C BIOLOGICAL AND HISTORICAL/CULTURAL RESOURCES OF THE STUDY AREA

APPENDIX C

BIOLOGICAL AND HISTORICAL/CULTURAL RESOURCES OF THE STUDY AREA FOR THE CHANNEL ISLANDS NATIONAL MARINE SANCTUARY MANAGEMENT PLAN UPDATE

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1.0 BIOLOGICAL RESOURCES

As a supplement to Section 3, Affected Environment, this appendix provides additional information on the biological resources within the Study Area for this Environmental Impact Statement (EIS), including the Channel Islands National Marine Sanctuary (CINMS) and surrounding area. This includes additional discussion of habitats and species present, including special-status species, such as rare, threatened, or endangered species. Much of this information was taken directly from the 2002 document *Marine Protected Areas in NOAA's Channel Islands National Marine Sanctuary - Final Environmental Document* (California Department of Fish and Game 2002), available on line at http://www.dfg.ca.gov/mrd/ci_ceqa/index.html, with the cooperation of the California Department of Fish and Game.

1.1 HABITAT TYPES

Important habitats in the CINMS are classified according to a simple, multidimensional habitat classification, using depth, exposure, substrate type, and dominant plant assemblages (Table C-1). The classification was conducted used existing maps and sediment samples taken throughout the CINMS. These included a Shoreline Inventory Database (Minerals Management Service [MMS] 2000) that describes a variety of coastal features in Santa Barbara County, a series of maps of over 5,000 sediment grabs around the Channel Islands (Amuedo and Ivey, Engineers 1967), a database of soft sediment samples in the northern Channel Islands (U.S. Geological Survey [USGS] unpublished data) and substrate maps of the sea floor around Channel Islands (MMS 1984).

These sources were combined using a geographic information system (GIS) to develop a comprehensive substrate map of the CINMS, divided into soft substrate (e.g., mud, sand, gravel) and hard substrate (e.g., rock, boulder, bedrock). A bathymetric map of the Channel Islands (Waltenberger 1995) was used to distinguish habitat types at the following depth intervals: shoreline, euphotic zone (intertidal–30 meters), upper continental shelf (30–100 meters), lower continental shelf (100–200 meter), continental slope (>200 m). Dominant plant species, including giant kelp and seagrasses, form marine habitats used by diverse groups of invertebrates, fish, mammals and seabirds (Anderson *et al.* 1993). The potential distribution of giant kelp around the northern Channel Islands and Santa Barbara Island was determined from aerial photographs of the region between 1980 and 1989 (Ecoscan 1989). Most of the kelp (approximately 17.2 square nautical miles [nmi^2]) is concentrated on the southwestern coasts of San Miguel and Santa Rosa islands.

The habitat types that occur in the Study Area for this EIS, are discussed below.

Table C-1

Habitat Classification and the Approximate Abundance of Each Criterion in Each of the Biogeographical Regions in the CINMS

Ecological Criteria	Units	Oregonian Bioregion	Transition Zone	Californian Bioregion
Coastline characteristics				
1. Sandy beach	mi of coastline	24.8	13.8	4.7
2. Rocky coast (low exposure)	mi of coastline	28.2	11.6	12.5
3. Rocky coast (high exposure)	mi of coastline	27.4	13.6	1.4
Substrate type and depth				
4. Soft sediment (0–30 m)	square NM	38.9	29.6	16.4
5. Hard sediment (0–30 m)	square NM	34.3	7.2	6.6
6. Soft sediment (30–100 m)	square NM	211.6	63.6	56.2
7. Hard sediment (30–100 m)	square NM	23.4	10.1	3.9
8. Soft sediment (100–200 m)	square NM	157	62.9	27.2
9. Hard sediment (100–200 m)	square NM	-	7.3	1.1
10. Soft sediment (>200 m)	square NM	226.7	176.9	160.7
11. Hard sediment (>200 m)	square NM	-	14.6	2.3
Additional features				
12. Emergent rocks (nearshore)	no. <1 NM/ from shore	216	208	95
13. Emergent rocks (offshore)	no. >1 NM/ from shore	12	5	1
14. Submerged rocky features (pinnacles, ridges, seamounts)	square NM	5.9	26.7	4
15. Submarine canyons	square NM	1	33.7	5
Dominant plant communities				
16. Giant kelp	square NM	16.1	5.9	1.8
17. Surfgrass	square NM	13.4	6.7	3.2
18. Eelgrass	square NM	0.3	0.1	0.2

Source: California Department of Fish and Game 2002.

1.1.1 Intertidal Habitat

The intertidal zone is comprised of a variety of coastal habitats that are periodically covered and uncovered by waves and tides. This transition zone between sea and land is the strip of shore ranging from the uppermost surfaces wetted during high tides to the lowermost areas exposed to air during low tides. The vertical extent of tidal change within the Channel Islands can be as high as 3 meters (+2.4 to -0.6 meters) during full or new moon periods. On surf-swept rocky cliffs, the wave splash can extend the marine influence upward another 5 meters or more. Shores with lesser slopes have broader intertidal surface areas although less splash influence. Low-sloping shores have intertidal regions tens of meters wide.

The intertidal zone is typically divided into four sub-zones defined by tidal exposure (Ricketts and Calvin 1968). The infrequently wetted splash zone includes the area from the highest reach of spray down to the mean high tide line. The high tide zone, exposed more often to air than water, extends from mean high tide level down to the average height of the higher of the two daily low tides. The middle intertidal zone, ranging from mean higher low water to mean lower low water (zero tide level), is typically covered and uncovered twice each day. The low intertidal is normally uncovered only by minus tides. In addition, tidepools, special intertidal features, support pockets of continually submerged life at varying shore levels. Intertidal habitats vary in the type of substrate and degree of exposure to surf. Bottom types in intertidal zones include fine muds, sand, gravel, cobble, boulders, and bedrock. Rock types range from soft sedimentary to hard metamorphic forms. Rocks also vary in the extent of roughness, depressions, cracks, crevices, and vertical relief. Protected embayments and estuaries contain mostly fine particulate substrates while outer coast shores range in composition from sand to various rock types.

The plants and animals inhabiting intertidal shores are subject to periodic immersion in water followed by exposure to air. These intertidal communities must withstand varying degrees of wave shock, dramatic temperature changes, desiccation, and attacks from terrestrial predators. Algae are rare on unconsolidated muddy or sandy shores and much of the invertebrate life, such as worms, crustaceans, snails, and clams dwell under the substrate. Rocky shores support a rich assortment of plants and animals. Numerous green, brown, and red algae are found on rocky shores as well as beds of surfgrass. A wide variety of sedentary invertebrates, including barnacles, limpets, and mussels, compete for space with the plants in the intertidal zone. Mobile invertebrates, such as snails and crabs, often hide in crevices or under rocks, then emerge to graze on plants or prey on other animals. Fishes are limited to tidepools or passing through the intertidal zone at high tide. Seabirds forage in the intertidal zone at low tide. Some seabirds roost in aggregations on cliffs just above the shore. Seals and sea lions haul out on particular intertidal shores, sometimes in dense aggregations.

The Channel Islands experience varying degrees of exposure to winds, waves, currents, and a range of water temperatures. Lacking major rivers and shallow coastal shelves, island shores are predominantly rocky. Of the five islands, Santa Barbara Island has the most bedrock (74 percent), and Santa Rosa the least (62 percent). Santa Barbara Island also has the greatest expanse of boulder beaches (22 percent) while San Miguel Island has almost none (0.2 percent). San Miguel and Santa Rosa Islands have the greatest extent of sandy beaches (36 percent and 33 percent, respectively). Sandy beaches on the Northern Channel Islands occur primarily on the southern shores, except for San Miguel Island, which has sandy beaches on north and south shores.

1.1.2 Subtidal Habitat

Subtidal habitats include those marine habitats ranging from the lower limit of the intertidal zone down to deepwater offshore. To separate nearshore from offshore environments, nearshore subtidal habitats have been defined as depths of 30 meters because these relatively shallow depths are most influenced by coastal oceanographic processes and light levels diminish rapidly in this zone such that few benthic algae exist at greater depths. Nearshore subtidal habitats include mud, sand, gravel, cobble, and bedrock substrates. Rock types range from soft sedimentary to hard metamorphic forms. Protected embayments and estuaries contain mostly fine particulate substrates, while outer coast shores range in composition from sand to various rock types. Though less variable than the intertidal zone, shallow-water habitats are subject to dynamic physical processes, including wave exposures, along-shore currents, upwelling, temperature/salinity/nutrient differentials, and suspended sediment loads.

Typical shallow subtidal areas contain assemblages of plants dominated by giant kelp, invertebrates, and fishes. However, many shallow reefs overgrazed by sea urchins have little macroalgae and greatly reduced species diversity. Deeper current-swept reefs with lower light levels support suspension-feeding invertebrates, including sponges, sea anemones, sea fans, plume worms, bryozoans, and tunicates. Some low-relief rock/cobble/sand habitats in high current areas are dominated by large numbers of filter-feeding brittle stars (*Ophiothrix spiculata*) or sea cucumbers (*Pachythyone rubra*).

1.1.2.1 Nearshore Subtidal - Soft Bottoms

Along unprotected shores, plants cannot anchor on the shifting sands, and surface-dwelling animals are limited to hardy species specially adapted to this rigorous, featureless environment. Such animals include sea pens, sea pansies, sand crabs, moon snails, sand dollars, sand stars, bottom-dwelling sharks and rays, and flatfishes. More animals and some plants occur on protected, stable sand habitats found in the lee of ocean swells or in deeper water less exposed to surge. In contrast to the relatively sparse community living above the sand, a diverse assemblage dwells within the soft sediment. These typically small infaunal (life within the substrate) organisms include worms, crustaceans, snails, and clams. Populations can be quite variable in shallow areas with heavy surge, but they become more stable in calmer and deeper waters.

Many sandy habitats at the islands have relatively steep slopes. The sand on these slopes often is coarse shelly debris because there is little sediment runoff from land and strong water currents sweep away organic material. Stable sand habitats with fine grain sediments generally are limited to sheltered coves at canyon mouths, such as those found around Santa Cruz Island. A few of these locations have well-developed eelgrass meadows. Many other sandy habitats consist of patches of shelly sand between rock reefs, forming mosaics of hard and soft substrata. Rocky habitats at the islands are widespread, especially high-relief volcanic reefs with walls, ledges, caves, and pinnacles. Low-relief sedimentary reefs exist as well, particularly around Santa Rosa Island.

1.1.2.2 Nearshore Subtidal - Hard Bottoms

Rocky subtidal environments are capable of supporting thousands of plant, invertebrate, and fish species, depending on the extent of habitat heterogeneity and influence of physical factors such as water motion, light, temperature, nutrients, and sedimentation. Boring clams and sea urchins create holes and depressions in soft sedimentary reefs that also are utilized by other smaller creatures. These reefs can be broken up or worn down by waves and surge. In addition to hardness, rocks vary in the extent of roughness, cracks, crevices, and vertical relief, all of which provide microhabitats for a host of organisms, including worms, crustaceans, mollusks, brittle stars, and fishes. Water motion can increase ecosystem productivity by supplying planktonic food to filter and suspension feeding invertebrates such as sponges, cnidarians, plume worms, bivalves, and tunicates. In contrast, sedimentation can cover rock surfaces and reduce productivity by preventing settlement of spores and larvae, by clogging filtering apparatuses, and by blocking light required by plants.

Plants need light and nutrients for photosynthesis, and hence are more abundant in shallow water. Numerous green, brown, and red algae occur, as well as surfgrass. Algae may form crusts, turfs, large blades, stalked plants, or tall kelps. Plants provide microhabitats and food for animals, but they also compete for space with sessile invertebrates. As light diminishes in deeper water, plants disappear. Here reefs become increasingly covered with attached invertebrates (e.g., sponges, sea anemones, cup corals, sea fans, plume worms, rock scallops, and tunicates), which in shallow habitats, often are limited to vertical surfaces and under hangs not suitable for plants.

The distribution of shallow subtidal reefs is less well known than the distribution of the rocky intertidal reefs. Large-scale studies have not been done, and the rigorous ocean conditions in many areas make scuba diving surveys difficult. Often nearshore reefs are found where rocky intertidal habitat occurs. Kelp beds generally are good indicators of subtidal reefs (except for beds of the *Macrocystis angustifolia* form that occur on sand). Kelp canopies have been mapped by aerial surveys (Crandel 1915; Ecoscan 1989; Hodder and Mel 1978).

Short-lived, opportunistic species commonly occur on freshly exposed rock surfaces. Deeper nearshore habitats are often dominated by extensive algal cover, including red algae and sea palms. The cold, nutrient-rich waters of the northern islands support well-developed assemblages of suspension-feeding invertebrates (e.g., sponges, anemones, plume worms, bryozoans, and tunicates), as well as algal grazers such as snails, sea urchins, and crabs. Fishes, such as rockfishes, are characteristic of the cold-water Oregonian Province.

1.1.2.3 Offshore Subtidal

Beyond the nearshore subtidal zone are deep-water habitats extending from 30 to >200 meters deep over the continental shelf and slope. East of the continental slope, the Continental Borderland is characterized by ridges, basins, and submarine canyons. The Santa Barbara Basin, which reaches a depth of 590 meters, is prominent in the Santa Barbara Channel. Well over 90 percent of deep-water benthic habitats in the Channels Islands consist of fine sands in shallower portions, grading into silt and clay-dominated sediments in deeper portions (Science Applications International Corporation [SAIC] 1986; Thompson *et al.* 1993). These soft-bottom particulates are derived from terrestrial runoff and decaying plankton. Coarse sediments occur near Point Conception, and north of San Miguel Island (Blake and Lissner 1993). Fine sediments occur on the sill at the western end of the Santa Barbara Channel, and in the Santa Barbara Basin.

Records of the bottom composition for the remaining hard-bottom areas are incomplete and are based on old lead-line soundings, snags reported by fishermen, and geophysical surveys conducted by the USGS and oil companies. Direct observational evidence has revealed that many previously reported hard-bottom areas are not exposed rock but reefs covered by soft sediments (SAIC 1986). Deep rock bottoms often are located offshore from major headlands and islands, and on the highest parts of undersea ridges, banks, and pinnacles. Most of the deep-water hard bottom substrates are low-relief reefs less than 1 meter in height; some reefs have 1- to 5-meter high features. Boulders and bedrock outcrops are the predominant rocky substrates. Higher relief pinnacles and ridges occur in some areas, such as off the northwest end of San Miguel Island.

Light disappears rapidly below 50-meter depths, thus offshore benthic habitats do not support marine algae and plants. The fauna of these habitats have been described from remote grab, dredge, trawl, remote-operated vehicle (ROV), and manned submersible surveys conducted from surface vessels for research, fisheries, and environmental studies, especially those related to municipal outfalls and oil development activities. Major deep-water biological surveys include those conducted for the Bureau of Land Management (BLM) (Fauchald and Jones 1979a,b), the Southern California Coastal Water Research Project (SCCWRP) (e.g., Allen *et al.* 1998), and the MMS (Blake and Lissner 1993; SAIC 1986).

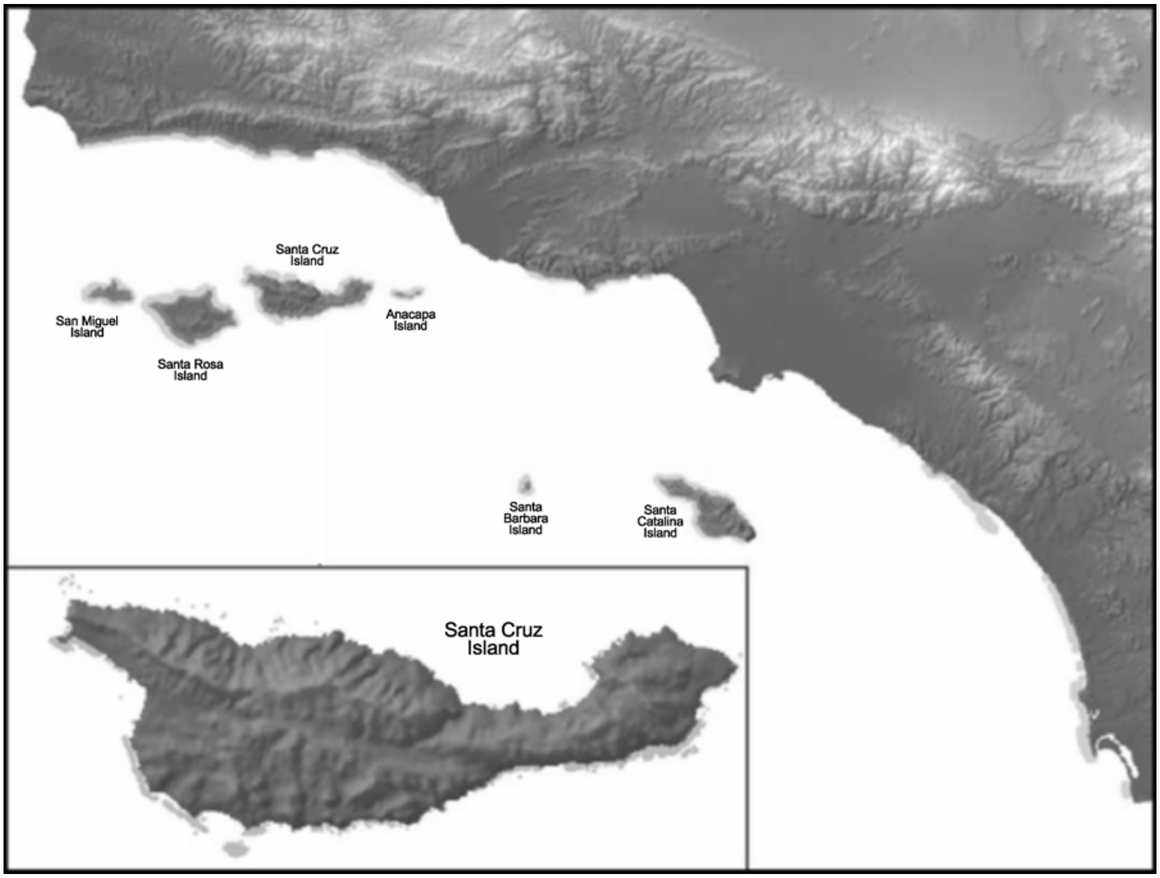
Offshore deep-water communities have few species in common with nearshore communities, due in part to cold temperatures and reduced light. The composition of deep assemblages depends particularly on sediment composition, water depth, vertical relief, and extent of siltation (SAIC 1986; Thompson *et al.* 1993). For a given depth, deep assemblages tend to be more similar over broad geographic ranges than shallow-water communities because the physical environment (e.g., temperature, salinity, darkness) is fairly stable. Most deep muddy-bottom invertebrates are detritus feeders while rocky-substrate invertebrates are predominantly suspension-feeders. Low-relief deep reefs often are heavily silted, with greatly reduced species diversity. Increasing siltation smothers attached invertebrates, gradually changing the habitat to soft bottom. Scour from deep-water currents also influences the distribution of marine life.

The stability of most deep-water soft-bottom habitats supports greater diversity of infaunal and epifauna (life on or just above the substrate) compared to shallow particulate substrates disturbed by waves and surge. Typical infauna on deep fine-sediment habitats include sea pens (*Stylatula elongata* and *Ptilosarcus gurneyi*), polychaete worms (*Heteromastus* sp., *Prionospio lobulata*, and *Chloeia pinnata*), echiuran worms (*Urechis* sp.), amphipods (*Orchestoidea* spp., *Photis* spp., *Polycheria* sp., *Oligochinus* sp., and *Caprella* spp.), brittle stars (*Amphiodia squamata* and *A. urtica*), and small snails and clams (Family Mollusca). Epifauna include shrimp (*Pandalus* spp.), octopus (*Octopus* spp.), sea cucumbers (*Parastichopus* spp.), seastars (Class Asteroidea), heart urchins (*Lovenia* spp.), and flatfishes (Families Bothidae and Pleuronectidae). Fauchald and Jones (1979a,b, 1983) and Thompson *et al.* (1993) divide the assemblages into four major benthic habitats: (1) mainland shelves (50 to 150 meters) often dominated by brittle stars; (2) offshore shelves, ridges, and banks (50 to 500 meters) with brittle stars, the clam *(Parvilucina tenuisculpta*), the polychaete (*Chloeia pinnata*), and the amphipod (*Photis* spp.); (3) basin slopes (150 to 600 meters) with the polychaete worms most common in the Santa Barbara Channel; and (4) basin floors (deeper than 600 meters) where assemblages are not stable over time because these areas often experience anoxic conditions.

