during winter and early spring as they migrate to and from calving grounds in Baja. Pilot whale populations, though small, also peak during the winter season, although the bulk of the population at that time is concentrated within 20 km of the Palos Verdes Peninsula, well to the north of the project area.

## Pinnipeds

Six pinniped species occur off southern California (Table Ap.2-9). The pinnipeds are the California sea lion (*Zalophus californianus)*, the Northern or Steller sea lion (*Eumetopias jubatus)*, the northern fur seal (*Callorhinus ursinus)*, the Guadalupe fur seal (*Arctocephalus townsendi*) and the northern elephant seal (*Mirounga angustirostris)*, and the harbor seal *Phoca vitulina* (Bonnell et al., 1983). The total population size for the continental shelf is estimated to exceed 50,000 animals in the fall and nearly 50,000 animals during the spring. At least 30,000 pinnipeds are estimated to occur in the area all year-round. When one population is at its peak, the other is at its low for the area (Bonnell et al., 1983). Northern fur seals reach their peak in winter and spring, as migrants from the Bering Sea arrive to overwinter in California waters. California sea lions reach their peak in fall, as the breeding population disperses from rookery islands such as San Miguel.

Pinnipeds occur year-round within the three-mile boundary of the project area. The California sea lion is the most abundant and common pinniped in the project area. Within the Bight, the California sea lion represents between 50-93% of all pinnipeds on land and approximately 95% of all sightings at sea (Bonnell et al., 1981; Bonnell and Ford 1987).Their numbers are highest in the autumn and lowest in the winter. Although fewer in numbers, harbor seals also occur throughout the year in the project area. Their numbers, however, are highest during the spring and lowest in the summer.

The northern elephant seal and Steller sea lions occur to the north of the project area most of the year, having rookeries on several of the Channel Islands, predominately San Nicholas and San Miguel Islands. Both species haul-out at various locations on the central California coast, but are not known to have haul-outs near the project area.

Table Ap.2-9.
Pinnipeds of the Eastern North Pacific and Their Status in the Southern California Bight
(Adapted from Bonnel and Dailey, 1993)

| Common Name | Scientific Name | Abundance | Status |
|---|---|---|---|
| California sea lion | Zalophus californianus | Abundant, year-round resident | NA |
| Northern (Steller) sea lion | Eumetopias jubatus | Occasional visitor to area from northern latitudes. Not common | NA |
| Northern fur seal | Callorhinus ursinus | Common, year-round resident | NA |
| Guadalupe fur seal | Arctocephalus townsendi | Occasional visitor to area from southern breeding grounds. Not common | T |
| Northern elephant seal | Mirounga angustirostris | Year-round resident. Common on land, uncommon at sea. | NA |
| Pacific harbor seal | Phoca vitulina | Year-round resident. Common | NA |

T = Threatened Species; NA = Not Applicable

Five pinniped species maintain breeding populations off southern California. They are the California sea lion, the northern elephant seal, the Guadalupe fur seal, northern fur seal, and the harbor seal. A harbor seal rookery is located to the south of the project area on a mainland beach in La Jolla, while the Guadalupe fur seal rookeries are centered at Guadalupe Island well offshore Mexico. The nearest northern elephant seal rookies are at Piedras Blancas in central California, and on the Channel Islands. California sea lions and northern fur seals also maintain rookeries at the Channel Islands, particularly at San Miguel Island.

## Fissipeds

Historically, the southern sea otter (*Enhydra lutris*) ranged from Prince William Sound in Alaska to Morro Hermoso in Mexico, and numbered about 150,000 animals (Kenyon, 1969). During the 18th and 19th centuries otters were extensively hunted for their luxurious pelts, and by the early 1900s the species was believed to be extinct. The current population of southern sea otters are descended from a small colony (about 150 individuals) discovered off the Big Sur coast in 1938. Since that time, the population has slowly grown, reaching a peak of 2,377 individuals during a 1995 statewide survey. The otter population then declined substantially, about 5 percent per year, between 1995 and 1999. Currently, the population totals approximately 2,200 animals and generally ranges from Half Moon Bay in the north to Point Conception and Santa Barbara in the south.

A second, more southerly population was established beginning in 1987, when sea otters began being transplanted to San Nicolas Island in the hope that establishing a second population would guard against possibility of the mainland population being eliminated by an oil spill or similar coast-wide catastrophic event. Between 1987 and 1991, approximately 140 sea otters were transplanted to the island. However, this population has never established itself in great numbers at the island, and the annual population is usually comprised of less than 20 individuals. In 1996, only 17 otters remained.[11] Although technically within the sea otter's historical range, otters are not generally found within the project area.