Common invertebrates on deep hard substrates include sponges, anemones, cup corals, sea fans, bryozoans, feather stars, brittle stars, sea stars, and lamp shells. Demersal fishes can be common in these habitats, especially various species of rockfishes. In the northern Santa Barbara Channel, three principal hard bottom assemblages were described for outer shelf-upper slope depths (105-213 meters) in MMS surveys (SAIC 1986): (1) a low-relief assemblage dominated by anemones, brittle stars, and lamp shells; (2) a medium relief assemblage characterized by the anemone *Corynactis californica* and deep-water coral *Lophelia californica*; and (3) a broadly distributed community composed of the anemone *Metridium senile*, cup corals, and the feather star *Florometra serratissima*.

1.1.3 Kelp Forest Habitat

Giant kelp (*Macrocystis pyrifera*) forms extensive underwater beds on rocky substrates (the *M. angustifolia* form on the south coast occurs on sand) at shallow subtidal depths (3 to 45 meters) throughout the project area (Figure C-1). Giant kelp, a keystone species, transforms reefs into lush underwater forests. This highly productive plant provides food, attachment sites, and shelter for a myriad of invertebrates and fishes. The dense thicket of kelp in the water column and at the surface is particularly important as a nursery habitat for juvenile fishes (Carr 1989).



Source: Christensen 2003. Data compiled from 1988, 1999, 2002.

Figure C-1 Giant Kelp Canopies of the CINMS

Giant kelp forests range from San Francisco to central Baja California. Giant kelp is a perennial species that has multiple fronds buoyed up by pneumatocysts arising from a large holdfast. Individual fronds live only about 6 months (during which time they may grow 30 meters or more in length), but new fronds are continually produced during the several year life span of the plant (Rosenthal *et al.* 1974). Giant kelp has a life cycle that alternates between the large sporophyte phase and a microscopic gametophyte generation. The impressive underwater kelp forests with extensive surface canopies are conspicuous and popular features of this region. The complex vertical structure of highly productive kelp ecosystems provides food, attachment sites, and shelter for a diverse assemblage of plants and animals, many of which are targeted for sport and commercial harvest. Kelp itself is harvested commercially for use in a wide variety of food and industrial products.

The particular structure of plant and animal assemblages within kelp forests depends on many factors, including the nature and profile of the substrate, degree of wave exposure, water clarity, and temperature/nutrient conditions (Ebeling *et al.* 1980a; Foster and Schiel 1985; Hodder and Mel 1978; Murray and Bray 1993). Kelp beds typically have several layers of understory algae that increase habitat heterogeneity (Dayton *et al.* 1984: Foster and Schiel 1985). Boa kelp, palm kelps, and bladder weeds can rise 1 or more meters off the bottom like bushes. Below these are smaller prostrate or low-growing algae less than 1 meter in height. Below these kelps can be a turf layer, and finally a crust layer often dominated by pink coralline algae.

The location and extent of kelp beds in the Southern California Bight (SCB) have been determined at various times through aerial photographic surveys by commercial harvesters, Bureau of Land Management, Department of Fish and Game, and others (Crandall 1915; Hodder and Mel 1978; Kelco unpublished maps; Neushul 1981). Locations supporting kelp generally have been consistent through time, but the extent of these beds has varied considerably. The physical settings for kelp habitats around the Channel Islands are more variable than mainland locations (Hodder and Mel 1978). Extent of wave exposure, substrate types, and slopes vary extensively. Water clarity is greater at the islands, allowing light to penetrate deeper, thus kelp ranges into deeper water compared to the mainland. The greater habitat heterogeneity at the islands has resulted in greater kelp forest species diversity compared to mainland kelp beds (Murray and Bray 1993).

Kelp mortality can occur from various physical and biological conditions. Powerful storm swells can rip out plants that entangle other plants, resulting in considerable losses. These largely seasonal (winter) disturbances are most prevalent in exposed locations. High temperature/low nutrient conditions may cause deterioration of kelp in the warmest summer months and during El Niño periods (Foster and Schiel 1985; Murray and Bray 1993; Tegner and Dayton 1987). Increased turbidity and sedimentation in kelp habitats can reduce productivity and increase mortality, particularly of the microscopic gametophyte and tiny sporophyte stages (Dean and Deysher 1983).

Grazing invertebrates and fishes consume kelp. Sea urchins are especially efficient at munching through kelp holdfasts, causing detached plants to drift away. Normally dwelling in crevices where they feed on drift kelp, urchins may emerge when drift plants are scarce and overgraze entire kelp beds, turning areas into "urchin barrens" (Ebeling *et al.* 1985; Foster and Schiel 1985; Murray and Bray 1993). These overgrazed areas can persist because high densities of urchins are capable of surviving in a near-starvation state while consuming any edible plants that settle from the plankton (Carroll *et al.* 2000). Urchin barrens have become increasingly common during the past two decades at the Channel Islands coincident with the long-term warming period accompanied by numerous El Niño events and unusually powerful storms (Engle unpublished data).

Kelp beds also are foraging habitats for seabirds and marine mammals. Cormorants dive through the forests seeking fish; while gulls, pelicans, and terns hunt surface fishes in or near the canopy. Where sea otters occur, they are closely associated with kelp beds, diving for a variety of invertebrate prey. Sea lions, seals, and occasional whales use kelp beds as foraging areas.

1.1.4 Surfgrass and Eelgrass Habitat

There are two types of marine flowering plants found in the CINMS consisting of four species. Surfgrass (*Phyllospadix spp*.) and eelgrass (*Zostera spp.*) are commonly confused due to their similar appearance. Each forms dense beds on different substrate and in different conditions.

1.1.4.1 Surfgrass (*Phyllospadix* spp.)

Surfgrass attaches by short roots to rock on surf-swept shores from the low intertidal zone to depths of 10 to 15 meters. The emerald green grass commonly occurs in dense perennial beds 0.5 to 2 meters tall formed primarily by vegetative growth from spreading rhizomes. Two species (*Phyllospadix torreyi* and *P. scouleri*) overlap in geographical distribution and morphological characteristics (Dawson and Foster

1982). *Phyllospadix torreyi* generally has longer (1 to 2 meters), narrower (1 to 2 millimeters) leaves, longer flower stems with several spadices (floral spikes), and occurs more in semi-protected habitats as well as in deeper water. *Phyllospadix scouleri* tends to have shorter (less than 50 centimeters), broader (2 to 4 millimeters) leaves, shorter flower stems with 1 to 2 spadices, and is found more often in wave-swept intertidal areas (Figure C-2).

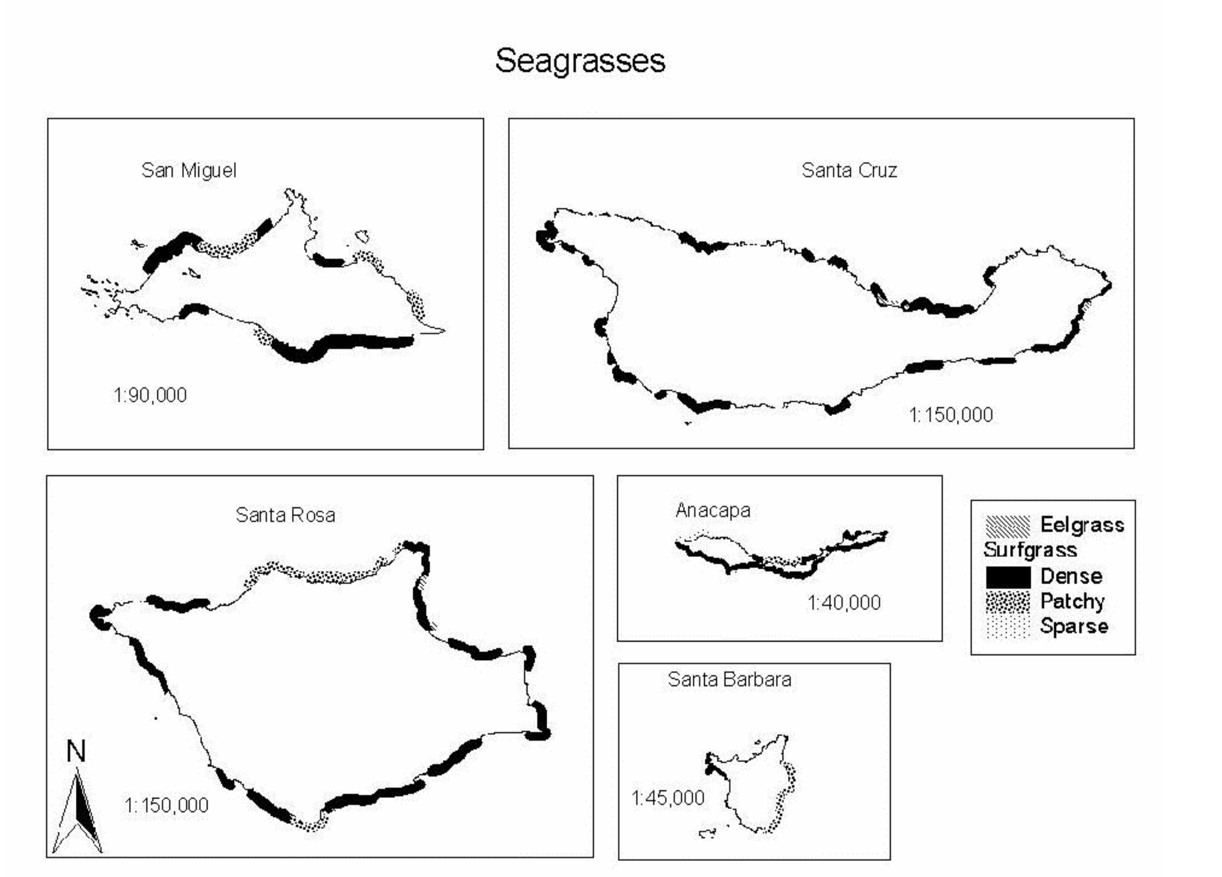


Figure C-2 Distribution of Seagrasses Within the CINMS

Surfgrass beds are highly productive ecosystems, providing structurally complex microhabitats for a rich variety of epiphytes, epibenthos, and infaunal species. Stewart and Myers (1980) identified 71 species of algae and 90 species of invertebrates associated with surfgrass habitats in San Diego. Some organisms, such as the red algae *Smithora naiadum* and *Melobesia mediocris*, are exclusive epiphytes on surfgrass (or eelgrass) (Abbott and Hollenberg 1976). *Phyllospadix* spp. beds provide nursery habitat for various fishes and invertebrates, including the California spiny lobster (*Panulirus interruptus*) (Engle 1979).

Surfgrass beds are persistent (Turner 1985) and can preempt space from other plants, including boa kelp (Black 1974) and sargassum weed (Deysher and Norton 1982). Surfgrass cannot tolerate much heat or drying; the leaves will bleach quickly when midday low tides occur during hot, calm-water periods. Surfgrass can be particularly sensitive to sewage discharge (Littler and Murray 1975) and oil pollution (Foster *et al.* 1988). Recovery can be relatively rapid if the rhizome systems remain functional, but it might take many years if entire beds are lost because recruitment is irregular and must be facilitated by the presence of perennial turf algae to which surf grass seeds attach (Turner 1983, 1985). Eelgrass (*Zostera* spp.)

Eelgrass is the second type of flowering plant that grows within the CINMS. Eelgrass beds are known to be ecologically important for primary production, nutrient cycling, and substrate stabilization (Phillips 1984). They provide habitat and food for a unique assemblage of plants, invertebrates, and fishes (den Hartog 1970; McConnaughey and McRoy 1979; Phillips 1984). Eelgrass grows worldwide in quiet, temperate-water mud or sand habitats, especially in bays and estuaries from the low tide level down to 6 meters. It also occurs on sheltered substrates on the open coast to depths of 18 to 30 meters. The shallow limit for *Zostera* is generally determined by wave action while the deep limit is determined by light limitations (den Hartog 1970; Phillips 1984). Open coast subtidal *Zostera* beds have not been well studied, but extensive literature exists for embayment meadows (den Hartog 1970 and Phillips, 1984 for overviews). Eelgrass produces seeds that may drop nearby or can be carried by floating flower stalks to distant locations. The viability of seeds can be low and successful recruitment to new habitats relatively rare (den Hartog 1970; Phillips 1984). Once established, *Zostera* patches can expand to form vast meadows through vegetative growth along extended rhizomes.

All eelgrass throughout California was considered to be *Z. marina* until Phillips and Echeverria (1990) reported *Z. asiatica* along the mainland coast from Tomales Bay to Santa Monica. Typical characteristics of *Z. marina* include: presence at depths less than 5 meters, leaf width 1 to 12 millimeters, leaf tips obtuse, seeds ridged, March flowering, and seeds present May to June. In contrast, *Z. asiatica* characteristics include: 5- to 17-meter depths, leaf width 12 to 18 millimeters, leaf tips notched, seeds smooth, August flowering, and seeds present September to October. However, characteristics for the two species are variable and intergrade such that species designation is difficult and subject to continuing scientific debate.

At the Channel Islands, a total of 278 species (and higher taxa) were identified from eelgrass beds, not including most infaunal species, species requiring laboratory identification, or minute species (Engle *et al.* unpublished data). The diversity of conspicuous plant, invertebrate, and fish epibiota was nearly twice as high within eelgrass beds (approximately 150 species) as on surrounding sand habitats (approximately 80 species).

Important invertebrates include sea anemones, worms, crabs, snails, clams, and seastars. Some species are obligate dependents on *Zostera*. In the Channel Islands the brown alga *Punctaria occidentalis*, the flatworm, *Phylloplana viridis*, the sea hare, *Phyllaplysia taylori*, and the limpet, *Tectura depicta*, are epiphytes unique on *Zostera*. The red algae, *Smithora naidum* and *Melobesia mediocris*, also occur on eelgrass and surfgrass (*Phyllospadix spp*.). The isopod, *Idotea resecata*, pipefish, *Syngnathus sp.*, and giant kelpfish, *Heterostichus rostratus*, can occur with other plants, but they are closely associated with eelgrass, often appearing grass green in color. *Zostera* meadows are nursery habitats for a variety of fishes, including bottom-dwellers (e.g., flatfishes and gobies) and epibenthic swimmers (e.g., clinids, seaperches, and basses). Eelgrass beds at the Channel Islands are host to schools of juvenile fishes, especially giant kelp fish, surf perches, senoritas, olive rockfish, and kelp bass (Engle *et al.* unpublished data).

Eelgrass habitats are vulnerable to oil spills, but the impacts are not well understood. Unlike slime-producing algae that can slough off oil, eelgrass has non-mucilaginous leaves to which oil quickly adheres (CDFG 2002). Jackson *et al.* (1989) reported substantial oil effects on tropical grass beds of Panama; however, Dean *et al.* (1996) found neither acute nor sub-lethal effects on Alaskan eelgrass. Adverse effects on invertebrate communities associated with eelgrass beds have been documented more clearly: hydrocarbons were most persistent, recovery longer, and injury levels higher in eelgrass habitats of Alaska (Dean *et al.* 1996). Other threats to eelgrass meadows include pollution, habitat disturbances from development (e.g., changes in sediment runoff and water clarity, piers, moorings), cumulative impacts from boat anchors, and overgrazing by sea urchins.

Eelgrass has been found at 10 locations around the Northern Channel Islands at depths of 3 to 15 meters (see Figure C-2), but it is unclear which species is present because their characteristics intergrade (Engle *et al.* in press). The *Zostera* sites occur on both north and south sides of the islands in coves sheltered from west and northwest swells. The largest beds (approximately 3 to 12 hectares) occur at Smugglers Cove, Canada del Agua, and Prisoners Harbor on Santa Cruz Island and at Bechers Bay on Santa Rosa Island. Moderate beds (approximately 0.3 to 0.7 hectare) are found at Scorpion and Forney Coves on Santa Cruz Island and at Johnsons Lee on Santa Rosa Island. A few small patches of eelgrass exist at Cathedral Cove and Cat Rock on Anacapa Island and at Yellowbanks Anchorage on Santa Cruz Island. The single patch at Cathedral Cove is the only known remnant of once widespread beds scattered along the north side of Anacapa Island.

1.1.5 Water Column Habitats

The water column habitat can be subdivided into the neritic/epipelagic, mesopelagic, and bathypelagic zones (Cross and Allen 1993). Light penetration, water temperature, and water mass structure define vertical zonation.

Neritic/epipelagic habitats in the Channel Islands extend to depths of 100 meters. This zone is euphotic generally to 30 meters, and temperatures fluctuate diurnally and seasonally. It is approximately 50 meters deep in turbid nearshore waters and expands offshore in clear oceanic waters (Cross and Allen 1993). The neritic/epipelagic zone is inhabited by fishes that migrate to the surface waters at night (nyctoepipelagic), bottom-associated species that feed in the water column (nektobenthic) (Horn 1980), and the eggs and larvae of most pelagic and demersal fishes (Loeb *et al.* 1983).

The mesopelagic zone is characterized by steep environmental gradients. It extends from the permanent thermocline below the compensation depth to the 6-degree C isotherm at 500 to 600 meters (Cross and Allen 1993). The bathypelagic zone is characterized by uniformity and extends nearly to the bottom. It is absent or restricted in the nearshore basins and expands offshore (Cross and Allen 1993). Fish typical of the mesopelagic and bathypelagic zones include species from the following families: Alepisauridae (lancetfishes), Anoplomatidae (sablefishes), Bathylagidae (deep-sea smelts and owlfishes), Cottidae (sculpins and blob sculpins), Gonostomatidae (bristlemouths), Liparidae (snailfishes), Macrouridae (rattails or grenadiers), Moridae (codlings or morids), Myctophidae (lanternfishes), Nemichthyidae (snipe eels), Ophidiidae (cusk-eels and brotulas), Sternoptychidae (hatchetfishes), Stomiidae (dragonfishes and viperfishes), and Zoarcidae (eelpouts) (Drazen 2003).

1.1.6 Marsh Habitats

1.1.6.1 Freshwater Marsh Habitats

Freshwater marsh habitats occur in areas where water remains at or near the ground surface for the entire year and soils remain saturated. Freshwater marshes occur predominantly in perennial watercourses along the mainland coastline of the Channel Islands region (examples include San Antonio Creek on Vandenberg Air Force Base and the Santa Ynez, Ventura, and Santa Clara rivers) but also in vernal pools, swales and other natural and artificial water impoundments (McGinnis 2000).

The growth of plant species in freshwater marshes is greatest during the summer months. Dominant plant species include: California bullrush, tule, American bullrush, broad-leaved cattail, giant bur-reed, hoary nettle; a number of rushes and sedges.

1.1.6.2 Coastal Brackish and Salt Marsh Habitats

Serving as transition zones between freshwater and marine species, coastal brackish marsh habitats (such as estuaries) are important to many of the species found in the Sanctuary. Salinity in coastal marshes may vary considerably from site to site, but typically increases at high tide or during seasons of low freshwater runoff. This type of habitat usually transitions into coastal salt marsh habitat along the ocean and into freshwater marsh habitat at the mouths of rivers. Important regional coastal brackish marsh habitats include Shuman Canyon and San Antonio Lagoon on VAFB, the Santa Ynez River, Goleta Slough, Carpinteria Marsh, the Santa Clara river, Ormond Beach and Point Mugu Lagoon (McGinnis 2000).

In addition to Shuman Canyon and San Antonio Lagoon, VAFB includes the coastal ecosystems of the Santa Ynez River and the San Antonio Creek Estuary, which are habitat for a number of threatened and endangered species (U.S. Air Force 1997). These sensitive coastal systems contribute to the general health of the regional marine ecosystem by providing nutrients and habitat for birds, fish, pinnipeds and other marine species (U.S. Air Force 1997).

The Carpinteria Salt Marsh is habitat to at least 139 resident and transitory bird species (Ferren et al., 1996). The marsh provides habitat for reproductive populations of invertebrate species found only in estuarine environments, acts as a feeding ground for juveniles of the commercially important California halibut and other fish species. In addition, the Carpinteria Salt Marsh harbors several distinct species of plants, including the federally-listed and endangered salt marsh bird's-beak.

Farther south is Mugu Lagoon, the largest regional estuarine lagoon and one of the most pristine wetlands remaining in southern California (Saiki 1997). Contained entirely within the Naval Air Station at Point Mugu, Mugu Lagoon supports the greatest concentration of water birds between Morro Bay and Anaheim-Bolsa Bay (Coastal Conservancy 1997).[1] As a remote site with restricted public access, Mugu Lagoon is recognized as one of the most important mainland roosting sites for the Anacapa Island breeding colony of California Brown Pelicans. The Lagoon also serves as an important staging area for other birds and seals moving to and from Anacapa Island. (Jaques et al., 1996).