## Noise Effects

Noise caused by support vessels and equipment may potentially disturb marine mammals. The degree of noise impact will depend on the emitted sound level and the proximity to marine mammals.

Noise from vessels have been shown to elicit a startle reaction from gray whales or mask their sound reception capabilities. Although sensitivity varies with whale activity, avoidance and approach responses have been observed in field studies (Watkins, 1986; Malme et al., 1989; Richardson et al., 1991). Migrating gray whales have been observed to avoid the approach of vessels to within 200-300 m (Wyrick, 1954) or to within 350-550 m (Bogoslovskaya et al., 1981). There is very little data on the sound levels involved but effects on gray whales from vessels are expected to be limited to within 200-550 m of the vessel, to be sublethal, and temporary in nature.

Few authors have described responses of regional pinnipeds to offshore noise generated by boats or ships. Johnson et al. (1989) report that Northern fur seals can be wary and showed avoidance at distances of up to one mile. Wickens (1994), however, reported that fur seals can be attracted to fishing vessels to feed. Sea Lions in the water can tolerate close and frequent approaches by vessels, especially around fishing vessels. Sea lions hauled out on land are more responsive and react when boats approach within

[11] http://pacific.fws.gov/news/1996/9631nr.htm

100-200 m (Peterson and Bartholomew, 1967). Harbor seals often move into the water in response to boats. Even small boats that approach within 100 m displace harbor seals from haulouts; less severe disturbance can cause alert reactions without departure (Bowles and Stewart, 1980; Allen et al., 1984; Osborn, 1985).

Dolphins of many species often tolerate or even approach vessels but at times members of the same species show avoidance. Reactions to boats often appear related to the dolphins' activity: resting dolphins tend to avoid boats, foraging dolphins ignore them, and socializing dolphins may approach (Richardson et al., 1995).

The literature indicates that while marine mammals hear man-made noises and sounds generated by vessels, there is no indication that they are affected deleteriously by the noise (Richardson et al., 1995). Because noise and vessels sounds generated from this project are highly localized and short-term in nature, adverse impacts to marine mammals from noise are not expected. The literature indicates that some species such as dolphins may be attracted to vessels but the majority will maintain distances of 100-200 m. Pinniped haulout areas are not located within the immediate project area so animals are not expected to be displaced by project activities.

## Sea Turtles

Although infrequent, sea turtles have occasionally been reported in coastal southern California. Over the years, four species have been reported in the project area. The four species are the green turtle (*Chelonia mydas)*, the Pacific ridley turtle (*Lepidochelys olivacea)*, the leatherback turtle (*Dermochelys coriacea)*, and the loggerhead turtle (*Caretta caretta)* (Hubbs, 1977). Three of the four species (Pacific ridley, leatherback, and green) are listed as endangered species under the U.S. Endangered Species Act. The remaining species, the loggerhead turtle is listed as a threatened species under the same Act.

Populations of marine turtles have been greatly reduced due to overharvesting and loss of nesting sites in coastal areas (Ross, 1982). In the eastern Pacific, most of the turtles nest along the coasts of Mexico and Central America. The nesting season varies with species, but is generally from May to September (Mager, 1984). Sea turtles breed at sea; and the females return to their natal beaches to lay their eggs (Mager, 1984). Female turtles can nest several times in a season but at two to three-year intervals. The eggs, after being laid in the sand, hatch in about two months; and the young instinctively head for the sea.

Although marine turtles are not common to the project area, they have occasionally been reported. According to the California Marine Mammal Stranding Network Database, 12 marine turtles were reported between Morro Bay and Pismo Beach during the 1982-1995 period. Of the 12 sightings, 10 were leatherbacks, and 1 each was a loggerhead, and green (NOAA, 1997). At the Diablo Canyon Nuclear Power Plant, 1 green turtle was reported in 1994 and 1997 (NOAA, 1997; Port San Luis Harbor District, 1997). No marine turtles were reported at SONGS during either 2002 or 2003. General distribution information for marine turtles is provided below.

### Green Sea Turtles (*Chelonia mydas*)

Green sea turtles occur worldwide in waters above 20°C; however, they have been reported as far north as Redwood Creek in Humboldt County, and off the coasts of Washington and Oregon (Green et al., 1991; Smith and Houck, 1983). Green turtles are also present in San Diego Bay (Hubbs, 1977). Currently, the warm discharge from the local power plant supports a small year-round population of approximately 30-60 turtles at the southern end of the bay. The area near the Duke Energy power plant is the only area on the west coast of the United States where green turtles are known to aggregate (Stinson, 1984). The green sea turtle is thought to nest on the Pacific coasts of Mexico, Central America, South America, and the Galapagos Islands (Mager, 1984). The only known nesting location in the continental U.S. is on the east coast of Florida. The green sea turtles are herbivores, feeding on algae and sea grasses.

## Pacific Ridley Sea Turtle (*Lepidochelys olivacea*)

The Pacific ridley or olive sea turtle is an infrequent visitor to the California coast. In the past, they have been reported as far north as Washington, Oregon, and California (Green et al., 1991; Houck and Joseph, 1958; Smith and Houck, 1983; Hubbs, 1977). In the eastern North Pacific, the primary range of the Pacific ridley extends from Columbia to Mexico (USDOI, 1996a). Major nesting beaches are located on the Pacific coasts of Mexico and Costa Rica. The population on Pacific beaches in Mexico has declined from an estimated 10 million adults in 1950 to less than 80,000 in 1983 (Mager, 1984). The Pacific ridley sea turtle is omnivorous, feeding on fish, crabs, shellfish, jellyfish, sea grasses and algae (Ernst and Barbour, 1972). There have not been sightings of Pacific ridley turtles in the project area in recent years (NOAA, 1997).

## Leatherback Sea Turtle (*Dermochelys coriacea*)

Leatherback sea turtles range farther north than any of the other sea turtles. This is due to their ability to maintain warmer body temperatures in colder waters (Frair et al., 1972). These turtles have been sighted as far north as Alaska and British Columbia (Mager, 1984; Smith and Houck, 1983).

Leatherback sea turtles are the most common sea turtle off the west coast of the U.S. (Dohl et al., 1983a; Green et al., 1989). From aerial surveys off the coast of Washington and Oregon, 16 sightings of leatherbacks have been reported between June and September when sea surface temperatures were the warmest (Green et al., 1991). During a three-year survey, leatherback sea turtles were reported off the coast of central California (Dohl et al., 1983a). The majority of their sightings occurred during the summer and fall seasons. Their sightings were distributed from 10 to 185 km offshore, but occurred primarily in waters over the continental slope. Ten strandings of leatherback sea turtles were reported between Morro Bay and Pismo Beach between 1982 and 1995 (NOAA, 1997).

Leatherback sea turtles are omnivores and but feed principally on soft prey items as jellyfish and tunicates (Mager, 1984). The population of leatherback sea turtles in the eastern Pacific is estimated at 8,000 nesting females and is concentrated in western Mexico, Central America, and northern Peru (Pritchard, 1971; Mager, 1984).

## Loggerhead Sea Turtles (*Caretta caretta*)

Loggerhead turtles primarily occur in subtropical to temperate waters and are generally found over the continental shelf (Mager, 1984). The eastern Pacific population breeds on beaches in Central and South America (Mager, 1984). Southern California is considered to be the northern limit of loggerhead sea turtle distribution (Stebbins, 1966). However, loggerheads have stranded on beaches as far north as Washington and Oregon (Green et al., 1991). In 1978, a loggerhead sea turtle was captured near Santa Cruz Island in southern California (Guess, 1982), while a second was reported stranded in the Morro Bay area (NOAA, 1997). Loggerhead sea turtles are omnivorous and feed on wide variety marine life including shellfish, jellyfish, squid, sea urchins, fish, and algae (Carr, 1952; Mager, 1984).

# Seabirds

The seabird fauna of southern California is large, diverse, and conspicuous from the coastline to hundreds of kilometers offshore. However, because of the limited range of project activities, this discussion is limited to seabirds or those species that obtain most of their food from the ocean or are predominantly found over water.

## Regional Perspective

Seabirds found in the Southern California Bight are far ranging and come from all corners of the Pacific Ocean, Bering Sea, Arctic Ocean, inland North America, and the North Atlantic. More than 195 species of seabirds use coastal or offshore habitats in the SCB, and 17 species breed within the SCB (Baird, 1993). For three of these species, black storm-petrels, Xantus' murrelets, and brown pelicans, the Bight is their only California breeding location.

Seabirds, together with sea ducks (scoters), loons, and western grebes, constitute the greatest biomass of avifauna that use the SCB. Of the seabirds, shearwaters, storm-petrels, phalaropes, gulls, terns, and auklets are the most numerous (Table Ap.2-10). Seabirds commonly eat fishes, squid, and crustaceans. Consequently, upwelling is extremely important for seabird foraging. Upwelling of dinoflagellates furnishes food for larval northern anchovies, which in turn are one of the most common prey items of seabirds in the SCB.