1.1.7 Essential Fish Habitat (EFH)

The Pacific Fishery Management Council (PFMC) manages 93 species of fish under three Fishery Management Plans: 1) Coastal Pelagic Species Fishery Management Plan, 2) Pacific Salmon Fishery Management Plan, and 3) Pacific Groundfish Fishery Management Plan. The Magnuson-Stevens Act defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." National Marine Fisheries Service (NMFS) guidelines state that "adverse effects from fishing may include physical, chemical, or biological alterations of the substrate, and loss of, or injury to, benthic organisms, prey species and their habitat, and other components of the ecosystem." The EFH has been established for five species of coastal pelagic species: Pacific sardine, Pacific mackerel, northern anchovy, jack mackerel, and market squid.

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[1] *A comprehensive survey of the biological and ecological importance of Mugu Lagoon is found in Jaques* et al. *(1996) and Saiki (1997).*

The EFH also has been established for 83 species of groundfish. EFH for Pacific Coast groundfish is defined as the aquatic habitat necessary to allow for groundfish production to support long-term sustainable fisheries for groundfish and for groundfish contributions to a healthy ecosystem. Descriptions of groundfish fishery EFH for each of the 83 species and their life stages result in over 400 EFH identifications. When these EFHs are taken together, the groundfish fishery EFH includes all waters from the mean higher high water line and the upriver extent of saltwater intrusion in river mouths, along the coast of Washington, Oregon, and California seaward to the boundary of the EEZ. The seven “composite” EFH identifications are as follows: estuarine, rocky shelf, non-rocky shelf, canyon, continental slope/basin, neritic zone (33 feet and shallower), and the oceanic zone (66 feet and deeper).

1.2 SPECIES

1.2.1 Plankton

1.2.1.1 Phytoplankton

Phytoplankton are single cell or colonial algal species that range in size over three orders of magnitude (Siebruth 1979). Phytoplankton can be classified according to size: very small species (autotrophic bacteria) are classified as picoplankton (0.2 to 2 micrometers), most are classified as nanoplankton (2 to 20 micrometers) or microplankton (20 to 200 micrometers), and a few large species as mesoplankton (0.2 to 20 millimeters) (Hardy 1993).

Phytoplankton form the base of the food web; they support grazing zooplankton, fish, and, through their decay, large quantities of marine bacteria. The success of zooplankton depends upon both the quantity and quality of their phytoplankton food supply (Dailey *et al.* 1993). For example, the fecundity (egg production) of zooplankton depends upon the nutritive value (e.g., nitrogen content) of the phytoplankton on which they feed (Checkley 1980a, b). Fish production, in turn, is highly dependent on the growth and productivity of phytoplankton and zooplankton (Ryther 1969). The success of larval fish and their subsequent recruitment into the adult fish population often depend upon spatial and temporal concurrence of fish larvae with an abundance of their plankton food source (Mullin *et al.* 1985).

Many species of phytoplankton inhabit the CINMS. Their relative abundance in terms of numbers, biomass, and production varies greatly both spatially and temporally. The two most abundant and important components of the phytoplankton community are generally the diatoms (bacillariophytes) and the dinoflagellates (pyrrophytes).

The community of larger (greater than 50 millimeters) phytoplankton in the CINMS includes a broad range of temperate water forms as well as forms that characteristically occur in either warmer or colder water. This diversity reflects the general transitional nature of the Channel Island’s flora, which results from the physical oceanographic and mixing characteristics of the region. For example, incursions of exceptionally warm water currents in the area generally carry with them warm water species.

Seasonal and geographic variations in nanoplankton are remarkably stable, and variations in plankton productivity are due primarily to the larger microplankton (see Section 3.2.1). The coastal zone color scanner (CZCS) on the Nimbus 7 satellite has provided useful information on the distribution of phytoplankton by measuring chlorophyll over extensive areas of the SCB. Such data provide synoptic views of complex oceanographic regions, which are impractical to obtain from ships alone. Satellite imagery has also allowed the identification of persistent and striking biological features. Many of these recurring large-scale patterns were either unknown or only dimly perceived prior to the advent of satellite imagery. For example, Nimbus 7 CZCS imagery revealed the occurrence far offshore of a large region of high phytoplankton pigment, a biological "hot spot" that loosely overlies a system of submarine ridges, banks, and basins of the Continental Borderland. Shallow basins and enclosed shallow areas, such as the Santa Barbara Channel, consistently show high pigment content, with an approximately threefold change in phytoplankton pigment content over a distance of a few kilometers. These large-scale structures undergo significant monthly, seasonal, and annual changes although the large-scale pigment patterns for a given season tend to reappear from one year to another (Pelaez and McGowan 1986).

Numerous measurements of primary production (the photosynthetic conversion of inorganic carbon to organic cellular material by phytoplankton), have been conducted in the SCB. The efficiency of conversion of solar energy into organic matter in the SCB has been estimated to be well under 1 percent (Eppley and Holm-Hansen 1986).

Environmental factors regulating growth lead to a complex spatial and temporal pattern of phytoplankton and productivity in the region. Every point in the water column is basically unique with regard to variables such as light intensity, nutrient mixture and concentration, and temperature. Small-scale biomass patchiness occurs even on scales of less than 1 meter (Hardy 1993). Physical factors of mixing and currents also determine the distribution of phytoplankton. Each species differs in its unique physiological requirements and optima for both light and nutrients. Topographic features of the SCB such as the complex of offshore islands and banks, which run from Santa Rosa and San Nicolas south to Tanner and Cortes banks, impose additional heterogeneity (Hardy 1993).

As is typical of the California coast, plankton abundance and primary production in the SCB are generally higher nearshore than offshore. Since the continental shelf is only a few kilometers wide, internal waves from deep water typically move shoreward, injecting nutrient-rich water onto the shelf area. Episodic sediment disturbance and suspension are important mechanisms of nutrient regeneration in the shallow nearshore area (Fanning *et al.* 1982). Significant differences in longshore abundances of phytoplankton species occurred between the north and south parts of the SCB. Out of 45 cases tested, 19 had greater abundances in the south (Cullen *et al.* 1982). Only three species had greater abundances to the north. In addition to horizontal patterns, the abundance of individual species, total biomass, and productivity of phytoplankton generally show marked differences vertically through the water column (Hardy 1993).

Temporal patterns can be divided into short-term "events" on a scale of hours, days, or a few months and longer term seasonal or recurring annual trends. Like other areas, the Channel Islands can experience blooms (dense growths and accumulations of phytoplankton). Short-term blooms of diatoms and other phytoplankton associated with upwelling events often occur in winter or spring and last for a few days to a few weeks. A typical year has three such blooms each lasting 5 to 6 weeks (Tont 1976). The variance in abundance of phytoplankton between bloom and non-bloom periods can be almost as great as the annual variation in abundance (Tont and Platt 1979).

In general, diatoms have several major peaks of abundance that are 5 to 6 weeks in duration, usually during the first half (but occasionally the latter half) of each summer (Tont 1976, 1981; Tont and Platt 1979). A high correlation in the occurrence of blooms was generally observed between San Diego and Port Hueneme, although the dominant species in the two locales were frequently different. The majority of these blooms occurred in conjunction with upwelling events. Sea surface temperature decreases of 2.5 degrees C indicating upwelling often were associated with diatom standing stock increases of four orders of magnitude (Hardy 1993).

The biomass of the larger diatoms tends to be maximum in late winter or spring although fall blooms also occur (Allen 1936). Large dinoflagellates tend to bloom in summer and slightly earlier at La Jolla than at Port Hueneme, but winter blooms are also known (Allen 1941). Unlike at La Jolla, phytoplankton densities at Port Hueneme show seasonal variations that exceed the variability on shorter time scales (Tont and Platt 1979).

Under certain oceanographic conditions, blooms are dense enough to alter the color of the water to red, yellow, green, or brown (Oguri *et al.* 1975). Although these blooms can be caused by different groups of organisms, including diatoms, they are most commonly caused by dinoflagellates (Hardy 1993). Although not related to the tidal cycle, blooms of red-pigmented dinoflagellates are called “red tide”. Red tides can occur in the Sanctuary almost any month of the year and are generally most pronounced nearshore (Oguri *et al.* 1975). Spring red tide blooms are dominated by *Prorocentrum micans* while the more intensive and frequent blooms during July through October are dominated by *Gonyaulax polyhedra* (Sweeney 1975).

Many phytoplankton can generate toxins, including *Pseudonitzschia australis*, a phytoplankton species found in the Santa Barbara channel. This diatom produces a neurotoxin called domoic acid. Elevated domoic acid levels in plankton have been linked to deaths of dolphins, sea lions, seabirds, and other marine mammals. By May of 2002, elevated domoic acid levels had led to 70 dolphin beachings and caused 200 sea lions and 200 seabirds to become sick or die (ProMed-mail 2003). During May of 2002, domoic acid was measured at up to 380 parts per million in mussels taken from Santa Barbara waters (ProMed-mail 2003). The federal alert level is 20 parts per million (ProMed-mail 2003). Research on plankton is currently investigating what triggers the algae growth and why different levels of toxins are produced at different times (ProMed-mail 2003).

1.2.1.2 Zooplankton

Zooplankton of the region comprise a large and diverse group of animals. This section will address the interrelationships between the distribution and abundance of these organisms and the oceanography that influences these distributions.

Roseler and Chelton (1987) summarized CalCOFI zooplankton data (displacement volumes) over a 32-year period from 1951 to 1982. They noted that non-seasonal zooplankton variability was dominated by very low-frequency patterns with periods of 3 to 5 years associated with variations in large-scale equatorward transport of the California Current. Years when California Current flow was higher than normal were associated with larger zooplankton biomass of 3 to 4 months' duration.

McGowan *et al.* (1998) note that zooplankton biomass has declined over 70 percent in the central north Pacific ocean since the late 1970s in concert with increasing sea surface temperature. This interannual variable should be considered the baseline for understanding higher frequency events and processes, including biological interactions. These smaller scale, higher frequency processes include seasonal changes and localized events such as coastal upwelling, eddies, plumes, tidal oscillations, bottom processes, diel cycles, wind stress, and turbulence. The extent to which these physical events control or modify zooplankton ecology is a function of the particular organism, including its size, swimming ability, reproductive state, food needs, and other requirements (Dailey *et al.* 1993).

The three zones developed to describe zooplankton are harbor and bay, nearshore (shelf and shelf break), and offshore (open ocean and basins). The spatial distribution of the dominant zooplankton reflects the environmental characteristics of the zone’s waters (Dailey *et al.* 1993).

The nearshore zone, which encompasses waters shoreward of the continental shelf slope break or approximately the 200-meter depth contour, is a useful demarcation for study of zooplankton since the water over the continental shelf tends to be an area of high productivity. This augmented region of productivity (Ryther 1969) is usually associated with increased vertical mixing and, thus, greater nutrient recycling and upwelling, both of which are wind-forced phenomena. The maintenance of a shelf zooplankton assemblage is largely dependent on the physical width of the shelf as well as on the frequency of offshore advection over the shelf.

Microzooplankton feed on particulate organic sources; they comprise protozoan as well as juvenile stages of larger zooplankton. Protozoans account for the greatest percentage of the microzooplankton numerically while the micrometazoans dominate the biomass (Beers and Stewart 1967, 1969a, b, 1970). Because of their high reproductive capacities relative to the metazoans, protozoans have a markedly more important effect on the dynamics of the pelagic trophic web. Since protozooplankton can reproduce by simple asexual binary fission, they are able to respond rapidly to a changing environment. In addition, because generally higher physiological rates are found among small organisms, they are considered by Beers (1986) to be among the most important pelagic herbivores, a role generally reserved for copepods in the past. Beers and Stewart (1969b, 1970) have shown that the biomass of the microzooplankton is generally 20 to 25 percent of the total larger macrozooplankton, both inshore and offshore in the SCB.

The macrozooplankton are a diverse group of animals composed of a number of major taxonomic categories. The medusae, ctenophores, and planktonic molluscs and tunicates are sometimes grouped into what is commonly termed gelatinous zooplankton. The chaetognaths (arrow worms) are important carnivorous zooplankters, but the majority of the zooplankton are made up of crustaceans, mostly copepods. Planktonic copepods are primarily calanoids. Of the calanoid copepods, *Acartia*, *Paracalanmus*, *Labidocera*, and *Calanus* are the most common genera collected nearshore in the SCB (Barnett and Jahn 1987).

Regarding offshore zooplankton, a number of investigators (Eppley *et al.* 1979) have maintained that for eastern boundary currents, including the California Current, wind-drive coastal upwelling is the main source of new nutrients entering the euphotic zone. Others (Reid 1962; Bernal and McGowan 1981; Roesler and Chelton 1987) have found a correlation between zooplankton biomass, cold water temperature, and increased flow of the California Current. Chelton *et al.* (1982) analyzed 30 years of CalCOFI data to identify factors that play dominant roles in California Current zooplankton biomass fluctuations. They compared the longshore component of wind stress with mean monthly zooplankton volumes and concluded that, while wind-induced upwelling may play some role in zooplankton fluctuations, instead fluctuations are more related to changes in the transport of the California Current in the SCB.

Beers and Stewart (1969b) found a gradient of decreasing microzooplankton from onshore to offshore in the SCB. They also found an increasing concentration of microzooplankton relative to the concentration of chlorophyll-a with distance offshore, and suggested that the microzooplankton may play a more significant role in the offshore than in the nearshore realm.

Macrozooplankton of the offshore zone often are many of the same species as those found nearshore. In addition, more oceanic and deeper water species have been collected. Of the calanoid copepods, *Calanus*, *Pleuromanmma*, and *Metridia* are common offshore genera in the SCB (Dailey *et al.* 1993).

Although the SCB contains some unique species, it is largely a transition zone between subarctic, central, and equatorial species. Thus, biomass fluctuations may also be accompanied by changes in species composition. The boundary (or clinal region) between cold, nutrient-rich California Current water (and its associated subarctic species) can vary in position relative to warmer, nutrient-poor water from the south (equatorial water) and west (central water) (Dailey *et al.* 1993).

1.2.2 Macroalgae and Vascular Plants

The northern Channel Islands include a wide variety of marine plants due to its transitional location between cold- and warm-water biogeographic provinces and its diversity of coastal environments, ranging from sheltered embayments to exposed open coast mainland and island habitats (Abbott and Hollenberg 1976; Murray *et al.* 1980). Most marine macrophytes require hard substrate for attachment, and all need light for photosynthesis, thereby largely restricting their depth distribution to the upper 50 meters or less depending on water clarity. In the SCB, 492 species of algae and 4 species of seagrasses are known to occur out of the 673 species described for California in Abbott and Hollenberg (1976) (Murray and Bray 1993). Of the 492 species, 59 are green algae (Chlorophyta), 86 are brown algae (Phaeophyta), and 347 are red algae (Rhodophyta).

Knowledge of the distribution and abundance of marine plants in the SCB has expanded considerably since the mid-seventies, largely due to the quantitative intertidal surveys conducted by the BLM from 1975 to 1979 (Littler 1980; Littler *et al.* 1991). The results of these and other studies are summarized in Murray and Bray (1993). During the 1980s and 1990s, surveys by Channel Islands National Park, MMS, Tatman Foundation, and others focused on monitoring population dynamics of key species at representative regional sites (Dunaway *et al.* 1997). The University of California Santa Barbara (UCSB) has research projects targeting surfgrass (*Phyllospadix*) (Reed *et al.* unpublished data) and boa kelp (*Egregia*) (Blanchette *et al.* unpublished data). Most research on subtidal plants has concentrated on giant kelp forest communities (Foster and Schiel 1985). Much less is known about other subtidal macrophyte assemblages, despite the importance of plant-dominated habitats for a multitude of invertebrates and fishes. Reconnaissance and monitoring surveys focused on the islands have been carried out by CINP-KFMP (CINP 1982 to 1997) and the Tatman Foundation Channel Islands Research Program (CIRP 1980 to 1998). Subtidal eelgrass (*Zostera*) habitats at the islands were investigated recently for the California Coastal Commission (Engle *et al.* unpublished data).

Northern species are defined here as ranging northward from northern Baja California (at about Bahia del Rosario) into and often beyond the Oregonian Province. Southern species, on the other hand, range southward from central California (in the Monterey area) into and, less commonly, through the Californian Province. Transitional species are narrowly defined as endemics restricted to the region of overlap, i.e., between northern Baja California and central California. Species classified as widespread range broadly along the coast between central Baja and northern California.

Species distributions from BLM surveys (Murray and Bray 1993) and more recent surveys support that the northern Channel Islands encompass the transition between southern, warm-water Californian flora and northern, cold-water Oregonian flora. The Channel Islands are particularly transitional, with each island having its own mix of southern versus northern species. Santa Barbara Island is most favored by southern species, Anacapa and Santa Cruz Islands are intermediate with both southern and northern components, while Santa Rosa and San Miguel Islands are populated with a greater portion of northern species. Intertidal algae surveyed along the mainland from Point Conception south to San Diego also show a north-south species gradient for the BLM program (Murray and Littler 1981). Three groupings were evident: (1) sites nearest Point Conception, (2) sites between the Santa Barbara Channel and Santa Monica Bay, and (3) sites between Los Angeles and San Diego.

No marine plants in the region are listed or proposed for listing under State or Federal programs for protecting species in danger of extinction. However, some species deserve special consideration because of their importance as keystone species, dominating ecosystems that are defined by their presence. Giant kelp, surfgrass, and eelgrass are described above.

Analyses of past studies indicate that marine plant diversity is greater in the SCB and the Channel Islands than the diversity associated with central California due to the greater variety of habitats present and to mixing of southern and northern species in the SCB. Murray *et al.* (1980) found that floral diversity in California was positively correlated with decreasing latitude; maximum richness (446 species) occurred between 33 degrees and 34 degrees north latitude.

1.2.2.1 Macroalgae

Algae include the macroscopic members of the plant divisions Chlorophyta (green algae), Phaeophyta (brown algae), and Rhodophyta (red algae), often referred to as seaweeds. The Channel Islands include a rich array of flora of benthic macroalgae and seagrasses. In shallow coastal habitats there is considerable variation in wave action, ocean water masses, thermal regimes, and substrata. The large coastal area and the degree of habitat heterogeny contribute to the great diversity of macrophytes documented for the SCB (Abbott and Hollenberg 1976; Murray *et al.* 1980).

A total of 492 species of algae occur in the SCB, including 59 species of Chlorophyta, 86 species of Phaeophyta, and 347 species of Rhodophyta, making the composition of the SCB seaweed flora 70.5 percent red, 17.5 percent brown, and 12 percent green (Murray and Bray 1993).

South of Point Conception, the flora tends to be dominated by shorter, more densely branched species of red algae instead of larger, fleshy forms (Abbott and Hollenberg 1976). Brown algae, especially those in the Order Dictyotales, also are more prominent in southern California subtidal habitats, replacing many of the bladed red algae common to the north.

Murray *et al.* (1980) suggested that the high diversity of SCB seaweed flora may be related to the greater amount of shoreline habitat found south of Point Conception and to the various exposures of island habitats to the warm and cold ocean currents prevalent in the SCB.

1.2.2.2 Giant Kelp (Macrocystis pyrifera)

See Section 1.1.3 on kelp forest habitat above.

1.2.2.3 Seagrasses

See Section 1.1.4 on surfgrass and eelgrass habitat above.

1.2.3 Invertebrates

Benthic invertebrates include species from nearly all phyla of invertebrates that live in (infauna) or on (epifauna) the sea floor during most of their lives. They may also be characterized as sessile (attached or sedentary) or motile (free-moving). Benthic invertebrates range in size from little known microscopic forms (microinvertebrates) to the more common larger organisms (macroinvertebrates). Most benthic invertebrates also have pelagic larvae. The Channel Islands are characterized by a wide variety of benthic invertebrates due to its transitional location between biogeographic provinces and its diversity of substrates. These include sheltered and exposed coasts at depths from the intertidal to deep slopes, canyons and basins (Thompson *et al.* 1993). The total number of species of benthic invertebrates may well be in excess of 5,000, not including microinvertebrates (Smith and Carlton 1975: Straughan and Klink 1980).

Macroinvertebrates have been studied to varying degrees in representative habitats throughout the region. Ecological relationships are best known for invertebrates from intertidal and shallow subtidal environments because of their accessibility. However, there has been relatively little emphasis in the past two decades on species inventories or compiling species information from various individual nearshore projects. More emphasis has been placed on monitoring population dynamics of key rocky intertidal and kelp forest species by government agencies such as CINP, MMS, CCC, and Santa Barbara County (Dunaway *et al.* 1997; Engle 1994; Engle *et al.* 1997).

A major source for regional species distributional data is the BLM baseline survey program conducted in 1975 to 1979, which included intertidal and deep-water (but not shallow-water) habitats. Straughan and Klink (1980) compiled a taxonomic listing of the common nearshore species from southern California as part of the BLM program, including approximately 300 cnidarians, 60 nemerteans, 575 polychaetes, 1,100 mollusks, 20 pycnogonids, 250 crustaceans, 5 stomatopods, 20 tanaids, 30 cumaceans, 125 isopods, 300 amphipods, 20 sipunculids, 10 echiurans, 150 echinoderms, and 50 ascidians. Other major sources for deepwater invertebrate species inventories include surveys for coastal waste treatment and other outfall monitoring programs and studies sponsored by MMS to evaluate possible impacts of offshore oil and gas operations. The Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) compiled an extensive, standardized list of macro- and mega-invertebrates from SCB mainland soft-bottom habitats at depths from 10 to 300 meters (SCAMIT 1998). Although most of the species records were from outfall studies, other randomly sampled sites were included as part of the SCB Pilot Project (SCBPP) (Allen *et al.* 1998; Bergen *et al.* 1998). These largely unpublished data were compiled primarily from reconnaissance surveys at the Channel Islands during the 1980s and 1990s conducted by the Tatman Foundation CIRP. Other data were included from CINP, CCC, and MMS surveys. Records from the 1975 to 1978 BLM program were not included.

Species distributions from BLM surveys (Seapy and Littler 1980, 1993; Thompson *et al.* 1993) and more recent surveys confirm that the Channel Islands encompass the transition between southern and northern fauna. The Channel Islands are particularly transitional, with each island having its own mix of southern versus northern species. Although conditions are dynamic, the general pattern is that Santa Barbara Island is mostly composed of southern species, Anacapa and Santa Cruz Islands have both southern and northern components, while Santa Rosa and San Miguel Islands have northern species.

The white abalone, which was recently Federally listed as endangered, is the only invertebrate species currently listed under either State or Federal Endangered Species acts. Black abalone was recently listed as a candidate species for Federal listing. A number of invertebrate species deserve special consideration because of their importance as keystone dominants, harvested species, or species particularly sensitive to environmental impacts. These species are highlighted below.

1.2.3.1 Corals

California hydrocoral (*Stylaster californicus* [= *Allopora californica*]). Spectacular, but little known California hydrocoral colonies inhabit subtidal depths (known to 96 meters) from Vancouver Island (Canada) to central Baja California. Hydrocoral colonies occur on current-swept rocky reefs and pinnacles (Engle and Coyer 1981; Osterello 1973). These purple or pink-red hydrocorals resemble small branching tropical staghorn coral (to 53 centimeters). Sessile, filter-feeding adults produce planktonic larvae with limited dispersal. Slow-growing (approximately 0.8 centimeters per year) colonies may live well over 30 years. At least four obligate commensals are supported by the hydrocoral colonies: two polychaetes, one snail, and one barnacle (Osterello 1973; Wright and Woodwick 1997).

Since California hydrocoral keeps its color when dried, it has been commercially harvested in the past for sale in shell shops. The fishery is presently closed. The slow growth and limited dispersal of the

California hydrocoral suggests that it may be particularly sensitive to disturbance and fishery pressure. Colony branches are easily broken by anchors, trawlers, and divers. California hydrocoral has no known predators (Osterello 1973). However, colonies are susceptible to overgrowth by algae or smothering by sediments (Morris *et al.* 1980; Osterello 1973; Thompson *et al.* 1993). California hydrocoral is rare, at least within scuba diving depths, and is especially rare in the Sanctuary. Here it is known from only a few deep, current-swept reefs at Santa Barbara, Santa Cruz, and San Miguel Islands (Engle unpublished data). Its abundance in deepwater is largely unknown although BLM surveys assessed abundances at Tanner and Cortes Banks, south of San Nicolas Island.

1.2.3.2 Ridgeback Prawn (*Sicyonia ingentis*)

Ridgeback prawns occur in subtidal depths (48 to 175 meters) from Monterey Bay to central Mexico. Preferred habitats are deep sand, shell, and mud substrates (Leet *et al.* 1992). These prawns are identified by a prominent ridge along the dorsal midline of the abdomen and a short rostrum. Adult prawns are relatively sedentary. The diet is not well known, though it is suspected to be a detritus feeder as are related prawns. This species may live about 5 years. A commercial fishery using trawling gear began in 1966. Landings decreased dramatically from 1985 to 1991 (population decline confirmed by Department surveys at that time), but have since increased to over 1.4 million pounds in 1999 (Leet *et al*. 1992, 2001; Thompson *et al.* 1993). Surveys by the Department confirmed population declines since 1985.

1.2.3.3 Spot Prawn (*Pandalus platyceros*)

Spot prawns occur in deep water (50- to 533-meters depth) from Alaska to San Diego. These prawns are reddish-brown with two prominent posterior white spots and 3 to 4 longitudinal white stripes on their carapace. They may be associated with hard or soft substrates. The diet of spot prawns consists of small crustaceans, plankton, mollusks, polychaetes, sponges, and carcasses (O'Clair and O'Clair 1998). This species may live for more than 6 years. A commercial fishery using trawling gear and traps began in the Channel Islands area in 1974 (Leet *et al.* 1992). State-wide landings increased steadily from 1984 to nearly 800,000 pounds in 1998 with a drop to 600,000 pounds in 1999 (Leet *et al.* 2001).

1.2.3.4 Spiny Lobster (*Panulirus interruptus*)

California spiny lobster inhabit low intertidal levels to subtidal depths (to 80 meters) from Monterey Bay to central Mexico, but they are rare north of Point Conception. These warm-water crustaceans are identified by their long antennae, reddish-brown color, and large size (to 60 centimeters). Juveniles (under 2 years) utilize shallow vegetated reefs, especially surfgrass beds as nursery habitats (Engle 1979). Adults inhabit crevices in rocky areas, from which they emerge at night to forage on a wide variety of invertebrates, including worms, mollusks, and sea urchins. Spiny lobsters may live 30 years or more (Leet *et al.* 1992). Spiny lobsters occur at all of the Channel Islands, but are more abundant in those locations in the Californian and Transition Zones.

Spiny lobsters have been commercially harvested using traps in California for over 100 years. Most of the fishery is in water less than 30 meters deep although the fishery has expanded to include deeper habitats. A sport fishery (hand capture) is popular among scuba divers in the Channel Islands area. Other sources of mortality include predation by octopus and fishes. California spiny lobster populations have not been well studied; however, population levels appear to have been maintained by recruitment from Baja California facilitated by warm-water patterns over the past two decades (Engle 1994). Landings declined from 1950 to 1975, then increased coincident with establishment of escape ports for sublegal lobsters in traps and development of the long-term warming trend (Leet *et al.* 1992). During the 1990's landings generally ranged from 600,000 to 800,000 pounds with a peak of 950,000 pounds in 1998, then fell about 500,000 pounds in 1999. Landings in this fishery are strongly influenced by weather, oceanographic conditions and the export market (Leet *et al.* 2001).

1.2.3.5 Crabs

Crabs are primarily benthic arthropods of the Class Brachyura. There are many species, with varying ecological niches. Three major groups of crabs occur in the region, each with multiple species: spider, cancroid, and grapsoid crabs. Three species of cancroid crabs are of particular interest due to their commercial harvest.

Rock crabs: Brown rock crab (*Cancer antennarius*), yellow rock crab (*C. anthonyi*), and red rock crab (*C. productus*).

Rock crab species inhabit low intertidal levels to subtidal depths (less than 40 meters). The brown rock crab occurs from Washington to central Baja California. The yellow rock crab occurs from northern California to southern Baja California. The red rock crab occurs from Alaska to central Baja California. Yellow rock crabs prefer soft substrate habitats while brown and red rock crabs prefer rocky substrata. Rock crabs have smooth carapaces, dorsal shell colorations matching their name, and a yellow underside. Migration is unknown, though they range randomly over several kilometers. Rock crabs are predators (feeding on a wide variety of invertebrates) and scavengers. They may live about 6 years or more (Leet *et al.* 1992).

Large-scale commercial harvest of rock crabs using traps began in 1950. Santa Barbara and the Channel Islands represent major fishery areas. A minor sport fishery, using hoop nets and star traps, exists. Rock crab landings steadily increased through 1984 to over 2 million pounds and have since declined to 700,000 pounds in 1999 with some fluctuation (Leet *et al.* 2001). Other sources of mortality include predation by fishes, octopus, sea stars, and sea otters. Rock crab populations in the region have not specifically been assessed. However, experimental trapping has shown that catches are lower in commercially targeted areas (Gotshall and Laurent 1979; Leet *et al.* 1992; Morris *et al.* 1980).

1.2.3.6 Abalone

Seven species and one sub-species of abalone are found in the Channel Islands. All species are mollusks of the Family Haliotidae, genus *Haliotis*, which adhere with an enlarged foot to rocky substrata, and feed primarily on drift algae. Five species of abalone (black, green, pink, red, and white) were popular sport and commercial species until populations experienced severe declines during the 1980s and 1990s. These declines likely resulted from a combination of overharvest, disease (except for white abalone), and a long-term warming trend leading to poor recruitment coincident with enhanced storm activity, reduced kelp abundance, and increased competition with sea urchins (Leet *et al.* 1992; Engle 1994). The take of abalone has been prohibited in California since 1996, except for sport take by free divers in northern California. Mariculture operations supply small red abalone for restaurants. One species, white abalone, has been listed as endangered and black abalone is a candidate species for such listing under the Federal ESA. The five major species of abalone in the Channel Islands typically occupy different, but overlapping, depth ranges (Haaker *et al.* 1986). From intertidal to deepwater, dominant species are black, green, pink, red, and white abalone.

Black Abalone (Haliotis cracherodii)

Black abalone inhabit mid-low intertidal levels down to shallow subtidal depths (to 6 meters) from Oregon to southern Baja California (Morris *et al.* 1980). They are readily identified by dark, bluish-black coloration, a smooth shell with 5 to 7 open respiratory holes, and relatively small size (5 to 20 centimeters as adults). Black abalone are relatively sedentary and typically found clustered in wet crevices, under boulders, or on the walls of surge channels along exposed shores. Juveniles graze on diatom films and coralline algae while adults primarily eat drift algae, especially brown kelps. Black abalone compete with sea urchins and other crevice-dwellers for space and food (Miller and Lawrenz-Miller 1993; Taylor and Littler 1979). Where abundant, abalone may be stacked on top of each other, reaching densities of more than 100 per square meter (Douros 1987; Richards and Davis 1993). Black abalone are slow-growing and long-lived, with recruitment apparently being low and variable (Morris *et al.* 1980; VanBlaricom 1993). Growth rates depend on animal size, location, food availability, reproductive condition, and other factors. Absolute longevity has not been determined, but ages greater than 30 years appear likely based on tagging and other population studies (VanBlaricom 1993).

Although once an important fishery resource throughout the region, landings peaked in 1973 and declined thereafter (Leet *et al.* 1992). Sport and commercial black abalone fisheries have been closed since 1993. Black abalone populations in southern California suffered catastrophic declines since the mid-1980s that resulted in nearly complete disappearance of black abalone along mainland shores south of Point Purisima (Miller and Lawrence-Miller 1993; Carr 1989), as well as at many of the Channel Islands (Lafferty and Kuris 1993; Richards and Davis 1993). Mortality was associated with "withering syndrome" (WS), in which the foot shrinks and weakened individuals lose their grip on rock surfaces (Antonio *et al.* 2000; Friedman *et al.* 1997; Gardner *et al.* 1995). WS or its prokaryotic infection has been observed in abalone north of Point Conception in recent years; however the disease is not widespread (Altstatt *et al.* 1996). Overfishing also played a role in the population declines (CDFG 2002). Other sources of mortality include smothering by sand burial, dislodgment by storm waves, and predation by octopus, sea stars, fishes, and sea otters (Morris *et al.* 1980; VanBlaricom 1993). Impacts from oil are little known, but North *et al.* (1964) reported black abalone mortality following a spill in Baja California. Because of low recruitment, slow growth, and already reduced reproductive populations, additional mortality from oil spills would further inhibit recovery.

Green Abalone (Haliotis fulgens)

Green abalone inhabit low intertidal levels to subtidal depths (to 18 meters) from southern California to southern Baja California (Morris *et al.* 1980). These warm-water abalone are identified by lighter, olive-green to red-brown, shell coloration, a finely ribbed shell with 5 to 7 open holes, relatively small size (usually less than 20 centimeters), and a green and brown mottled foot. Green abalone are relatively sedentary and are commonly found in deep crevices exposed to strong wave action. Adult population density may depend on the availability of suitable crevice habitats. They feed almost exclusively on large drift algae. This species may live 20 years (Leet *et al.* 1992). Green abalone was an important fishery in California, with landings peaking in 1971 and rapidly declining thereafter (Leet *et al.* 1992). Green abalones were most common at the southern Channel Islands (including Santa Barbara Island) and present at the northern Channel Islands, but are now rarely encountered. The green abalone commercial and sport fishery is currently closed. Sources of mortality include predation by octopus, sea stars, fishes, and sea otters.

Pink Abalone (Haliotis corrugata)

Pink abalone inhabit subtidal depths (to 60 meters) from southern California to central Baja California (Morris *et al.* 1980). They are identified by lighter, green or red-brown shell coloration, an irregularly ribbed shell with 2 to 4 open holes, an arched shell with a scalloped margin, relatively small size (usually less than 17 centimeters), and their black and white mottled foot. Pink abalone are sedentary, occupying a permanent scar on a home rock. This species occurs in partially sheltered waters, infrequently dwelling in crevices. They feed almost exclusively on large drift algae. This species may live 20 years (Leet *et al.*1992).

In the early 1950s, pink abalone comprised the largest segment of the abalone fishery, about 75 percent, and had a significant effect on the total abalone landings. Commercial landings originated at the eastern northern Channel Islands (Anacapa, Santa Cruz), and the southern Channel Islands (San Nicolas, Santa Catalina, Santa Barbara, San Clemente). Because pink abalone are more fragile than others and grow more slowly, the high level of take could not continue (Leet *et al.* 2001). Department research cruises to San Clemente, Santa Catalina, and Santa Barbara Islands in 1996 and 1997, were used to investigate pink, and other, abalones. The number of abalones sighted per unit of time was used to quantify stocks, and a factor was applied to estimate the number of commercially legal pink abalone that could be collected per hour. Estimates ranged from about one to 1.5 abalone per hour. Similar cruises conducted in 1999, estimated only 0.28 commercial legal pink abalone per hour. At Catalina Island, no commercial sized pink abalone were found.

Red Abalone (Haliotis rufescens)

Red abalone inhabit low intertidal levels to subtidal depths (to 26 meters, rarely to 180 meters) from Oregon to southern Baja California (Morris *et al.* 1980). They are identified by brick red shell coloration, an irregular shell surface with 3 to 4 open holes, and relatively large size (to 30 centimeters). These colder-water abalone are relatively sedentary on reef tops or in crevices. They feed on drift algae and, especially when young, on microscopic algal films. This species may live 20 years (Leet *et al.* 1992).

Red abalone were previously an important fishery in California, with landings peaking in 1967 and steadily declining thereafter (Leet *et al.* 1992). In central and southern California, red abalone declined less than the other five species by the time the fishery was closed in 1997 (Leet *et al.* 2001). Combined landings of red abalone declined during the period from 1969 to 1982 stabilizing at 1/10 their historic average during the 14 year period before the 1997 closure (Leet *et al.* 2001). Detailed examination of catch by area and fishery independent assessments reveal that the stability in landings masked ongoing reductions of local populations, as successive areas declined by over two orders of magnitude. From 1952 to 1968 most red abalone were caught in central California, followed by southern mainland, Santa Cruz, Santa Rosa and San Miguel Islands (Leet *et al.* 2001). Catches declined first along the central coast under the combined effects of expanding sea otters and fishing pressure. Outside the sea otter range catches declined more slowly along the southern mainland than at Santa Rosa, Santa Cruz, and San Nicolas Islands. From 1983-1996, catch decreased off these three islands to three percent, for Santa Rosa, and less than one percent, for Santa Cruz and San Nicolas, of their respective peak catches by the 1997 closure (Leet *et al.* 2001). San Miguel Island and the north coast were the exceptions to this pattern. Catches from San Miguel Island, the farthest and most northern of the Channel Islands, and the north coast comprised 71 of the 87 tons landed in 1996 prior to the fishery closure in 1997 (Leet *et al.* 2001). The red abalone commercial and sport fishery is currently closed, except for sport take by free divers in northern California. Other sources of mortality include predation by crabs, octopus, sea stars, fishes, and sea otters.

White Abalone (Haliotis sorenseni)

White abalone occur subtidally (about 20 to 65 meters) from southern California to southern Baja California. These deep-water abalone are readily identified by their red-brown shell color, a ribbed shell with 3 to 5 open holes, and a yellow-green and beige mottled foot. They grow to approximately 25 centimeters. Individuals up to about 25 years of age have been reported (Davis *et al.* 1996; Gotshall and Laurent 1979). White abalone are sedentary, inhabiting open, exposed deep-water reefs with a kelp understory. Adults consume drifting and attached macroalgae. Juveniles are cryptic, hiding in crevices and beneath rocks where they feed on microalgal films (Davis *et al.* 1996). The white abalone fishery developed late with the first reported commercial landings in 1968; however, they were popular because the foot meat is tender. Abundances were highest at the southern and northeastern Channel Islands. Peak landings occurred in 1972 and decreased thereafter (Leet *et al.* 1992). Average density during periods of peak harvest in the 1970s was one abalone per square meter. Density has dramatically decreased since to 0.002 per square meter (Carlton *et al.* 1999). Surveys in the Channel Islands area found that density may have further decreased to 0.0001 per square meter (Davis *et al.* 1998). Since females must be within a few meters of a male during spawning for fertilization to occur, present population densities in the area may preclude successful spawning. Some sections of the white abalone fishery have been closed since 1977 and the entire fishery has been closed since 1993, though densities have continued to fall (Carlton *et al.* 1999; Davis *et al.* 1998). Subthreshold breeding density and continued predation (e.g., fish, octopus, and sea stars) suggest that recovery without significant human intervention is unlikely. Submersible surveys were carried out to further evaluate population status and to explore possibilities for collection of specimens for a captive breeding program. The rarity of this species prompted NMFS to list it as a candidate species under the Endangered Species Act in 1997. This action required a status review, which concluded that overexploitation was the major cause of the decline. Subsequently, in May 2000, the white abalone became the first marine invertebrate to receive Federal protection as an endangered species.

1.2.3.7 Limpets

Owl Limpet (Lottia gigantea)

Owl limpets are common in high and middle intertidal zones of exposed rocky shores from Washington south to Baja California. Adult *Lottia* are relatively easy to identify because of their large size (5 to 10 centimeters), oval shape with low rounded profile, and color patterns of brown, white, and black on the often eroded shell. Accessory gills on the mantle increase surface area for aerial respiration during low tide periods. Owl limpet habitats extend from the barnacle and *Endocladia* zones in the high intertidal zone down to the mussel beds in the mid tide zone. Owl limpets maintain feeding territories on relatively smooth rock surfaces which they keep free of (by rasping and bulldozing) most macroalgae and invertebrates (Stimpson 1970; Wright 1982). By removing most competitors they promote the growth of algal films upon which they systematically graze. These "clearings" vary in appearance with *Lottia* size and structural features of the substrate, creating a patchwork of differing microhabitats. *Lottia* tend to occupy one or more characteristic "home scars" within their territories. The limpets also may tuck into crevices and under mussels for protection from heat, desiccation, and high surf.

Lottia grow slowly, taking up to 10 to 15 years to reach maximum size (Morris *et al.* 1980). As an ecological dominant, any change in *Lottia* populations greatly affects abundances of other species. The limpets and their feeding territories are vulnerable to oiling, but oil impacts are unclear. For example, they were not obviously affected by the 1971 San Francisco oil spill (Chan 1973). Due to their slow growth, recovery from any major disturbance likely would be lengthy. Larger owl limpets are collected for food, tasting much like abalone (Murray 1998). Since the largest individuals are nearly always females (*Lottia* are protandrous hermaphrodites) (Wright and Lindberg 1982), collecting may impair reproductive capabilities within owl limpet populations.