Table Ap.2-10.
Population Numbers and Densities of the Principal Species of Seabirds in the Southern California Bight
(adapted from Briggs et al., 1987)

| Species | Annual or Highest Population Size |
|---|---|
| Pacific loons | 40,000-46,000 |
| Western and Clark's grebes | 27,000 |
| Scoters | 125,000 |
| Pink-footed shearwaters | 40,000-400,000 |
| Sooty shearwaters | 2.7-4.7 million |
| Black-vented shearwaters | 20,000-30,000 |
| Northern fulmars | 120,000-300,000 |
| Leach's storm-petrels | 150,000 |
| Black storm-petrels | 100,000 |
| Least storm-petrels | 200,000 |
| Brown pelicans | 6,000-90,000 |
| Red and red-necked phalaropes | 925,000 |
| Bonaparte's gulls | 300,000 |
| Heermann's gulls | 45,000 |
| California gulls | 5,000 |
| Herring gulls | 32,500 |
| Western gulls | 25,000-50,000 |
| Black-legged kittiwakes | 50,000-300,000 |
| Common and arctic terns | 30,000-50,000 |
| Common murres | 20,000-30,000 |
| Cassin's auklets | 50,000-100,000 |
| Rhinoceros auklets | 100,000-300,000 |

Sooty shearwaters (*Puffinus griseus*) are among the most abundant and common species of seabird in the SCB. Their greatest numbers over the continental shelf occur in late spring when large concentrations appear near areas of upwelling. Northern fulmars have also been associated with regions of cool surface temperatures and high surface salinities characteristic of upwelling events (Ainley, 1976). In contrast, the least storm-petrel, black storm-petrel, the brown pelican and the pink-footed and black-vented shearwaters are all associated with areas of warmer water within the SCB (Briggs et al., 1987).

Most gulls in the SCB are present in greatest numbers only during the winter (Baird, 1993). Of the four species of gulls listed in Table Ap.2-10, only one, the western gull (*Larus occidentalis*) breeds in the SCB. Heermann's gull (*Larus heermanni*) is the most numerous gull on the beaches in San Diego County (Briggs et al., 1987). It remains near the coastline, usually foraging nor more than a few kilometers offshore. California gulls (*Larus californicus*) are among the most abundant gulls in nearshore waters in the fall and winter. Their numbers peak in the area from January through March just before they head to inland nesting grounds in spring. Bonaparte's gulls (Larus Philadelphia) also overwinter in southern California, remaining in the area from December to March.

Rhinoceros auklets constitute up to 30% of all seabirds off southern California during the winter, when the majority of the eastern Pacific population nests on offshore islands. Cassin's auklets also nest well offshore, with colonies established off San Miguel Island. Both these birds, though present in the area, generally remain well offshore of the mainland coast.

In central California, Souls et al. (1980) estimated that about 7% of the seabird population breeds between Ventura and Monterey Counties; but that the majority of this occurs on the Channel Islands. In the area from Morro Bay south to Point Conception, Chambers Consultants and Planners (1980) reported that very few seabirds breed in coastal mainland habitats due to human disturbances. The southern Channel Islands, however, provide habitat and breeding grounds for many bird seabird species, most notably, the brown pelican.

## Project Area

Seabirds occur year-round in the project area and the species present vary according to the season (Briggs et al., 1981). However, the highest density of seabirds occurs during the fall and winter months due to the combined presence of migrants, winter visitors, and year-round residents. The lowest density of birds occurs during the summer months. Common nearshore species were the California gull, herring gull, western gull, Bonaparte's gull, Brandt's cormorant, surf scoter, and western grebe. The dominant species in the area, by season, are provided in Table Ap.2-11.

More recently, aerial surveys conducted from 1999-2003 by researchers from USGS and Humboldt State University, and in conjunction with the MMS, identified 54 species of seabirds the southern coastal California region. The surveys were conducte in January, May and September of each year on transects that stretched from Cambria to the Mexican border.[12] Seabird species that were most abundant at sea during the January surveys include California gulls, western grebes, and Cassin's auklets, whereas sooty shearwaters, phalaropes, and western gulls were most abundant during the May and September surveys.