1.2.3.8 Mussels, Clams, and Scallops

Mussels, clams, and scallops are mollusks of the Class Bivalvia. All bivalves have two hinged shells enclosing the rest of the animal. Bivalves feed by filtering particulate matter from sea water through their gills. They reside in or on the substrate as adults. Many species of bivalves occur in the Channel Islands area, with a sport fishery (for food or bait) being supported by the four species of particular interest described below plus others including purple clams (*Nuttallia nuttallii*), Washington clams (*Saxidomus nuttallii*), jacknife clams (*Tagelus californianus*), gapers (*Tresus nuttallii*), spiny cockles (*Trachycardium quadragenarium*), abalone jingles (*Pododesmus sepio*), oysters, San Diego scallops (*Pecten diegensis*), and speckled scallops (*Argopecten aequisulcatus*) (Thompson *et al.* 1993).

California Mussel (Mytilus californianus)

California mussels are abundant at middle to low levels of exposed rocky shores along the entire Pacific Coast. These 10- to 20-centimeter black/blue/gray mussels firmly attach to rocks or other mussels by tough byssal threads, forming dense patches or beds. The literature on *Mytilus californianus* is extensive, including key ecological studies on the effects of predation, grazing, and disturbance on succession and community structure (see for discussion Kinnetics,1992; Morris *et al.* 1980; Ricketts *et al.* 1985). The bay mussel, *M. galloprovincialis* (formerly mis-identified as *M. edulis*), can co-occur with *M. californianus*, but is most common in sheltered habitats.

Thick (20 centimeters or more) beds of California mussels trap water, sediment, and detritus that provide food and shelter for a large diversity of plants and animals, including cryptic forms inhabiting spaces between mussels as well as biota attached to mussel shells (Kanter 1980; MacGinitie and MacGinitie 1968; Paine 1966; Suchanek 1979). For example, MacGinitie and MacGinitie (1968) counted 625 mussels and 4,096 other invertebrates in a single 25 square centimeter clump, and Kanter (1980) identified 610 species of animals and 141 species of algae from mussel beds at the Channel Islands. Kinnetics (1992) documented location differences in the composition and abundance of mussel bed species. Northern sites had densely packed, multi-layered beds, but the more open southern sites had higher species diversity. Mussels feed on suspended detritus and plankton. Young mussels settle preferentially into existing beds at irregular intervals, grow at variable rates depending on environmental conditions, and eventually reach ages of 8 years or more (Morris *et al.* 1980, Ricketts *et al.* 1985). Desiccation likely limits the upper extent of mussel beds, storms tear out various-sized mussel patches, and sea stars prey especially on lower zone mussels. Mussels are popularly harvested by sport collectors for food and bait. *Mytilus* are adversely affected by oil spills (Chan 1973; Foster *et al.* 1971). Recovery from disturbance varies from fairly rapid (if clearings are small and surrounded by mussels that can move in) to periods greater than 10 years (if clearings are large and recruitment is necessary for recolonization) (Kinnetics 1992; Vesco and Gillard 1980).

Pismo Clam (Tivela stultorum)

Pismo clams inhabit the intertidal zone to subtidal depths (to 25 meters, but mostly less than 7 meters) from Monterey to central Baja California. Adults are found along surf-swept sandy shores. Pismo clams are identified by light colored shell with fine concentric growth lines and short externally-visible siphons. Adult Pismo clams are buried in the substrate and are relatively sedentary. This species may live up to 50 years (Leet *et al.* 1992). Pismo clams have supported a commercial and sport fishery in California since at least 1916. Natural predators include sea stars, snails, fishes, birds, and sea otters. Natural populations of Pismo clams on the mainland have been studied by the Department since 1923. Pismo clams occur at two specific locations at the Channel Islands (at Santa Cruz and Santa Rosa Islands) (Dugan *et al.* 1993; Engle *et al.* 1998).

Geoduck (Panopea abrupta)

Geoducks inhabit low intertidal levels to subtidal depths (to 100 meters) from Alaska to central Baja California. Adults are found in the sandy mud of protected bays or in deep water soft substrates. Geoducks are identified by whitish shells with irregular concentric growth lines and a huge, externally visible siphon (to 1 meter long). Adult geoducks are buried in the substrate and are relatively sedentary.

This species has an extremely long life span (up to 146 years) (O'Clair and O'Clair 1998). Geoducks support a modest sport fishery in California, with divers or individuals on the beach digging up the clams. Their great depth in the sediment requires the use of high-pressure water jets for harvest which seriously disturbs the substrate. Some have expressed interest in developing such a fishery in southern California, but there is also concern about quickly overharvesting such long-lived animals. Natural predators of the geoduck are not known (Morris *et al.* 1980; O'Clair and O'Clair 1998). Populations of the geoduck are found around all four of the northern Channel Islands and along the coast south of Point Conception (Engle *et al.* 1998).

Rock Scallop (Crassedoma giganteum [= Hinnites giganteus])

Rock scallops inhabit low intertidal levels to subtidal depths (to 50 meters) from British Columbia (Canada) to central Baja California. In the Channel Islands, adults are found primarily on high-relief rocky reefs, pinnacles, and walls with moderate to high water motion. Rock scallops are identified by yellow-orange shell, orange flesh, blue eyes on tentacles at edge of mantle, and lack of a visible external siphon. The shell is frequently covered with fouling organisms. Adult rock scallops are attached to the substrate; post-larval juveniles (larger than 45 mm) can swim limited distances. This species may live up to 25 years (Leet *et al.* 1992). Rock scallops support a popular sport fishery for their tasty adductor muscle. It is difficult to assess the total fishery harvest of rock scallops, but nearly 1,000 were reported taken each year between 1978 and 1987 by divers aboard CPFVs, mostly at the Channel Islands (Leet *et al.* 2001). The sport fishery appears to have depleted some local populations. Known natural predators include sea stars although there are likely others. Populations of the rock scallop have not been well studied (Leet *et al.* 1992; Morris *et al.* 1980).

Market Squid (Loligo opalescens)

The California market squid occurs off southern Alaska to central Baja California. They inhabit pelagic coastal waters, congregating to spawn in semi-protected bays, usually over a sand bottom with rocky outcroppings. Spawning in the Channel Islands often occurs from October through May. The average age of squid from fishery samples is approximately 185 days old (Leet *et al.* 2001). Eggs are deposited on the bottom in clusters, with juveniles emerging within approximately one month. Adults die after spawning. The diet of squid consists of small pelagic crustaceans, fishes, benthic worms, and their own young. Market squid have been harvested in California since 1863. The California fishery shifted its emphasis to the region in1961, where it is currently centered. The fishery has been marked by large-scale fluctuations in landings, with no apparent overall trend. Squid landings decrease greatly during strong el Nino events. Squid are harvested using strong lights over the water to attract schools of squid in relatively shallow spawning areas. Since 1984 squid landings have increased steadily to over 200 million pounds in 1999 with severe declines in 1992 and 1998 during strong El Nino events (Leet *et al.* 2001). The present status or structure of populations in the region is unclear and is presently being evaluated by the Department. However, historical evidence from research surveys and recent landing data indicate that the biomass is large (Leet *et al.* 2001).

Squid are important prey for numerous fishes, birds, and marine mammals and their eggs are eaten by benthic echinoderms (Morris *et al.* 1980, Leet *et al.* 1992). The market squid is one of the principal items of the diet of Dall's porpoise and Risso's dolphins, pilot whales, sea lions, and elephant seals (Bonnell and Dailey 1993). Overall, squid are an important part of many food webs in the SCB (Leet *et al.*1992).

1.2.3.9 Sea Urchins

Sea urchins are benthic grazers relying on their outer covering of spines and tube feet for locomotion and protection. Five principal species occur within the Channel Islands: red, purple, white, coronado, and pink. The nocturnal, invertebrate-grazing coronado urchin (*Centrostephanus coronatus*) is a tropical species that reaches its northern limit at the Channel Islands. The pink urchin (*Allocentrotus fragilis*) occurs primarily on soft substrates at depths greater than 150 meters. Pink urchins are scavengers and often dominate the community in terms of biomass (Blake *et al.* 1996). The other urchins are major consumers of kelps and other algae. Red and purple urchins dwell in crevices and feed on drift kelp or emerge to consume attached plants (Morris *et al.* 1980; Leet *et al.* 1992). Urchin grazing may denude entire reefs of nearly all macroalgae, after which the urchins are capable of persisting in a near-starvation state, continuing to eat any newly settled plants (Ambrose *et al.* 1993; Carroll *et al.* 2000; Engle 1994; Harold and Reed 1985; Richards *et al.* 1997). These urchin barrens no longer support the highly diverse assemblages characteristic of balanced kelp-dominated ecosystems. Red, purple, and white urchins are susceptible to disturbance from major storms and a poorly understood disease that may dramatically reduce population sizes (Ebeling *et al.* 1985; Lafferty and Kushner 2000).

Red Urchin (Strongylocentrotus franciscanus)

Red urchins inhabit low intertidal to subtidal depths (to 90 meters) from Alaska to central Baja California. They prefer open rocky shores. Red urchins are identified by their red, maroon, or black color and large size (10 centimeters commonly, to 20 centimeters) (Leet *et al.* 1992; Morris *et al.* 1980). When food is abundant, red urchins are relatively sedentary. However, when food is scarce, red urchin motility increases (to 1 meter per day) (Harrold and Reed 1985). Red urchin spines are refuges for a variety of small invertebrates (including juvenile red urchins) and fishes (Tegner and Dayton 1977). The diet of red urchins consists of a variety of red and brown algae, but Giant kelp is preferred. Red urchins compete with abalone for food and space, though their spine canopy provides shelter for smaller abalone. Red urchins may live 20 years or more (Morris *et al.* 1980). A significant commercial fishery for red urchin began during the 1970s in the region (Leet *et al.* 1992). Commercial hookah divers harvest red urchins using rakes at depths of up to 33 meters.

The relative abundance of red urchins has declined since the 1970's (e.g., Carroll *et al.* 2000). In southern California, the red sea urchin resource now produces about 10 million pounds annually, with harvestable stocks (defined as exceeding the minimum legal size and containing marketable gonads) in decline since 1990 (Leet *et al.* 2001). Between 1985 and 1995, the percentage of legal-sized red sea urchins at survey sites in the northern Channel Islands declined from 15 percent to 7.2 percent (Leet *et al.* 2001). Although fishing has significantly reduced density in many areas and catch-per-unit of effort has decreased, localized juvenile recruitment has, thus far, somewhat mitigated fishing pressure (Leet *et al.* 2001). Consistent recruitment has been noted on artificial settlement substrates and along subtidal transects over the last decade at monitoring stations along the southern California mainland coast and the northern Channel Islands (Leet *et al.* 2001). This may be partly due to ocean current patterns in the SCB, where water retention may increase the chances for larvae to encounter habitat suitable for settlement. Continued recruitment at present levels, however, is not guaranteed; in fact, intensive sea urchin harvesting in northern California and Baja California could result in a decrease in sea urchin larvae in southern California in the future. Other sources of mortality include predation by sea stars, fishes, lobsters, and sea otters (Leet *et al.* 1992; Tegner and Dayton 1981; Tegner and Levin 1983; Rogers-Bennett 1998).

Purple Urchin (Strongylocentrotus purpuratus)

Purple urchins inhabit low intertidal to subtidal depths (to 160 meters) from southern British Columbia (Canada) to central Baja California. They prefer rocky habitats with moderate to strong wave action, where they normally inhabit crevices or depressions they create. Purple urchins are identified by their purple color and relatively small size (to 8 cm). The diet of purple urchins consists of a variety of red and brown algae, but giant kelp is preferred. They are relatively sedentary when food is abundant, with motility increasing as food availability decreases (to 1 meter per day) (Harrold and Reed 1985). This species may live at least 30 years (Morris *et al.* 1980).

Coincident with the decline of competing red urchins, purple urchins populations have increased tremendously at many island sites, creating vast areas denuded of macroalgae (Harold and Reed 1985; Ambrose *et al.* 1993; Engle 1994; Richards *et al.* 1997; Carroll *et al.* 2000, Lafferty and Kushner 2000). A small fishery has existed sporadically for this species which peaked in 1992 at 400,000 pounds and then declined to less than 50,000 pounds in 1999 (Leet *et al.* 2001). A limited amount of this harvest has come from the Channel Islands.

White Urchin (Lytechinus anamesus)

White urchins inhabit subtidal depths (2 to 300 meters) from the Channel Islands to central Baja California. They prefer soft substrates where they often occur in high densities. They can be one of the most dominant megafaunal species on deep-water mainland shelves (Thompson *et al.* 1993). They also periodically invade some shallow-water sand and rock habitats (Ambrose *et al.* 1993; Engle 1994; Richards *et al.* 1997; Carroll *et al.* 2000). White urchins are identified by their whitish color, small size (to 4 cm), and fragile test. White urchins are extremely effective grazers, capable of consuming kelp and other algae when density is high (Morris *et al.* 1980; Ambrose *et al.* 1993; Engle 1994; Richards *et al.* 1997; Carroll *et al.* 2000). In the Channel Islands, feeding fronts of white urchins apparently have eliminated eelgrass beds on the north side of Anacapa Island (Engle 1994). White urchins may also consume invertebrates, including other urchins (Coyer *et al.* 1987). There is no fishery for these small urchins. Predators of white urchins include sea stars and fishes (Schroeter *et al.* 1983).

1.2.3.10 Sea Cucumbers

Sea cucumbers are benthic animals with a variety of feeding strategies, from planktivory to bottom feeding (Morris *et al.* 1980). At least 12 species are known to occur in the Channel Islands though two (California and Warty sea cucumbers) are of particular interest as they support an expanding commercial fishery which began in 1978 and peaked in 1998 at nearly 900,00 pounds (Leet *et al.* 2001). It is apparent that harvesting has significantly reduced some sea cucumber populations.

California Sea Cucumber (Parastichopus californicus)

California sea cucumbers inhabit low intertidal levels to subtidal depths (to 90 meters) from Alaska to central Baja California; however, they rarely occur at depths above 30 meters in the region. Here, they occur predominantly on deep-water, soft-bottom habitats. These colder-water sea cucumbers are identified by their red, brown, or yellow color, large stiff papillae, and large size (to 40 centimeters). Although relatively sedentary, they may move up to 4 meters per day (Lambert 1997). The diet of California sea cucumbers consists of detritus and small organisms, which they ingest with bottom sediments. No sport fishery for this species exists. A commercial fishery using trawl gear for California sea cucumbers started in California in 1978 and dominated total sea cucumber landings until 1996 (Leet *et al.* 2001). In 1982, the center of the fishery shifted to the CINMS where they are harvested from the

Santa Barbara Channel by trawling. This species may live about 12 years. (Morris *et al.* 1980; Leet *et al.* 1992). Sources of mortality other than fishing include predation by sea stars, fishes, and crabs.

Warty Sea Cucumber (Parastichopus parvimensis)

Warty sea cucumbers inhabit low intertidal levels to subtidal depths (to 27 meters) from Monterey Bay to central Baja California. These warmer-water sea cucumbers are common on both soft substrates and rocky reefs. Warty sea cucumbers are identified by their light-brown color, dorsal papillae, and smaller size than the California sea cucumber (to 25 centimeters). Warty sea cucumbers are common in the Channel Islands, though natural populations are poorly studied (Gotshall and Laurent 1979; Morris *et al.* 1980). This slow-moving sea cucumber feeds on detritus and small organisms, which it ingests with bottom sediments. It may live about 12 years (Morris *et al.* 1980; Leet *et al.* 1992). No sport fishery for this species exists. A commercial fishery by hookah divers using rakes started in California in 1978 (Leet *et al.* 1992). Initially, total sea cucumber landings were dominated by the trawl caught California sea cucumber, but since 1997 the total landings have been consisted of over 80 percent of the diver caught Warty sea cucumbers (Leet *et al.* 2001). Other sources of mortality include predation by sea stars, fishes, crabs, and sea otters, and a bacterial disease that may significantly reduce population sizes (Eckert *et al.* 2000; Engle 1994).

Ochre Sea Star (Pisaster ochraceus)

Ochre sea stars are found on middle and low tide levels of wave-swept rocky coasts from Alaska to Baja California, but they are much less common south of Point Conception. Their relatively large size (to 45 centimeters diameter), variety of colors (yellow, orange, purple, brown), and ability to withstand air exposure (at least 8 hours) attract considerable attention from visitors exploring the shore at low tide. The ochre sea star typically is associated with mussels, which constitute its chief food, but barnacles, limpets, snails, and chitons also may be taken (Morris *et al.* 1980).

Predator-prey interactions involving ochre sea stars have been intensely studied, especially the role of *P. ochraceus* in determining the lower limit of northern mussel beds (Dayton 1971; Paine 1966, 1974). Like black abalone, ochre sea stars are relatively slow-growing, long-lived, and apparently variable in recruitment success. Tolerant of high surf, they use their numerous tube feet to remain firmly in place, often in cracks and crevices. They have few predators, except for the occasional sea gull or sea otter and curious tidepool visitor. However, in southern California, *P. ochraceus* populations have been decimated by a widespread wasting disease caused by a warm-water bacterium of the genus Vibrio (Eckert *et al.* 2000). Sensitivity to oil spills is not well known; Chan (1973) saw no obvious effects from a San Francisco oil spill. Due to their slow growth and low reproductive success recovery time from any major population loss likely would be very long.

1.2.4 Fishes

About 481 species of fish inhabit the SCB (Cross and Allen 1993). The great diversity of species in the area occurs for several reasons: (1) the ranges of many temperate and tropical species extend into and terminate in the SCB, (2) the area has complex bottom topography and a complex physical oceanographic regime that includes several water masses and a changeable marine climate (Cross and Allen 1993; Horn and Allen 1978), and (3) the islands and nearshore areas provide a diversity of habitats that include soft bottom, rock reefs, extensive kelp beds, and estuaries, bays, and lagoons.

The fish species found around the Channel Islands generally are representative of fish assemblages that occur along the southern California coast, with the addition of some central California species (Hubbs 1974). Eschemeyer *et al.* (1983) list 406 fish species whose ranges include the CINMS (Table C-3).

Table C-3
Common Fish Species Found in the CINMS

Common Name	Scientific Name
Albacore	*Thunnus alalunga*
Anchovy, Northern	*Engraulis mordax*
Barracuda, Pacific	*Sphyraena argentea*
Bass, Barred Sand	*Paralabrax nebulifer*
Bass, Giant Sea	Stereolepis gigas
Bass, Kelp	*Paralabrax clathratus*
Bass, Spotted Sand	*Paralabrax maculatofasciatus*
Bat Ray	*Myliobatis californica*
Blacksmith	*Chromis punctipinnis*
Bonito, Pacific	*Sarda chiliensis*
Brown Smoothhound	*Mustelus henlei*
Butterfish, Pacific	*Peprilus simillimus*
Ca. Scorpionfish (Sculpin)	*Scorpaena guttata*
Cabezon	*Scorpaenichthysm marmuratus*
California Sheephead	*Semicossyphus pulcher*
California Moray	*Gymnothorax nordax*
California Scorpionfish	*Scorpaena guttata*
California Flyingfish	*Cypelurus californicus*
California Halibut	*Paralichthys californicus*
Croaker, White	*Genyonemus lineatus*
Croaker, Black	*Cheilotrema saturnum*
Croaker, Yellowfin	*Umbrina roncador*
Eel, Monkeyface	*Cebidichthys violaceus*
Garibaldi	*Hypsypops rubicundus*
Goby, Bluebanded	*Lythrypnus dalli*
Goby, Blackeye	*Coryphopterus nicholsi*
Goby, Zebra	*Lythryphus zebra*
Greenling, Kelp	*Hexagrammos decagrammus*
Greenling, Painted	*Oxylebius pictus*
Greenling, Rock	*Hexagrammos lagocephalus*
Grunion	*Leuresthes tenuis*
Gunnel, Kelp	*Ulvicola sanctaerosae*
Hake, Pacific	*Merluccius Productus*
Half Moon	*Medialuna californiensis*
Horn Shark	*Heterodontus francisci*

Table C-3, Page 1 of 4

Table C-3
Common Fish Species Found in the CINMS (Continued)

Common Name	Scientific Name
Jacksmelt	*Atherinops californiensis*
Kelpfish, Island	*Alloclinus holderi*
Kelpfish, Crevice	*Gibbonsia montereyensis*
Kelpfish, Giant	*Heterostichus rostratus*
Kelpfish, Spotted	*Gibbonsia elegans*
Lingcod	*Ophiodon elongatus*
Mackerel, Pacific	*Scomber japonicus*
Mackerel, Jack	*Trachurus symmetricus*
Northern Ronquil	*Ronquilus Jordani*
Ocean Sunfish	*Mola mola*
Opah	*Lampris guttatus*
Opaleye	*Girella nigricans*
Orangethroat Pikeblenny	*Chaenopsis alepidota*
Queenfish	*Seriphus politus*
Reef Perch	*Micrometrus aurora*
Rock Wrasse	*Halichoeres semicinctus*
Rockfish, Gopher	*Sebastes carnatus*
Rockfish, Yellowtail	*Sebastes flavidus*
Rockfish, Black	*Sebastes melanops*
Rockfish, Black and Yellow	*Sebastes chrysomelas*
Rockfish, Blue	*Sebastes mystinus*
Rockfish, Bocaccio	*Sebastes paucispinis*
Rockfish, Brown	*Sebastes auriculatus*
Rockfish, Calico	*Sebastes dalli*
Rockfish, Calico	*Sebastes dalli*
Rockfish, Canary	*Sebastes pinniger*
Rockfish, China	*Sebastes nebulosus*
Rockfish, Copper	*Sebastes caurinus*
Rockfish, Vermillion	*Sebastes miniatus*
Rockfish, Grass	*Sebastes rastrelliger*
Rockfish, Halfbanded	*Sebastes semicinctus*
Rockfish, Kelp	*Sebastes atrovirens*
Rockfish, Olive	*Sebastes serranoides*
Rockfish, Rosy	*Sebastes rosaceus*
Rockfish, Stripetail	*Sebastes saxicola*
Rockfish, Tree	*Sebastes serriceps*

Table C-3, Page 2 of 4

Table C-3
Common Fish Species Found in the CINMS (Continued)

Common Name	Scientific Name
Rockfish, Yelloweye	*Sebastes rubervimus*
Rockfish,Tiger	*Sebastes nigrocinctus*
Ronquil, Stripedfin	*Rathbunella hypoplecta*
Salmon, King	*Oncorhynchus Tshawytscha*
Sanddab, Pacific	*Citharicthys sordidus*
Sanddab, Speckled	*Citharicthys stigmaeus*
Sarcastic Fringehead	*Neoclinux blanchardi*
Sardine, Pacific	*Sardinops sagax*
Sargo	*Anisotremus davidsoni*
Saury, Pacific	*Coloabis saira*
Sculpin, Snubnose	*Orthonopias Triacis*
Sculpin, Scalyhead	*Artedius harringtoni*
Sculpin, Wooly	*Clinocotius analis*
Seaperch, Sharpnose	*Phanerodon atripes*
Seaperch, Striped	*Embiotoca lateralis*
Seaperch, Rubberlip	*Rhacochilus toxotes*
Seaperch, Rainbow	*Hypsurus caryi*
Señorita	*Oxyjulis californuca*
Shark, Blue	*Prionace glauca*
Shark, Mako	*Isurus oxyrnchus*
Shark, Soupfin	*Galeorhinus galeus*
Shark, Spiny Dogfish	*Squalus acanthias*
Shark, Swell	*Cephaloscyllium ventriosum*
Shark, Thresher	*Alopias vulpinus*
Shark, White	*Carcharodon carcharias*
Shark, Leopard	*Triakis semifasciata*
Siversides	*Atherinidae*
Sole, Sand	*Psettichthys melanostictus*
Sole, English	*Pleuronectes vetulus*
Sole, Rock	*Pleuronectes bilineatus*
Spotted Cusk-eel	*Chilara taylori*
Spotted Turbot	*Pleuronichthys ritteri*
Surfperch, Barred	*Amphistichus argenteus*
Surfperch, Black	*Embiotoca jacksoni*
Surfperch, Island	*Cymatogaster gracilis*

Table C-3, Page 3 of 4

Table C-3
Common Fish Species Found in the CINMS (Continued)

Common Name	Scientific Name
Surfperch, Kelp	*Brachyistius frenatus*
Surfperch, Pile	*Damalichthys vacca*
Surfperch, Pink	*Zalembius rosaceus*
Surfperch, Shiner	*Cymatogaster aggregata*
Surfperch, Spotfin	*Hyperprosopon anale*
Surfperch, Calico	*Amphistichus koelzi*
Surfperch, White	*Phanerodon furcatus*
Surfperch, Walleye	*Hyperprosopon argenteum*
Swordfish	*Xiphias gladius*
Thornback	*Platyrhinoidis triseriata*
Topsmelt	*Atherinops affinis*
Tube Snout	*Aulorhynchus flavidus*
Turbot, Hornyhead	*Pleuronichthys verticallis*
Turbot, Curlfin	*Pleuronichthys decurrens*
Turbot, C-O	*Pleuronichthys coenosus*
White Sea Bass	*Atractoscion nobilis*
Whitespotted Greenling	*Hexagrammos stelleri*
Yellowfin Fringehead	*Neoclinus stephensae*
Zebra Perch	*Hermosilla azurea*

Table C-3, Page 4 of 4
Source: CDFG 2002.

1.2.4.1 Nearshore Fish

Abundance of fish assemblages is greater at the northern Channel Islands than at nearby coastal regions of the southern California mainland. One reason for this is the high quality of nearshore habitats associated with the northern Channel Islands.

Fish abundance on nearshore reefs is related to the presence or absence of kelp and substrate topography. The abundance of water column fish such as kelp surfperch (*Brachyistius frenatus*), kelp bass (*Paralabrax clathratus*), giant kelpfish (*Heterostichus rostratus*), and kelp rockfish (*Sebastes atrovirens*) are directly correlated with kelp density. Kelp beds are not important spawning areas for fish, but they are important nursery areas for juvenile fishes. Juvenile and adult kelp bass occur in both kelp beds and on rocky reefs devoid of kelp (Cross and Allen 1993).

Hard substrates are the least abundant, but among the most important of fish habitats in the SCB (Cross and Allen 1993). About 30 percent of the species and 40 percent of fish families in the SCB occupy this habitat (Cross and Allen 1993). The composition of reef fish assemblages is influenced by the physical characteristics of the reef (Ebeling *et al.* 1980a,b; Larson and DeMartini 1984), and by water temperatures (Stephens and Zerba 1981; Stephens *et al.* 1984). Shelter-seeking species such as blacksmith (*Chromis punctipinnis*), garibaldi (*Hypsopops rubicundus*), grass rockfish, (*Sebastes rastrelliger*) brown rockfish

(Sebastes *auriculatus*) and gopher rockfish (*Sebastes carnatus*) are abundant on high-relief reefs, but they are rare or absent on low-relief reefs (Larson and DeMartini 1984).

In the northern SCB, the kelp canopy is dominated by plankton-eating and kelp-browsing species such as blacksmith, kelp surfperch, blue rockfish (*Sebastes mystinus*) juvenile olive rockfish and senorita (Ebeling *et al.* 1980 a, b). The canopy assemblage is made up of large populations of just a few species of fish (Cross and Allen 1993). The most common, conspicuous fish in the canopies of kelp beds on high-relief bench reefs off Santa Barbara and Santa Cruz Island are blue rockfish (41 percent) and kelp surfperch (35 percent) respectively (Ebeling *et al.* 1980a). Blacksmith represent 36 and 33 percent of the assemblages at these locations, respectively. Fish that ambush their prey or graze, such as pile surfperch, (*Damalicthys vacca*) black surfperch, garibaldi, California sheephead (*Semicossphylus pulcher*) gopher rockfish (*Sebastes carnautus*) and black-and-yellow rockfish (*Sebastes chrysomelas*) occupy the reef itself. The kelp bed bottom assemblages consist of smaller populations of a relatively larger number of fish species. The most common fishes near the bottom of the Santa Barbara kelp bed are black surfperch (28 percent); at Santa Cruz Island, kelp bass (14 percent).

The rocky intertidal is a turbulent and dynamic environment where fish must cope with waves, surge and physiological stresses imposed by the ebb and flow of tides. Only six species of fish reside in the rocky intertidal including wooly sculpin (*Clinocotus analis*), reef finspot (*Paraclinus integripinnis*), rockpool blenny (*Hypsoblennius gilberti*), spotted kelpfish (*Gibbonsi elegans*), and California clingfish (*Gobiesox rhesssodon*) (Cross and Allen 1993).

1.2.4.2 Skates and Rays

Skates and rays are not specifically sought by commercial fishermen, but are taken incidentally, primarily by bottom trawlers in central and northern California waters (Leet *et al.* 2001). Of the species identified in the commercial catch the most common are the shovelnose guitarfish (*Rhinobatos productus*), bat ray (*Myliobatis californica*), big skate (*Raja binoculata*), and thornback (*Platyrhinoidis triseriata*). This does not represent the true catch composition, however, as 98 percent of the landings are listed as “unidentified skate” (Leet *et al.* 2001). A few nearshore species, most commonly the bat ray and shovelnose guitarfish, are the target of small sport fisheries.

Rays and skates occur in all marine habitats, from protected bays and estuaries to open seas, ranging from the surface to 9,500 feet deep (Leet *et al.* 2001). While some species are common, others are known from only a few specimens. From 1916 to 1990, skate landings, which ranged from 36,247 pounds (1916) to 631,240 pounds (1981), comprised two to 90 percent of the total elasmobranch catch (11.8 percent average) (Leet *et al.* 2001). Like the shark fishery, which had peaks from 1937 to 1948, and more recently from 1976 to 1990, the skate catch has fluctuated widely during the last half century (Leet *et al.* 2001). In the past 10 years, however, skate and ray landings have increased nearly ten-fold in California, from around 228,566 pounds in 1989 to 1,912,695 pounds in 1999 (Leet *et al.* 2001). This trend is most notable in the trawl fishery after 1994.

Some of the apparent increase may be due to increased landings of previously discarded catch. In 1994, the commercial groundfish fishery was divided into limited entry and open access components, each with new regulations and quotas. Groundfish quotas for both components were significantly reduced in the period from 1994 through 1999, leaving more space in the boats’ holds for non-quota species. Trawl vessels may have supplemented their groundfish landings with skate and ray bycatch. There is considerable uncertainty whether the total impact on the skate and ray resource has increased or if more of the catch is being retained and landed (Leet *et al.* 2001).

The impact of sport fisheries on skates and rays is relatively unknown. Data from 48 shark derbies in Elkhorn Slough from 1950 to 1990 show, however, that shovelnose guitarfish, which in the 1950s and 1960s were the second, and in some years the most abundantly caught elasmobranch, virtually disappeared from the catch in later years (Leet *et al.* 2001). In the 1990s, there was a two-thirds decrease in the catch-per-unit effort for bat rays compared to the 1950s catch rates in these derbies (Leet *et al.* 2001). MRFSS data, however, show continued catches of bat rays, big skates, shovelnose guitarfish, and thornback. The total numbers caught are hard to determine from the numbers of sampled skates and rays, as sampled catch numbers vary widely from year to year (Leet *et al.* 2001).

Based on existing data, little can be said about the current or past population levels of California's skates and rays (Leet *et al.* 2001). While landings are increasing dramatically, this may or may not reflect an actual threat to the resource. Fish that were discarded in the past, dead and alive, are now being retained and landed. Other regions have already witnessed decreases in skate and ray populations and the population status warrants close monitoring.

1.2.4.3 Nearshore Epipelagic Species

Nearshore epipelagic fishes found within the CINMS include California barracuda *(Sphyraena argentea)*, Pacific bonito *(Sarda chiliensis)*, white seabass *(sarda chiliensis)* and yellowtail *(Seriola lalandi)*. More information about these species can be found in Marine Protected Areas in NOAA's Channel Islands National Marine Sanctuary – Final Environmental Document (2002), available on line at http://www.dfg.ca.gov/mrd/ci_ceqa/index.html.

1.2.4.4 Groundfish

Groundfish species found within the CINMS include bocaccio *(Sebastes paucispinis)*, cowcod *(Sebastes levis)*, chilipepper *(Sebastes goodei)*, widow rockfish *(Sebastes entomelas)*, bank rockfish *(Sebastes rufus)*, dover sole *(Microstomus pacificus)*, English sole *(Pleuronectes vetulus)* and sablefish *(Anoplopoma fimbria)*. More information about these species can be found in Marine Protected Areas in NOAA's Channel Islands National Marine Sanctuary – Final Environmental Document (2002), available on line at http://www.dfg.ca.gov/mrd/ci_ceqa/index.html.

1.2.4.5 Coastal Pelagic Species (CPS)

Coastal pelagic species found within the CINMS include Pacific sardine *(Sardinops sajax)*, Northern anchovy *(Engraulis mordax)*, Pacific mackerel *(Scomber japonicus)* and jack mackerel *(Trachurus symmetricus)*. More information about these species can be found in Marine Protected Areas in NOAA's Channel Islands National Marine Sanctuary – Final Environmental Document (2002), available on line at http://www.dfg.ca.gov/mrd/ci_ceqa/index.html.

1.2.4.6 Highly Migratory Species

Highly migratory fish species found within the CINMS region include albacore *(Thunnus alalunga)*, swordfish *(Xiphias gladius)*, Pacific northern bluefin tuna *(Thunnus orientalis)*, skipjack tuna *(Katsuwonus pelamis)*, yellowfin tuna *(Thunnus albacares)*, striped marlin *(Tetrapturus audax)*, shortfin mako shark *(Isurus oxyrinchus)*, thresher shark *(Alopias vulpinus)*, blue shark *(Prionace glauca)*, opah *(Lampris guttatus)*, louvar *(Luvarus imperialis)* and dolphin *(Coryphaena hippurus)*. More information about these species can be found in Marine Protected Areas in NOAA's Channel Islands National Marine Sanctuary – Final Environmental Document (2002), available on line at http://www.dfg.ca.gov/mrd/ci_ceqa/index.html.

Regional upwelling carries nutrient-rich waters from canyons and island shelf areas to the photic zone resulting in increased primary productivity and larger zooplankton populations, which support exceptionally abundant populations of small schooling species such as the northern anchovy, Pacific saury (*Cololabis saira*), Pacific sardine, and Pacific and jack mackerel. These fish are in turn preyed upon by larger pelagic fish, and together they form a significant contribution to the forage base of marine mammals and birds. Schooling species found in offshore waters include northern anchovy, Pacific sardine, yellowfin tuna (*Thunnus albacares*), bluefin tuna (*T. thynnus*), albacore (*T. alalunga*), Pacific bonito and salmon (*Oncorhynchus spp*.). Northern anchovy and Pacific sardine are among the most abundant species and are the major prey of the mackerel and bonito; northern anchovy, Pacific sardine, mackerel, and bonito form the food base for the tuna.

The largest habitat in the SCB is the pelagic (open water) zone. Forty percent of the fish species in the SCB occupy this habitat, which has three vertical subzones (epipelagic, mesopelagic, and bathypelagic). The epipelagic zone is dominated by small, schooling fish such as northern anchovy, Pacific sardine and Pacific mackerel, which feed on plankton; by predatory schooling fish such as Pacific bonito and yellowtail; and by large, solitary predators like blue shark (*Prionace glauca*) and swordfish (*Xiphias gladius*) (Bedford and Hagerman 1983; Cailliet and Bedford 1983; Mais 1974, 1977; Squire 1983). Northern anchovy and Pacific Sardine are the most abundant epipelagic fish and may be the usually dominant species (MacCall *et al.* 1976; Squire 1983). However, abundance of epipelagic fishes varies with the seasons. Anchovy schools are more abundant and larger in the inshore areas of the northern SCB during the summer and fall (Cross and Allen 1993). From late winter to spring, anchovy schools move offshore to spawn (Mais 1974, 1977). Yellowtail migrate into the SCB from Baja California in the spring when surface water temperatures begin to warm. They spawn offshore in the summer and return south in the fall (Cross and Allen 1993).

The pelagic zone plays a critical role in sustaining fish populations because the eggs of nearly all fish are either deposited or hatched there. Even the larvae of fish that bear live young or attach eggs to the substrate (Cross and Allen 1993) spend the initial portion of their lives in the pelagic zone. Microscopic fish larvae are known as ichthyoplankton. The abundance of ichthyoplankton is greatest in the SCB and off northern Baja California (Cross and Allen 1993). The ichthyoplankton population of the SCB within 62 miles (100 kilometers) from the coast is dominated by northern anchovy larvae (83 percent). Rockfish (*Sebastes* spp.) and California smoothtongue (*Leuroglossus stilbius*) larvae each represent 4 percent of the ichthyoplankton population. Larvae of other species, such as white croaker, pacific hake, and California halibut form 2 percent or less of ichthyoplankton in the SCB (Gruber *et al.* 1982). Research on ichthyoplankton dynamics in the SCB has focused primarily on Pacific sardine, northern anchovy, and Pacific mackerel (Hunter 1981; Sherman *et al.* 1983).

1.2.5 Seabirds

Over 195 species of birds use open water, shore, or island habitats in the SCB south of Point Conception (Baird1990). Many of these species are found in the CINMS (Table C-4). The Channel Islands region is located along the Pacific Flyway, a major migratory route for birds, and acts as a stopover during both north (April through May) and south (September through December) migrations. The months of June and July are peak months for transient seabirds (Lehman 1994). The Channel Islands provide breeding and nesting sites for many species and large numbers of seabirds, including many threatened and endangered species (Table C-5). The diversity of habitats provided both on- and offshore also contributes to the high species diversity in the region (Figure C-4). Sandy beaches provide foraging and resting habitat for a number of seabirds including black-bellied plover, willet, whimbrel, long-billed curlew, gulls, and sanderlings. The upland potions of the beach provide kelp deposits that attract invertebrates where black and ruddy turnstones, dowitchers, and other seabird species forage.

Table C-4
Seabirds Associated with the CINMS

Common Names of Bird Families and Species	Scientific Names	Presence in CINMS*
Loons (offshore)	Family: Gaviidae	
Red throated Loon	*Gavia stellata*	Common visitor in winter; rare, but regular in summer
Pacific Loon	*Gavia pacifica*	Uncommon visitor in winter; abundant in spring; rare to locally uncommon in summer; common in fall
Common Loon	*Gavia immer*	Winter visitor; rare in spring; rare but regular in summer
Yellow-billed Loon	*Gavia adamsii*	Casual winter visitor
Grebes (offshore)	*Family: Podicipedidae*	
Pied-billed Grebe	Podilymbus podiceps	Winter visitor; fairly common summer resident
Horned Grebe	*Podiceps auritus*	Winter visitor; very rare in summer
Red-necked Grebe	*Podiceps grisegena*	Winter visitor; very rare fall transient
Eared Grebe	*Podiceps nigricollis*	Winter visitor; very rare in summer
Western Grebe	*Aechmophorus occidentalis*	Winter visitor; several spring breeding records; uncommon to locally common in summer
Clark's Grebe	*Aechmophorus clarkii*	Winter visitor; several spring breeding records; very uncommon to locally common in summer
Albatrosses (offshore)	*Family: Diomedeidae*	
Black-footed Albatross	*Phoebastria nigripes*	Uncommon to rare visitor in fall/winter; uncommon in spring/summer
Laysan Albatross	*Diomedea immutabilis*	Rare but regular visitor in winter/summer/fall
Fulmars (offshore)	*Family: Procellariidae*	
Northern Fulmar	*Fulmarus glacialis*	Winter/spring/fall visitor; very rare in summer
Petrels (offshore)	*Family: Procellariidae*	
Mottled Petrel	*Pterodroma inexpectata*	Casual winter visitor offshore
Murphy's Petrel	*Pterodroma ultima*	Very rare visitor well offshore
Cook's Petrel	*Pterodroma cookii*	Casual winter visitor; very rare visitor well offshore in spring/summer
Stejneger's Petrel	*Pterodroma longirostris*	Casual winter visitor
Shearwaters (offshore)	*Family: Procellariidae*	
Pink-footed Shearwater	*Puffinus creatopus*	Very rare in winter; common visitor in spring/summer

Table C-4, Page 1 of 7

Table C-4
Seabirds Associated with the CINMS (Continued)

Common Names of Bird Families and Species	Scientific Names	Presence in CINMS*
Flesh-footed Shearwater	*Puffinus carneipes*	Casual visitor offshore
Buller's Shearwater	*Puffinus bulleri*	Very rare fall visitor well offshore
Sooty Shearwater	*Puffinus griseus*	Common to abundant visitor in spring/summer/fall; very rare but regular in winter
Short-tailed Shearwater	*Puffinus tenuirostris*	Very rare winter visitor
Black-vented Shearwater	*Puffinus opisthomelas*	Rare winter visitor; casual in spring/summer; common to uncommon in fall
Storm-Petrels (offshore)	*Family: Hydrobatidae*	
Wilson's Storm-Petrel	*Oceanites oceanicus*	Casual visitor
Fork-tailed Storm-Petrel	*Oceanodroma furcata*	Casual visitor in winter/spring
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	Uncommon to common in winter/spring/fall; uncommon in summer, breeds on islands
Ashy Storm-Petrel	*Oceanodroma homochroa*	Casual visitor in winter; common resident in spring/summer/fall. Breeds on San Miguel and Santa Cruz Islands
Wedge-rumped Storm-Petrel	*Oceanodroma tethys*	Casual winter visitor
Black Storm-Petrel	*Oceanodroma melania*	Fairly common to common summer visitor, breeds on islands
Least Storm-Petrel	*Oceanodroma microsoma*	Irregularly uncommon to fairly common summer/fall visitor
Tropicbirds (offshore)	*Family: Phaethontidae*	
Red-billed Tropicbird	*Phaethon aethereus*	Very rare summer/fall visitor
Red-tailed Tropicbird	*Phaethon rubricauda*	Casual visitor
Pelicans (onshore and offshore)	*Family: Pelecanidae*	
American White Pelican	*Pelecanus erythrorhynchos*	Rare to very rare winter visitor
California Brown Pelican	*Pelecanus occidentalis californicus*	Common year-round. Breeds on Anacapa, Santa Cruz, Santa Barbara islands