[12] http://soundwaves.usgs.gov/2004/11/research.html

Table Ap.2-11.
Seasonal Distribution of Principal Coastal Seabirds in the Project Area
(adapted from Baird, 1993)

| Winter | Spring | Summer | Autumn |
|---|---|---|---|
| Northern fulmar | Sooty shearwater | Sooty shearwater | Sooty shearwater |
| Heermann's Gull | Pink-footed shearwater | Pink-footed shearwater | Pink-footed shearwater |
| Bonaparte's Gull | Bonaparte's Gull | Heerman's Gull | Heerman's Gull |
| Western Grebe | Western Grebe | Storm-petrels | Storm-petrels |
| Black–vented shearwater | Black–vented shearwater | Western Gull | Bonaparte's Gull |
| Western Gull | Western Gull | Brown Pelican | Western Gull |
| Brown Pelican | Brown Pelican | | Brown Pelican |
| Black-legged kittiwakes | Black-legged kittiwakes | | Black-legged kittiwakes |
| Pharalope | Pharalope | | Pharalope |
| Scoters | Scoters | | Western Grebe |
| California Gull | | | |
| Rhinoceros auklet | | | |

### Endangered or Threatened Seabirds

The California brown pelican (*Pelecanus occidentalis californicus*) is a federally and state listed endangered species and ranges from British Columbia to southwest Mexico. In the U.S., the California brown pelican nests only on West Anacapa and Santa Barbara Islands off the southern California coast.

The listing of the California brown pelican was based primarily on serious declines in the southern California population due to bioaccumulation of chlorinated hydrocarbon pesticides (DDT, DDE, dieldrin, and endrin) in the pelican's food chain (USDOI, 1996a). Bioaccumulation of these pesticides resulted in serious eggshell thinning and poor reproductive success (Schreiber and Risebrough, 1972). Food scarcity, primarily anchovies, also contributed to the species' decline (Keith et al., 1971).

The breeding season for California brown pelicans extends from March through early August. Preferred nesting habitat is on offshore islands. In 1991, about 12,000 breeding birds were reported at two colonies on Anacapa and Santa Barbara Islands (Carter et al., 1992). The California brown pelicans occur in coastal areas as far north as British Columbia and as far south as southwestern Mexico. Peak populations within the SCB have been recorded from September to October. Offshore rocks and coastal habitats as rocky shores, sandy beaches, piers, provide important roost sites in the project area. They feed by plunge diving from heights of up to 15 to 20 m above the ocean surface and feed primarily on small schooling fish (e.g., anchovies) (USDOI, FWS, 1982). Pelicans return to specific roosts each day and do not normally remain at sea overnight. These roosts are usually in regions of high oceanic productivity and isolated from predation pressure and human disturbances. Project activities are not expected to result in any adverse impacts to this species.

## Benthos

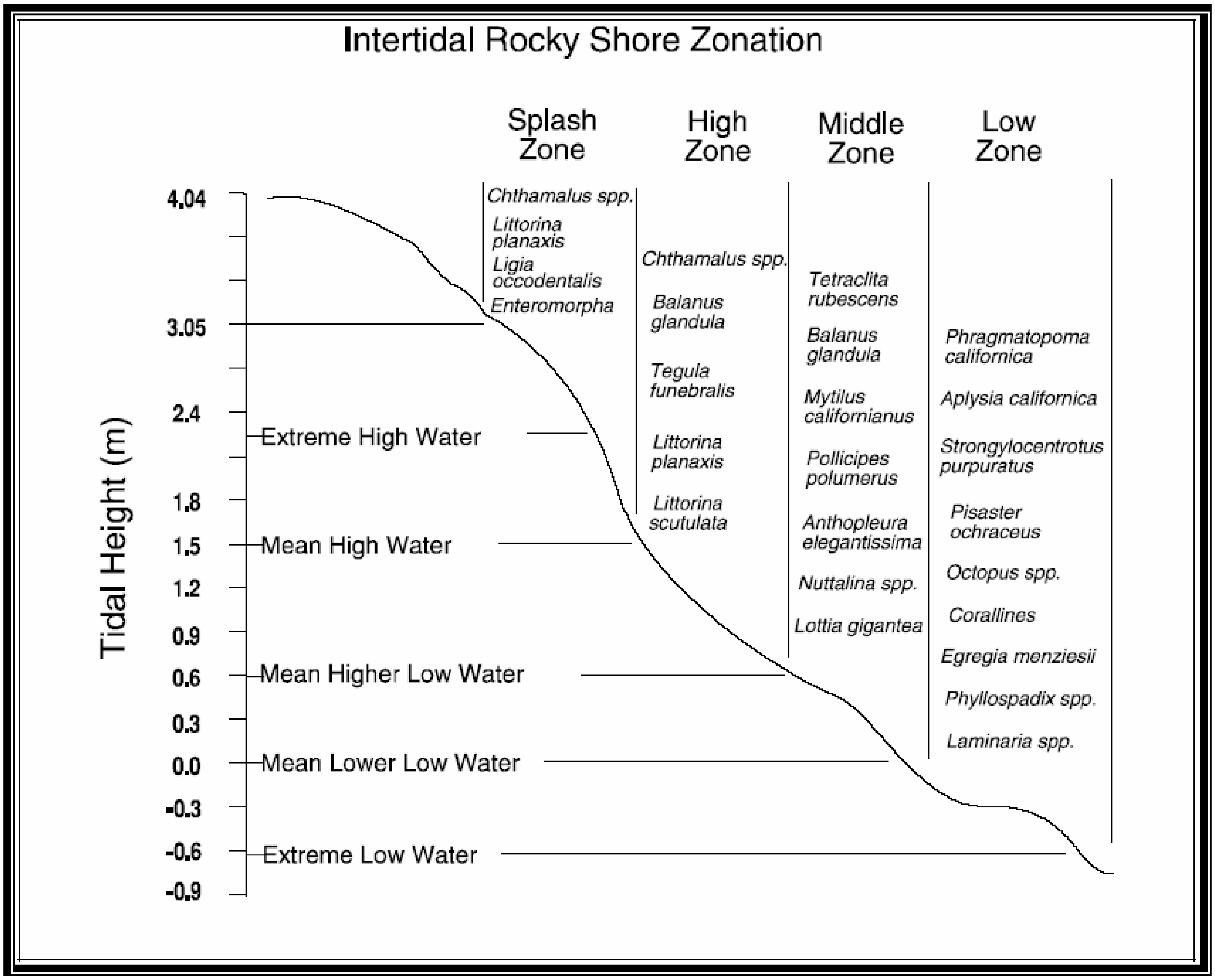
The benthos consists of organisms that live in or on the ocean floor. Benthic habitats are often classified according to substrate type, either unconsolidated sediments (e.g., gravel, sand, or mud) or rock. The former category is often referred to as soft bottom and the latter is often referred to as hard bottom or rocky substrate. Each supports its own characteristic biological community. In addition to substrate type, water depth and water temperature play important roles in the distribution of benthic organisms. Distance from shore, food availability, and water quality are also important factors that influence the distribution of benthic organisms. Benthic organisms can be epifaunal (attached or motile species that inhabit rock or sediment surfaces) or infaunal (live in soft sediments) (Thompson et al., 1993). Generally, more is known about intertidal and shallow subtidal benthic species than those of deeper areas.

## Rock Substrates (Hard-Bottom)

Rocky subtidal habitats within the study area are of interest because: (a) deepwater reefs are relatively rare along the central and southern California coast; (b) they support a diverse assemblage of epifaunal invertebrates; (c) they attract fish as a nursery ground, food source, and as shelter; and (d) epibiota are sensitive to mechanical disturbance (USDOI, 1995a) and increased sediment loads (Hardin et al., 1994). In addition to habitat disturbance, potential impacts to epibiota from the proposed project can arise from their sensitivity to increased suspended sediment loads. Many epifaunal taxa inhabiting high-relief rock outcrops are suspension feeders. They are not prevalent on low-relief (<1-m) rock substrates because of intolerance to near-bottom turbidity caused by resuspension of surficial sediments. In the Santa Maria Basin, off the central California coast, significant reductions in some epifaunal taxa were observed in response to exposure to drilling-mud discharge (Hyland et al., 1994). These biological changes were not associated with chemical contaminants, which were below toxic levels, but were related to the physical effects of particle loading.

Stable rocky areas consisting of large boulders, plateau-like mesas, and siltstone reefs are typically inhabited by a diverse flora and fauna which attach to the substrate and are collectively referred to as epifauna and epiflora. Although rocky intertidal and subtidal habitats are not present in the immediate vicinity of the project area, Pendleton artificial reef is located approximately 3.5 kilometers to the south, and areas of low-relief cobble substrate are present in the vicinities of both the San Onofre and San Mateo kelp beds.

Figure Ap.2-2. Intertidal Zonation of a Rocky Shore in Southern California (modified from Dailey et al., 1994)