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Table C-4
Seabirds Associated with the CINMS (Continued)

Common Names of Bird Families and Species	Scientific Names	Presence in CINMS*
Cormorants (onshore and offshore)	*Family: Phalacrocoracidae*	
Double-crested Cormorant	*Phalacrocorax auritus*	Winter visitor, uncommon and local in summer, breeds on islands
Brandt's Cormorant	*Phalacrocorax penicillatus*	Common to very common winter visitor. Breeds on Channel Islands
Pelagic Cormorant	*Phalacrocorax pelagicus*	Fairly common to common winter visitor; fairly common summer resident, breeds on islands.
Frigatebirds (offshore)	*Family: Fregatidae*	
Magnificent Frigatebird	*Fregata magnificens*	Rare summer visitor
Geese (onshore and offshore)	*Family: Anatidae*	
Brant	*Branta bernicla*	Rare winter and fall visitor; common to abundant transient just offshore in spring; very rare in summer
Scoters (offshore)	*Family: Anatidae*	
Surf Scoter	*Melanitta perspicillata*	Common winter visitor; rare to uncommon in summer
White-winged Scoter	*Melanitta fusca*	Transient winter visitor
Plovers (onshore)	*Family: Charadriidae*	
Black-bellied Plover	*Pluvialis squatarola*	Common winter visitor; uncommon to fairly common but local in summer
American Golden Plover	*Pluvialis dominica*	Casual spring transient; rare in fall
Pacific Golden Plover	*Pluvialis fulva*	Very rare in winter; very rare transient in spring; rare in fall
Western Snowy Plover	*Charadrius alexandrinus*	Fairly common, but local winter visitor; spring resident; uncommon to fairly common but local in summer, breeds on islands.
Semipalmated Plover	*Charadrius semipalmatus*	Uncommon and local winter visitor; fairly common transient in spring/fall; a few individuals in summer
Killdeer	*Charadrius vociferus*	Common permanent resident year round, breeds on islands

Table C-4, Page 3 of 7

Table C-4
Seabirds Associated with the CINMS (Continued)

Common Names of Bird Families and Species	Scientific Names	Presence in CINMS*
Oystercatchers (onshore)	*Family: Haematopodidae*	
Black Oystercatcher	*Haematopus bachmani*	Uncommon permanent resident year round, breeds on islands
Stilts (onshore)	*Family: Recurvirostridae*	
Black-necked Stilt	*Himantopus mexicanus*	Uncommon to rare in winter; uncommon resident in summer
Avocets (onshore)	*Family: Recurvirostridae*	
American Avocet	*Recurvirostra americana*	Fairly common transient
Yellowlegs (onshore)	*Family: Scolopacidae*	
Greater Yellowlegs	*Tringa melanoleuca*	Fairly common to locally common winter visitor; rare in summer
Lesser Yellowlegs	*Tringa flavipes*	Very rare to rare in winter; uncommon to fairly common fall transient
Sandpipers (onshore)	*Family: Scolopacidae*	
Solitary Sandpiper	*Tringa solitaria*	Very rare to casual in spring; rare but regular fall transient
Willet	*Catoptrophorus semipalmatus*	Winter visitor; fairly common in spring/summer
Wandering Tattler	*Heteroscelus incanus*	Winter visitor; casual in spring/summer
Spotted Sandpiper	*Actitis macularia*	Winter visitor; rare summer resident
Little Curlew	*Numenius minutus*	Casual vagrant
Whimbrel	*Numenius phaeopus*	Fairly common to locally common winter visitor
Long-billed Curlew	*Numenius americanus*	Winter visitor; uncommon in spring/summer
Marbled Godwit	*Limosa fedoa*	Winter visitor; uncommon to rare in spring/summer
Ruddy Turnstone	*Arenaria interpres*	Winter visitor; very rare in summer
Black Turnstone	*Arenaria melanocephala*	Winter visitor; very rare in summer
Surfbird	*Aphriza virgata*	Casual in winter; fairly common transient in spring; very rare in fall
Red Knot	*Calidris canutus*	Casual winter and summer transient
Sanderling	*Calidris alba*	Winter visitor; uncommon and local in summer

Table C-4, Page 4 of 7

Table C-4
Seabirds Associated with the CINMS (Continued)

Common Names of Bird Families and Species	Scientific Names	Presence in CINMS*
Semipalmated Sandpiper	*Calidris pusilla*	Casual spring transient
Western Sandpiper	*Calidris mauri*	Common to uncommon but local in winter; very rare in summer
Least Sandpiper	*Calidris minutilla*	Winter visitor; casual in summer
Baird's Sandpiper	*Calidris bairdii*	Casual in spring; very uncommon fall transient
Pectoral Sandpiper	*Calidris melanotos*	Casual in spring; locally uncommon fall transient
Sharp-tailed Sandpiper	*Calidris acuminata*	Very rare fall transient
Dunlin	Calidris alpina	Winter visitor; uncommon spring transient; fairly common to locally common fall transient
Stilt Sandpiper	*Calidris himantipus*	Casual in spring; very rare fall transient
Buff-breasted Sandpiper	*Tryngites subruficollis*	Casual fall vagrant
Ruff	*Philomachus pugnax*	Winter visitor; very rare fall transient
Short-billed Dowitcher	*Limnodromus griseus*	Very rare winter/spring transient
Long-billed Dowitcher	*Limnodromus scolopaceus*	Winter visitor; casual in summer
Common Snipe	*Gallinago gallinago*	Winter visitor
Phalaropes (onshore)	*Family: Scolopacidae*	
Wilson's Phalarope	*Phalaropus tricolor*	Uncommon to fairly common spring transient; fairly common to common fall transient
Red-necked Phalarope	*Phalaropus lobatus*	Common to locally abundant spring transient; rare in summer; common fall transient
Red Phalarope	*Phalaropus fulicaria*	Absent to fairly common winter visitor; rare to abundant in spring; very rare in summer; uncommon to common in fall
Jaegers (offshore)	*Family: Laridae*	
Pomarine Jaeger	*Stercorarius pomarinus*	Uncommon in winter, casual in summer
Parasitic Jaeger	*Stercorarius parasiticus*	Rare but regular winter visitor, casual in summer
Long-tailed Jaeger	*Stercorarius longicaudus*	Uncommon to rare fall transient
Skuas (offshore)	*Family: Laridae*	
South Polar Skua	*Catharacta maccormicki*	Rare spring/fall visitor well offshore; casual in summer

Table C-4, Page 5 of 7

Table C-4
Seabirds Associated with the CINMS (Continued)

Common Names of Bird Families and Species	Scientific Names	Presence in CINMS*
Gulls (onshore and offshore)	*Family: Laridae*	
Laughing Gull	*Larus atricilla*	Casual vagrant
Franklin's Gull	*Larus pipixcan*	Casual in winter/summer; very rare transient in spring/fall
Little Gull	*Larus minutus*	Casual vagrant
Common Black-headed Gull	*Larus ridibundus*	Casual vagrant in fall/winter
Bonaparte's Gull	*Larus philadelphia*	Winter visitor; rare in summer
Heermann's Gull	*Larus heermanni*	Common winter visitor; uncommon spring visitor
Mew Gull	*Larus canus*	Locally common winter visitor; casual in summer
Ring-billed Gull	*Larus delawarensis*	Common winter visitor; fairly common in summer
California Gull	*Larus californicus*	Common winter visitor; fairly common to locally common in summer
Herring Gull	*Larus argentatus*	Very uncommon to locally fairly common in winter; casual in summer
Thayer's Gull	*Larus thayeri*	Rare to locally winter visitor
Western Gull	*Larus occidentalis*	Common resident year round. Breeds along along North Coast and Channel Islands
Glaucous-winged Gull	*Larus glaucescens*	Uncommon to fairly common winter visitor; rare but somewhat regular in spring/summer
Glaucous Gull	*Larus hyperboreus*	Very rare winter visitor
Black-legged Kittiwake	*Rissa tridactyla*	Irregular winter visitor; offshore transient in spring
Sabine's Gull	*Xema sabini*	Uncommon spring/fall transient; casual in summer
Terns (onshore and offshore)	*Family: Laridae*	
Gull-billed Tern	*Sterna nilotica*	Casual visitor
Caspian Tern	*Sterna caspia*	Very rare to rare in winter; fairly common summer visitor
Royal Tern	*Sterna maxima*	Fairly common winter visitor; uncommon in spring; casual in summer; fairly common transient in fall
Elegant Tern	*Sterna elegans*	Casual in winter; rare in spring; common in summer/fall
Common Tern	*Sterna hirundo*	One winter record; rare summer visitor

Table C-4, Page 6 of 7

Table C-4
Seabirds Associated with the CINMS (Continued)

Common Names of Bird Families and Species	Scientific Names	Presence in CINMS*
Arctic Tern	*Sterna paradisaea*	Rare in spring; uncommon fall transient well offshore
Forster's Tern	*Sterna forsteri*	Common winter visitor; common transient and uncommon to fairly common summer visitor
California Least Tern	*Sterna antillarum brownii*	Fairly common but local resident in summer
Black Tern	*Chlidonias niger*	Rare and declining
<u>Skimmers (onshore and offshore)</u>	*Family: Laridae*	
Black Skimmer	*Rhynchops niger*	Very rare visitor, increasing
<u>Alcids (onshore and offshore)</u>	*Family: Alcidae*	
Common Murre	*Uria aalge*	Uncommon to common winter transient and offshore visitor; rare in spring/summer
Pigeon Guillemot	*Cepphus columba*	Casual in winter/spring/fall; common summer resident. Breeds on North Coast and Channel Islands
Marbled Murrelet	*Brachyramphus marmoratus*	Very rare visitor in winter/summer/fall; casual in spring
Xantus's Murrelet	*Synthliboramphus hypoleucus*	Very rare in winter/fall; common resident offshore in spring/summer. Breeds on Channel Islands
Craveri's Murrelet	*Synthliboramphus craveri*	Very rare summer/fall visitor offshore
Ancient Murrelet	*Synthlibormaphus antiquus*	Rare and irregular winter visitor; casual in spring/summer
Cassin's Auklet	*Ptychoramphus aleuticus*	Widespread in winter; locally common in summer. Breeds on Channel Islands
Parakeet Auklet	*Cyclorrhynchus psittacula*	Casual vagrant well offshore
Rhinoceros Auklet	*Cerorhinca monocerata*	Fairly common to common transient and visitor. Breeds at Point Arguello
Tufted Puffin	*Fratercula cirrhata*	Very rare visitor well offshore in winter, spring, and fall, breeding records from the islands.
Horned Puffin	*Fratercula corniculata*	Casual spring visitor well offshore

Table C-4, Page 7 of 7

Notes: *Common to Abundant*: 15 or more individuals per day in the proper habitat; *Uncommon to Fairly Common:* 1-15 individuals per day in the proper habitat; *Rare or Infrequent:* 1-15 individuals per season in the proper habitat; *Very Rare or Very Infrequent:* average of fewer than 1 record per season; *Casual:* 2-10 records total for Santa Barbara County; *Accidental:* 1 record for Santa Barbara County.

Source: The Birds of Santa Barbara County, California by Paul E. Lehman (1994, Vertebrate Museum, University of California, Santa Barbara)

Table C-5
Seabird Species Breeding in the CINMS

Common Name	Scientific Name
Western Grebe	***Aechmophorus occidentalis***
Clark’s Grebe	*Aechmophorus clarkii*
Ashy Storm-Petrel	*Oceanodroma homochroa*
Black Storm-Petrel	*O. melania*
Leach's Storm-Petrel	*O. leucorhoa*
California Brown Pelican	***Pelecanus occidentalis californicus***
Double-crested Cormorant	*Phalacrocorax auritus*
Brandt's Cormorant	*P. penicillatus*
Pelagic Cormorant	*P. pelagicus*
Great Blue Heron	*Ardea herodias*
Snowy Plover	*Charadrius alexandrinus*
Killdeer	*Charadrius vociferus*
Black Oystercatcher	*Haematopus bachmani*
Western Gull	*Larus occidentalis*
Pigeon Guillemot	*Cepphus columba*
Xantus's Murrelet	*Synthliboramphus hypoleuca*
Cassin's Auklet	*Ptychoramphus aleuticus*
Rhinoceros Auklet	*Cerorhinca monocerata*
Tufted Puffin	*Fratercula cirrhata*

Source: CDFG 2002.

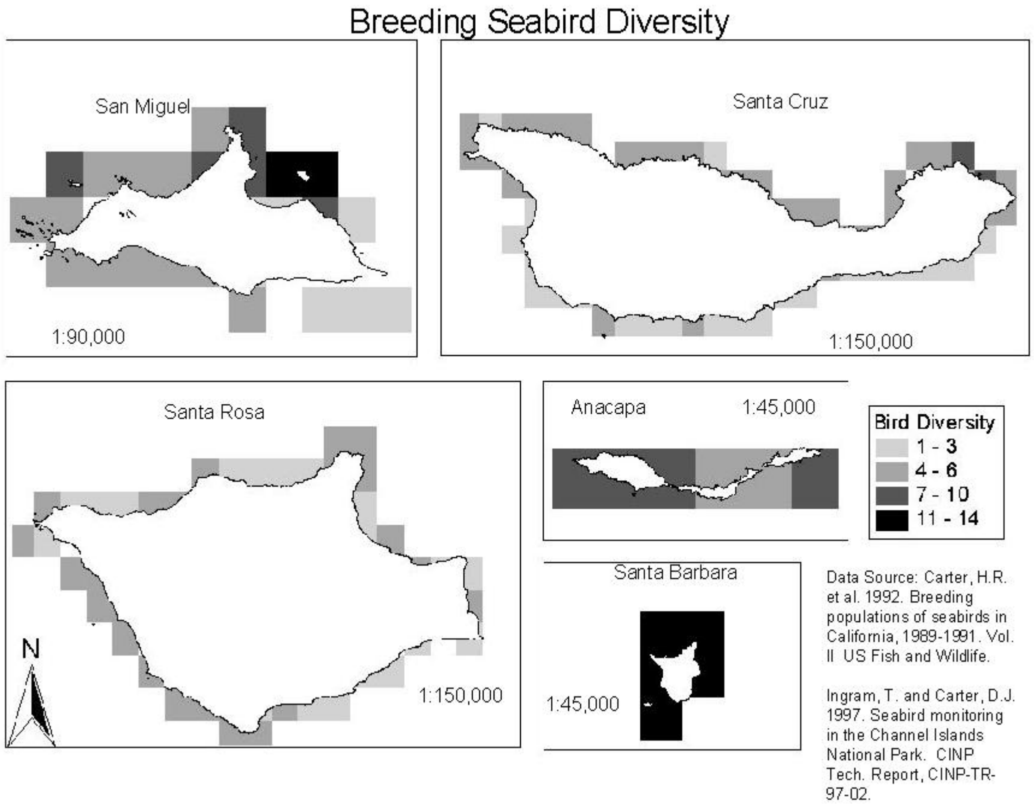

Figure C-4 Distribution of Breeding Seabird Diversity in the CINMS

Seabird occurrence in the open ocean (more than 1 kilometer offshore) is correlated to with currents and submarine topography. Water temperature affects seabird abundance as it affects upwelling. Near the Channel Islands region, upwelling occurs regularly in the waters off Point Conception, Arguello Canyon, and along the Santa Rosa-Cortez Ridge (Lehman 1994). In addition, certain seabirds frequent waters that have a specific range of temperatures. This is correlated to rare or one-time sightings of sub-tropical seabirds from the south when water temperatures become abnormally warm, and of cold-water seabirds from the north when waters become abnormally cool. Kittiwakes and fulmars have been observed in late winter and early spring when waters reach minimum temperature (Lehman 1994). Seabirds range over the open ocean, nearshore waters, bays, harbors, and rocky beaches.

Birds depend on healthy coastal and marine habitats in the CINMS. Seabirds feed and roost in many of the coastal areas of the northern Channel Islands. Sandy beaches provide foraging and resting habitat for a number of seabirds including black-bellied plover, willet, whimbrel, long-billed curlew, gulls, and sanderlings. Birds depend on the spatial transitional areas that exist between the subtidal, intertidal and upland areas for feeding and reproduction. The upland potions of the beach provide kelp deposits that attract invertebrates where black and ruddy turnstones, dowitchers, and other seabird species forage.

1.2.5.1 Special-Status Bird Species

Several bird species within the CINMS have special status under federal or State law (Table C-6). In addition, most seabirds are protected by the Migratory Bird Treaty Act. For several species listed as threatened or endangered, the northern Channel Islands represent designated critical habitat areas. Birds depend on a healthy coastal marine environment for survival, and feed near shore on small fishes associated with the CINMS. Additional descriptive information on many of these species is presented below.

Table C-6
Birds with Special Status Under Federal or California State Law Commonly Found in the CINMS

Common Name	Scientific Name	Status*
Ashy storm-petrel	*Oceanodroma homochroa*	California Species of Concern (CSC), Department of Fish and Game
Black storm-petrel	*Oceanodroma melania*	CSC
California brown pelican	*Pelecanus occidentalis californicus*	Federally Endangered, State Endangered, State Fully Protected Species
California least tern	*Sterna antillarum browni*	Federally Endangered, State Endangered, State Fully Protected Species
Double-crested cormorant	*Phalacrocorax auritus*	CSC
Rhinoceros auklet	*Cerorhinca monocerata*	CSD
Western snowy plover	*Charadrius alexandrinus nivosus*	Federally Threatened, CSC
Xantus' murrelet	*Synthliboramphus hypoleucus*	CSC

Source: CDFG 2002.

Leach's storm petrel is fairly common along the Pacific coast, uncommon south of breeding range along Atlantic coast, and has a highly restricted breeding range. It inhabits coastal islands and open sea. In the Channel Islands, Leach's storm-petrels bred on Santa Barbara and San Miguel Islands (Lehman 1994). It is nocturnal in its breeding activities and nests in colonies found on coastal islands, such as those within the region. During the day, they nest in horizontal burrows that can be up to 1 meter long or are at sea foraging for food. This species feeds by hovering just above the water and swooping down to catch plankton, small fish, and squid (Ehrlich *et al.* 1988). One egg is laid anytime from early June to late July, and the incubation lasts 40 to 50 days, during which time both parents tend the egg. Winters are spent at sea, possibly in the tropics. (Nova Scotia Museum of Natural History 2000)

Ashy storm-petrel (Oceanodroma homochroa)

Ashy storm-petrels are small, highly pelagic, seabirds that prey on small invertebrates (young squid, euphausiids, crab larvae) and small fish while they flutter along at the ocean's surface. Ashy storm-petrels are restricted to the north-east Pacific Ocean, breeding on islands from central to southern California (with a few small colonies in Baja California and northern California). Approximately one-half of the world population, estimated at less than 10,000 individuals, nest at the Farallon Islands and half in the Channel Islands, primarily at San Miguel, Santa Barbara, and Santa Cruz islands (Carter *et al.*

1992). The breeding period is from April through November, although birds may visit their nesting colonies year-round. Dispersal in the non-breeding season is thought to be limited. Large numbers congregate each fall in Monterey Bay. Populations of ashy storm-petrels have declined by an estimated 34 percent over the past 20 years at the Farallon Islands (Sydeman *et al.* 1998a,b) (long-term trends are not available for the Channel Islands population). Factors in the decline include habitat loss from invasive non-native plants; introduction of feral cats, house mice, and other nonnative animals; decline in zooplankton in the SCB; and predation by house mice, western gulls, burrowing owls, and other owl species (Sydeman *et al.* 1998; Nur *et al.* 1999). Ashy storm-petrels are also known to be sensitive to human disturbance, oil pollution, and marine pollution.