### *Intertidal*

The tidal cycle of coastal California is semidiurnal with two unequal high tides alternating each day with two unequal low tides. As a result, four bands or zones are delineated based on the physical habitats. The vertical zonation of typical rocky intertidal organisms along the California coast is shown in Figure Ap.2-2. The upper most zone, above the high-tide line, is referred to as the "splash zone" and is usually not covered by the tides. Some of the more common inhabitants of this zone are the rock lice, (*Ligia occidentalis*); periwinkles (*Littorina* spp.), and white acorn barnacles (*Chthamalus* spp.) along with the green algaes. Downward in progression are the upper and mid- intertidal zones. California mussels (*Mytilus californianus*) form dense beds in these zones which are the basis of a diverse array fauna. The seastar, *Pisaster ochraceus* is one of the hardiest predators within the middle intertidal. Other animals include the gooseneck barnacles (*Pollicipes* spp.); acorn barnacles (*Balanus* spp.); abalone (*Haliotis* spp.); limpets (*Lottia* spp.); chitons, and the anemones (*Anthopleura* spp.). Interspersed within the mussel beds are numerous species of polychaetes and amphipods. A variety of algae provide shelter and protection from desiccation for many animals that otherwise could not exist so high up on shore (Ricketts et al., 1985). Common invertebrate species within the low rocky intertidal zone are the sea urchin (*Strongylocentrotus* spp.) and the limpet (*Acmaea* spp.).

#### *Subtidal*

The species diversity of hard-bottom communities is influenced in part by the availability of light and nutrients, degree of exposure to waves, and substrate characteristics (i.e., relief and texture).

### Soft Substrates

This section describes the benthic infauna found within the soft seafloor sediments in the project area. Mainland and island shelves constitute 11% of the sea surface of the SCB; their sediments are generally sands, silty sands, and sandy silts. Basin and trough slopes and floors constitute approximately 80% of the sea surface area, and are generally comprised of silty clays and clayey silts (Emery, 1960). Sandy beaches are the predominant intertidal habitat in the project area. Because of the inherent difficulties in conducting ecological studies in sand, far less is known about invertebrate communities that live there than those found on rocky substrates. Sand dwelling organisms are very motile, difficult to mark, and cannot be easily monitored over time. Immigration and emigration rates are high and often contribute to the high levels of temporal and spatial patchiness in density that are often reported (Thompson et al., 1993). Also, studies are difficult to conduct in unstable sediments in a high-energy environment.

Although not obvious, vertical zonation of invertebrates occurs on sandy beaches. The invertebrates that live in sand (infauna) are quite motile and change position with respect to tidal level. Also, predictably, certain species will be found higher or lower than others. Common invertebrates in the upper intertidal are several species of amphipods in the genus Orchestoidea; the predatory isopod, Excirolana chiltoni; and several species of polychaetes (e.g., Excirolana chiltoni, Euzonus mucronata, and Hemipodus borealis). The middle intertidal is characterized by species such as the sand crab, Emerita analoga and the polychaete Nephtys californiensis. Emerita is generally the most abundant of the common middle intertidal organisms often comprising over 99 percent of the individuals on a given beach (Straughan, 1983). In the low intertidal, polychaetes and nemerteans dominate (Straughan, 1982).

In shallow water $<10$ m, epifaunal (organisms which live on the sediment or rock surfaces) communities are generally well developed (Thompson, 1993). With increasing depth, the density of epifaunal species decline while that of infauna increases probably because of the greater stability of sediments (Barnard, 1963). Also, with depth, polychaetes become more dominant over crustaceans (Oliver et al., 1980). Physical changes to nearshore subtidal habitats are associated with increasing depth. One of the most important is a decrease in wave surge and as a result, finer sediments which influences the distribution of epifaunal species in nearshore environments (Thompson, 1993). Merrill and Hobson (1970), have shown that shoreward limit of the sand dollars (Dendraster excentricus) occurs near the break line, with the inner most population consisting of small juveniles. Seaward, they found that sand dollars become progressively larger and more abundant.

The effects of wave action on benthic infauna are not well known. However, several studies indicate the declines in the abundance of tube-building polychaetes in shallow water ($<$ 10 m) to increasing substrate disturbance (Oliver et al., 1980; Davis and VanBlaricom, 1978).

#### *Horizontal and Temporal Distribution*

Many organisms are characterized by patchy distribution in the intertidal zone. Sand crabs show horizontal patchiness on scales from meters to kilometers due to alterations in longshore current patterns caused by natural topographic features or man-made structures such as jetties and pier pilings (Cubit, 1968). Natural and man-made features which create convergence areas where the water pools tend to be areas where sand crabs can concentrate (Thompson et al., 1993).

The local abundance of invertebrate species on sandy beaches can change significantly over short time periods. Sand crabs move up and down the beach with the tides and maintain their position in the swash zone (Thompson, 1993). Hence, abundances of sand crabs in the intertidal roughly corresponds to a curve that is similar to that of the tides (Efford, 1965; Cubit, 1968; Perry, 1980). Beach hoppers, (*Orchestoidea* spp.), also migrate vertically in the intertidal in approximate synchrony with the tides (Thompson, 1993). At low tides, they emerge from burrows in the high intertidal and move vertically down the intertidal to feed on stranded algal material. They then retreat before the incoming tide and return to their burrows in the high intertidal (Fawcett, 1969).

Seasonal variability in the population density of sand crabs is high. Normally, they tend to be more abundant in the summer and fall. Their numbers are reduced during the winter months and can be absent on beaches (Barnes and Wenner, 1968; Perry, 1980).

#### *Mechanisms Responsible for Distribution Patterns*

The composition of invertebrate assemblages on a sandy beach are correlated to slope and sand texture. Within a beach, crustaceans and molluscs tend to be more common on steeper, coarser, and dryer upper intertidal zone. Polychaetes and nemerteans are the dominant invertebrates in the lower intertidal where slope is not as steep and the sand usually finer and wetter (Wenner, 1988; McLachlan and Hesp, 1984; Straughan, 1982). Studies conducted on invertebrates (e.g., Emerita), demonstrate how physical forces such as wave action can influence the distribution and abundance of sand-dwelling invertebrates. Emerita aggregate in the middle intertidal and move vertically with the tides (Efford, 1965; Cubit, 1968; Barnes and Wenner, 1968). Small male crabs tend to occur highest on the shore, and the females predominate lower on the shore (MacGinitie, 1938; Efford, 1965; Cubit, 1968). Studies indicate that sand crab aggregations are formed by the response of crabs to waves and currents interacting with features on the beach (Cubit, 1968; Barnes and Wenner, 1968; Dillery and Knapp, 1969; Perry, 1980). Cubit (1968) performed a classic experiment that demonstrated how sand crabs react to physical forces that could account for distribution patterns. Breaking waves suspend sand. Sand crabs react by burrowing out of the sand and are carried up the beach. As the upwash loses momentum, the sand crabs burrow into the sand and begin to feed. Uprushing water reaching the top of the wash zone soaks through it causing it to become fluid or thixotropic. Sand crabs then respond to this change by burrowing out and are carried down the beach until the momentum of the backwash lessens. At this point, they then burrow into the sand. The behavior of burrowing out when the beach sand becomes fluid, combined with physical properties of waves, explain how aggregations of sand crabs are maintained in a swash zone that shifts among tidal levels (Thompson et al., 1993).

This mechanism also seems to account for lower density of sand crabs on shallow-sloped, fine-grained beaches were waves are small, and the dominance of small sand crabs near the top of the swash zone and large ones near the bottom. The change from thixotropic to nonthixotropic sand is less marked on shallow-sloping beaches because waves are smaller and sand is finer. Small waves suspend less sand at the bottom of the swash zone and fine sand tends to be saturated with water which does not undergo the shift from a nonfluid to a fluid state (Thompson et al., 1993). Other physical mechanisms also account for horizontal distribution of E. analoga. When cusps are formed on beaches, sand crabs tend to aggregate in their bays or furrows and in convergence areas (Cubit, 1968; Dillery and Knapp, 1969; Perry, 1980).

### *Biological Interactions*

Sand crabs are heavily preyed upon by shallow subtidal fishes. In particular, the barred surfperch, Amphistichus argenteus. Studies have shown that the sand crab constitutes as much as 90 percent of the surfperch diet (Carlisle et al., 1960; Fitch and Lavenberg, 1971). Staphlinid beetles have been reported to prey on beach hoppers in the upper intertidal (Craig, 1968). Beach hopper densities, however, were not significantly affected by beetle predation.

### *Influences to Invertebrates from Human Activities*

Human activities that have been reported to change invertebrate distributions include the construction of jetties, groins, sea walls, buildings, highways, channeling and damming of streams and rivers, beach maintenance, and oil spills (Thompson et al., 1993). However, the evidence that these changes cause long-term changes to population levels of sandy beach invertebrates is scant and indirect. Damming of streams reduces sediment input to beaches and, in some cases, has caused erosion that could affect invertebrate communities (Thompson et al., 1993). Straughan (1982) found that construction of a sea wall reduced the slope, intertidal range of a section of a sandy beach, and sediment grain size. She found that these changes appeared to select for polychaetes and nemerteans and against crustaceans. In her study of sandy beach invertebrates, Straughan found that heavily used and populated beaches in southern California were regularly cleaned of kelp and other debris. Sand was also added to these beaches periodically. These beaches were consistently depauperate and lacked beach hoppers over a ten-year period.

### *General Project Area*

Straughan (1982) conducted comprehensive intertidal surveys from southern California north to Morroy Bay and Guadalupe Beach in southern San Luis Obispo County over a 12-year period. At sampling sites located along a transect extending from the supratidal to intertidal areas, annelids and crustaceans dominated.

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