Black storm-petrel (Oceanodroma melania)

Black storm-petrels are found in the north-east Pacific Ocean. They primarily breed on islands of the coast of Baja California and in the Gulf of California (Harrison 1983). A small population, estimated at 274 individuals, breeds from April to October on Santa Barbara Island in Santa Barbara County (Carter *et al.* 1992). After breeding, birds generally move south towards northern South America, however, in warm-water years large numbers move as far north as Monterey and Point Reyes (Harrison 1983).

California brown pelican (Pelecanus occidentalis californicus)

The California brown pelican was listed as an endangered species under the ESA in 1970 and by the Commission in 1971 because of decreased population numbers and extensive reproductive failures. These resulted from the effects of DDT and other chlorinated hydrocarbons in the late 1960s. In addition, they are a fully protected species under Fish and Game Code Section 3511. California brown pelicans are found in estuarine, marine subtidal, and pelagic waters along the California coast. California brown pelicans breed in the SCB at West Anacapa Island, Ventura County, and Santa Barbara Island, Santa Barbara County, in the Channel Islands and several islands off Baja California, Mexico. During the non-breeding season birds disperse along the coast, as far north as Vancouver, British Columbia and south to El Salvador.

California brown pelicans are colonial nesters and require nesting grounds free from human disturbance and mammalian predators, and must be in proximity to adequate food supplies (Gress and Anderson 1983). Nest sites are located on steep, rocky slopes and bluff edges and are comprised of sticks or debris. Communal roost sites are essential habitat for California brown pelicans (Gress and Anderson 1983) because, unlike other seabirds, California brown pelicans have wettable plumage (Rijke 1970) which can become heavy and hypothermic in cold water if they do not come ashore regularly to dry and recondition their plumage. Roost site selection is based on minimal disturbances and microclimate features that aid in thermoregulation. California brown pelicans congregate in traditional high quality roosts at night with major night roosts supporting hundreds to thousands of pelicans (Briggs *et al.* 1987). Substantial numbers (averaging in the thousands) roost on South Farallon Island and feed in the surrounding waters during the fall and winter.

California brown pelicans are diving birds that feed almost exclusively on fish and dive from 6 to12 meters (6.6–13.2 feet) in the air (Johnsgard 1993). The main prey items in California are northern anchovies, Pacific sardines, and Pacific mackerel. After the collapse of the sardine fishery in the 1950s, northern anchovies were found to comprise 92 percent of the diet of California brown pelicans nesting in the SCB (Gress *et al.* 1980; Gress and Anderson 1983). In recent years however, Pacific sardine populations have been increasing and may now be common items in the California brown pelican diet.

Double-crested cormorant (Phalacrocorax auritus)

The double-crested cormorant is a California species of special concern. The double-crested cormorant is 26 to 32 inches in length. Adult plumage is black with iridescent green and purple above. The unfeathered throat pouch is yellow-orange, and the bill and feet are black. Juveniles are pale brown above with varying amounts of white below. The throat pouch and lower mandible are yellow and sometimes the upper mandible is yellow as well. The iris is brown in juveniles and blue-green in breeding adults. This species has a long tail and flies with a distinctive crook in its neck (Audubon 1988).

This migratory breeding seabird is a highly adaptive colonial breeder that utilizes a variety of habitats and is found both on the coast and inland. Breeding locations may change from year to year. This species breeds in the Aleutian Islands, Alaska and southwards along the Pacific coast, to Baja California, Mexico. This species breeds on Santa Barbara, Anacapa and San Miguel Islands (Lehman 1994). Double-crested cormorants feed on schooling fish, aquatic invertebrates, and, rarely, small invertebrates. This species uses wetland to open water habitats, and nests along seacoasts, on coastal cliffs and around rivers, marshes, and lakes. The birds build a platform nest of sticks, seaweed and other materials on the ground or in trees (Ehrlich *et al.* 1992).

Rhinoceros auklet (Cerorhina monocerata)

The rhinoceros auklet is a California species of special concern. This species is approximately 15 inches in length with plumage that is sooty brown above and a grayish-brown throat, breast, sides, and flanks. Two stripes of white plumes run backward across the face; one from the base of the bill below the eye, and one just above and behind the eye. The bill is reddish-orange with a pale knob at the base of the lower mandible. In winter, the facial stripes and knob on the bill are absent. Juveniles are darker in color, with a smaller, darker bill similar to the winter plumage adult (Audubon 1988).

The rhinoceros auklet is a pelagic migratory breeding seabird common along most of the West Coast in fall and winter. It breeds colonially in burrows in maritime and inland grassy slopes, occasionally on flat ground on forest floors, usually with other alcids, in areas from the western Sea of Okhotsk, Sakhalin, and the southern Kuril Islands south of Japan and northeast Korea. They also breed from the Aleutians east to southern Alaska, south through British Columbia and Washington to California. This species is often seen in large numbers close inshore and feeds on mostly small fish and some squid. Rhinoceros auklets breed on several of the Channel Islands (Lehman 1994).

California Least Tern (Sterna antillarum browni)

The California least tern is Federally and California State-listed as endangered. The California least tern is approximately 8 and a half to 9 and a half inches in length. In breeding plumage, adults have a broad white forehead framed by a black crown and a black line running from the crown through the eye to the base of the bill. The mantle and short, strongly forked tail are pearl gray. A long, thin wedge of black up the leading edge of the outer wing, formed by the two outermost primary feathers and coverlets, is conspicuous in flight. Both the narrow black-tipped bill and the feet are yellow. Winter adults retain the black head pattern, which is blurred by a mixture of black and white feathers. Juveniles have a largely white head with a black line through the eye and a black nape. The entire leading edge of the wing is dark. The bill is black and the legs are brown (Audubon 1988).

California least terns feed on fish, such as top smelt, and aquatic invertebrates. The California least tern is 1 of 12 recognized subspecies of the least tern, 3 of which inhabit the United States. The breeding range of this subspecies extends along the Pacific coast from San Francisco Bay, California, to Bahia de

San Quintin, Baja California, Mexico. The California least tern is a migratory species that arrives in California by late April to breed and departs to unknown southerly locations by August. It nests in colonies on coastal, sandy, open areas, usually around bays, estuaries, and creek and river mouths. Nests are unlined open scrapes or depressions in the sand on open, flat beaches that the birds often adorn with small fragments of shell or pebbles. During the average 2l-day incubation period, the nest is tended continually by both parents. The adults tend flightless, but quite mobile, chicks for approximately three weeks after hatching. After fledging, the young California least terns do not become fully proficient at capturing fish until after they migrate from the breeding grounds. Adults and fledglings usually leave the breeding colony within about ten days of fledging (Ehrlich *et al.* 1989).

Western Snowy Plover (Charadrius alexandrinus)

The Pacific coast population of the western snowy plover was Federally listed as threatened on March 5, 1993. A recovery plan is currently being prepared. The final rule listing the western snowy plover as threatened describes its biology and reasons for its decline (58 *Federal Register* 42: 12864). Critical habitat was designated for the western snowy plover and includes all suitable habitat from Point Sal to Point Conception including Vandenberg AFB, the Santa Ynez River mouth, and Jalama Beach; Santa Barbara coast beaches including Devereux Beach (Coal Oil Point), Santa Barbara Harbor Beach, and Carpinteria Beach; Oxnard lowlands beaches including San Buenaventura Beach, Mandalay Bay/Santa Clara River mouth, Ormond Beach, and Mugu Lagoon; and the Channel Islands including San Nicolas Island beaches (65 Federal Register 64:68508). In addition, the coastal population of the western snowy plover is a California Species of Special Concern, and on the Audubon Society's Watch List.

The western snowy plover has gray-brown upper parts, a conspicuous patch on either side of the breast, a white eyebrow extending back from the forehead, a long thin black bill, and slate-colored legs. Adults have dark ear coverlets and breast patches, are blackish in breeding plumage, and gray-brown in winter. Breeding birds have a black bar across the forecrown as well. Juveniles have paler ear coverlets and breast patches are the same colors as the upper parts (Audubon 1988).

Western snowy plovers are migratory breeding shorebirds that forage on invertebrates in intertidal zones, the wrack line, dry sandy areas above the high tide line, salt pans, and the edges of salt marshes. They feed by quickly running, stopping to pick up food or probe the surf line. Western snowy plovers eat marine worms, small crustaceans, and at inland locations, eat insects. The Pacific coast population nests near tidal waters along the mainland coast and offshore islands from southern Washington to southern Baja California, Mexico. Most nesting occurs on unvegetated to moderately vegetated, dune-backed beaches and sand spits. Other less common nesting habitats include salt pans, dredged soils, and salt pond levees. Nest site fidelity is common. Nesting and chick rearing activity generally occur between March 1 and September 30. During the non-breeding season, western snowy plovers may remain at breeding sites or may migrate to other locations, with most wintering south of Bodega Bay, California. Many birds from the interior population winter on the central and southern coast of California.

Xantus's murrelet (Synthliboramphus hypoleucus)

Xantus's murrelets are considered an California species of special concern and are a globally rare seabird species (one of the ten rarest seabird species in the North Pacific). Petitions have been made to list this species under both the Federal and State ESA, due to its small population size and limited breeding range, as well as declining world population size (estimated as less than 10,000 birds) and known threats to colonies. Xantus's murrelets are small birds that feed on larval fish including northern anchovies, sardines, rockfish, Pacific sauries, and crustaceans, and forage in the immediate vicinity of the colony during the nesting season (Hunt *et al.* 1979). The world population of Xantus's murrelet only breeds from the Channel Islands south to Central Baja Calfornia, Mexico. Eighty percent of the United States breeding population and 33.5 percent of the world's breeding population nest in the Channel Islands, primarily at Santa Barbara Island (also found at San Miguel, Santa Cruz, and Anacapa islands). They return to the nesting islands in February and disperse from the islands by mid-July. They nest in rock crevices along steep cliff edges, under bushes, on the ground in vegetation, in burrows, under debris piles, and under human made structures. Daylight hours are spent on nests or foraging at sea, whereas nest site selection, incubation shift changes, and fledging all occur under cover of night (Hunt *et al.* 1979). Chicks depart to the sea with their parents at night at 2 days of age and are dependent on their parents for an extended period of time (Gaston and Jones 1998). Chicks that get lost or separated from their parents at night, or those who leave the nest during the day, are often fed upon by predators (e.g., western gulls).

1.2.6 Sea Turtles

Four species of sea turtles have been reported in the offshore southern California region. Three of these are members of the family Cheloniidae while one is the only living member of the family Dermochelyidae. The cheloniids include the green sea turtle (*Chelonia mydas*), the loggerhead sea turtle (*Caretta caretta*), and the olive-Ridley sea turtle (*Lepidochelys olivacea*). The only dermochelyid is the leatherback sea turtle (*Dermochelys coriacea*) (National Marine Fisheries Service [NMFS] and United States Fish and Wildlife Service [USFWS] 1998a, b, c, d, e).

The leatherback sea turtle is the species most commonly seen off the coast of California and has been reported in the Pacific Ocean as far south as Chile and as far north as Alaska and the Bering Sea. In addition to offshore southern California, loggerhead sea turtles are also commonly found in the North Pacific Ocean, and travel between nesting beaches in Japan and north of Hawaii. The normal range of the remaining species does not extend north of Baja California, but individuals have been sighted or caught farther north (NMFS and USFWS 1998d).

None of the four sea turtles species are known to nest on the west coast of the United States. With all four species, sporadic sightings of turtles have been made within United States waters. Migratory routes of sea turtles have been increasingly studied in last 5-6 years and new information is emerging (NMFS 2004). However, much remains unknown about migration routes and normal movements of sea turtles while at sea, research (NMFS and USFWS 1998a, b, c, d, e).

All sea turtles are protected by the ESA. Leatherback sea turtles are listed as endangered. The other three species are listed as threatened; however the nesting populations of green and olive ridley sea turtles on the Pacific coast of Mexico are listed as endangered.

All four species have been heavily impacted by human and other factors. Terrestrial threats to all four species include: directed take of turtles and/or eggs; poaching; increased human presence; coastal construction; artificial lighting; beach mining; vehicles driving on beaches; beach cleaning; beach replenishment covering eggs too deeply; predation; and beach erosion. Marine threats include: directed take of juvenile or adult turtles; poaching; environmental contaminants; debris entanglement or ingestion; incidental take by fisheries; algae, sea grass and reef degradation; collisions with boats; marina and dock development; dynamite “fishing;” oil exploration and development; entrapment in power plants; underwater blasting; predation; and disease and parasites.

Recovery plans for four of the U.S. Pacific populations of sea turtles cover the west coast of the continental United States, the state of Hawaii, and all of the Pacific islands under U.S. jurisdiction, which extend as far west as Guam. There are two recovery plans for the green turtle, one for the eastern Pacific green turtle, and one for the central and western Pacific green turtle. Recovery plans include determining population status in U.S. waters and supporting censuses in other countries within the range of the four species of sea turtles.

With all four species, sporadic sightings of turtles within U.S. waters have been made. In addition, some information is available regarding incidental take by American net fisheries. Additional data are available from NMFS observers stationed aboard tuna purse seine boats in the eastern tropical Pacific. Stranding information is also available for the west coast and Alaska. More data are available from nesting beaches and limited catch records in other countries. A list of sea turtles present in CINMS is presented in Table C-7.

Table C-7
Testudines: Sea Turtles in the CINMS

Species	Population or Stock Size	Protected Status	Relative Abundance	Seasonality	Normal Habitat
Green sea turtle *(Chelonia mydas)*	Not available	Threatened and Endangered under ESA	Rare	Warm water months	Coastal to pelagic
Olive ridley sea turtle *(Lepodochelys olivacea)*	Not available	Threatened and Endangered under ESA	Rare	Warm water months	Coastal to pelagic
Loggerhead sea turtle (*Caretta caretta*)	Not available	Threatened under ESA	Rare	Warm water months	
Leatherback sea turtle (*Dermochelys coriacea*)	Not available	Endangered under ESA	Uncommon	Warm water months	Pelagic

Source: NMFS and USFWS 1998a, b, c, d, e.

Green sea turtle (Chelonia mydas)

The eastern Pacific green sea turtle is listed as threatened and endangered throughout its entire range under the ESA. The population has suffered a severe decline over the past 30 years. Between 1950 and 1970, the decline began when wintering green sea turtles in the Gulf of California were vastly over-harvested. The decline continued from 1960 through 1980 with egg harvests on the mainland coast of Mexico (NMFS and USFWS 1998a).

The normal range of the eastern Pacific green sea turtle is from Baja California to Peru and out to the Galapagos Islands. Green sea turtles have been reported as far north as British Columbia, and in 1993, a green sea turtle stranded at Homer Alaska. In 1996, another was recovered from Prince William Sound, Alaska (NMFS and USFWS 1998a).

Green turtles appear to prefer waters with temperatures above 18 - 20 Celsius. Green turtles in these areas are likely foraging in shallow waters or at shallow depths, or transiting to foraging grounds. During warm spells (e.g., El Niño), green turtles may be found considerably north of their normal distribution (NMFS 2004).

One resident population of green sea turtles exists in San Diego Bay (Dutton and McDonald 1990a, b and 1992; McDonald *et al.* 1994; Stinson 1982). About 30 juvenile and adult animals have congregated near the warm water discharge from the San Diego Gas and Electric Company Power Plant. This population is an anomaly.

Green sea turtles are mostly herbivores, but they also eat sardines and anchovies, jellyfish, mollusks, and even worms, among other things (NMFS and USFWS 1998a).

Olive ridley sea turtle (Lepodochelys olivacea)

The olive ridley has been regarded as the most abundant sea turtle in the world. Before it was exploited, Clifton *et al.* (1982) estimated that the population off the Pacific coast of Mexico numbered over 10,000,000 animals. Yet in just 1968, over 1,000,000 olive ridleys were caught in Mexico (Carr 1972). The population in Mexico is now listed as endangered because of gross over-harvesting. The rest of the eastern Pacific population is considered threatened. The usual range of the eastern Pacific olive ridley is from Baja California to Peru, usually within 1200 nautical miles of shore (NMFS and USFWS 1998a).

Satellite monitoring of post nesting movements showed migration routes traversing thousands of kilometers over deep (>1000 m) oceanic water, distributed over a very broad range, suggesting that olive ridleys are nomadic and exploit multiple feeding areas, rather than migrate to one specific foraging area (NMFS and USFWS, 1998d).

In 1983, an olive ridley was captured in Los Angles Harbor and brought to Sea World of San Diego. In 1996, an olive ridley stranded at Goleta beach State Park, near Santa Barbara and within the study area. It was cared for some months by the Santa Barbara Marine Mammal Center, then shipped to a turtle research facility in Hawaii (NMFS 2003).

Olive ridleys reportedly prey on benthic fish, mollusks, crustaceans, tunicates and algae. Pelagic prey includes jellyfish, salps and pelagic red crabs *(Pleuroncodes planipes)*, which in some parts of their range may be a dietary mainstay (NMFS and USFWS 1998b).

Loggerhead sea turtle (**Caretta caretta*****)***

The loggerhead sea turtle is listed as threatened throughout its range. In the eastern Pacific, it is rare, although it has been reported as far north as Alaska and as far south as Chile. Most sightings in the eastern Pacific have been made near Baja California, and the greatest concentrations have been off Bahia Magdalena. Strandings and sightings along the west coast have mainly been in Southern California, although a few sightings were reported off Washington (NMFS and USFWS 1998c).

Based on oceanographic conditions, the loggerheads are associated with fronts, eddies, and geostrophic currents. Loggerheads also appear to utilize surface convergent forage habitat to capture their primary prey organisms which float along currents and congregate at fronts (NMFS 2004).

Loggerheads appear to prey on benthic invertebrates, but fish and plants are also eaten. Juveniles off Baja California apparently feast on pelagic red crabs (NMFS and USFWS 1998c).

Leatherback sea turtle (**Dermochelys coriacea*****)***

The leatherback sea turtle is considered endangered throughout its range. In the eastern Pacific, the range extends mainly along the slope from Chile to Alaska. The leatherback is the most commonly seen sea turtle off the California coast. For example, from 1986 to 1991, 96 sightings were reported off Monterey Bay alone. Also, leatherback sea turtle strandings account for 50 of 104 sea turtle strandings on the west coast between 1982 and 1991.

Leatherback sea turtles once nested in tremendous numbers on the west coast of Mexico. Nearly half of the world's population of female leatherbacks nested there. Tragically, this population has noticeably declined in recent years. Eggs as well as adult females have been harvested in large numbers.

Leatherback sea turtles are highly migratory, exploiting convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Morreale, *et al*., 1994; Eckert, 1998; Eckert, 1999a). Recent information on leatherback sea turtles tagged off the west coast of the United States has revealed an important migratory corridor from central California, to south of the Hawaiian islands, leading to western Pacific nesting beaches (P. Dutton, NOAA Fisheries, personal communication, December 2003).

Leatherbacks consume mostly cnidarians (medusas and siphonophores) and tunicates (salps and pyrosomas); in lay terms, jellies (NMFS and USFWS 1998d).

1.2.7 Marine Mammals

The Channel Islands and surrounding waters support a great diversity of marine mammals. The marine mammals discussed in this section represent three orders: Cetacea--whales dolphins and porpoises; Pinnipedia--seals, sea lions and fur seals; and Carnivora, which in this case is represented only by the southern sea otter (*Enhydra lutris nereis*), a member of the family Mustelidae. Cetaceans live their entire lives at sea, while pinnipeds come ashore periodically to rest, breed, bear young, or molt. In California, sea otters normally spend their entire lives at sea, though some do haul out on land, whereas in Alaska, they often haul out (Vandevere 1972; Miller 1974).

All pinnipeds and cetaceans are protected under the Marine Mammal Protection Act of 1972 (MMPA) and its amendments. In addition, some species are listed under the MMPA as depleted or strategic stocks. Finally, some species are listed as threatened and endangered under the Federal and State ESA.

As in the case of birds, the abundance and distribution of marine mammals is an important indication of the general health and ecological integrity of the marine ecosystems of the CINMS. Marine mammals feed on fishes and invertebrates, which feed on other marine life of the northern Channel Islands. In general, the distribution and abundance of mammals, fishes and other marine life depend on healthy marine habitats, such as kelp forests and associated rocky reef ecosystems. For example, sea lions depend directly on fish and invertebrate prey, which then in turn depend on linkages with lower trophic levels.

Mammals, in turn, are important to healthy marine ecosystems because, for example, they distribute important nutrients and foods throughout the marine environment that other marine life depend on for survival. Pinnipeds depend on haulout and rookery sites throughout the Channel Islands (Figure C-5). This section describes the species of marine mammals known to occur in the Channel Islands, including population status, protected status, regional distribution, and seasonality of each species.

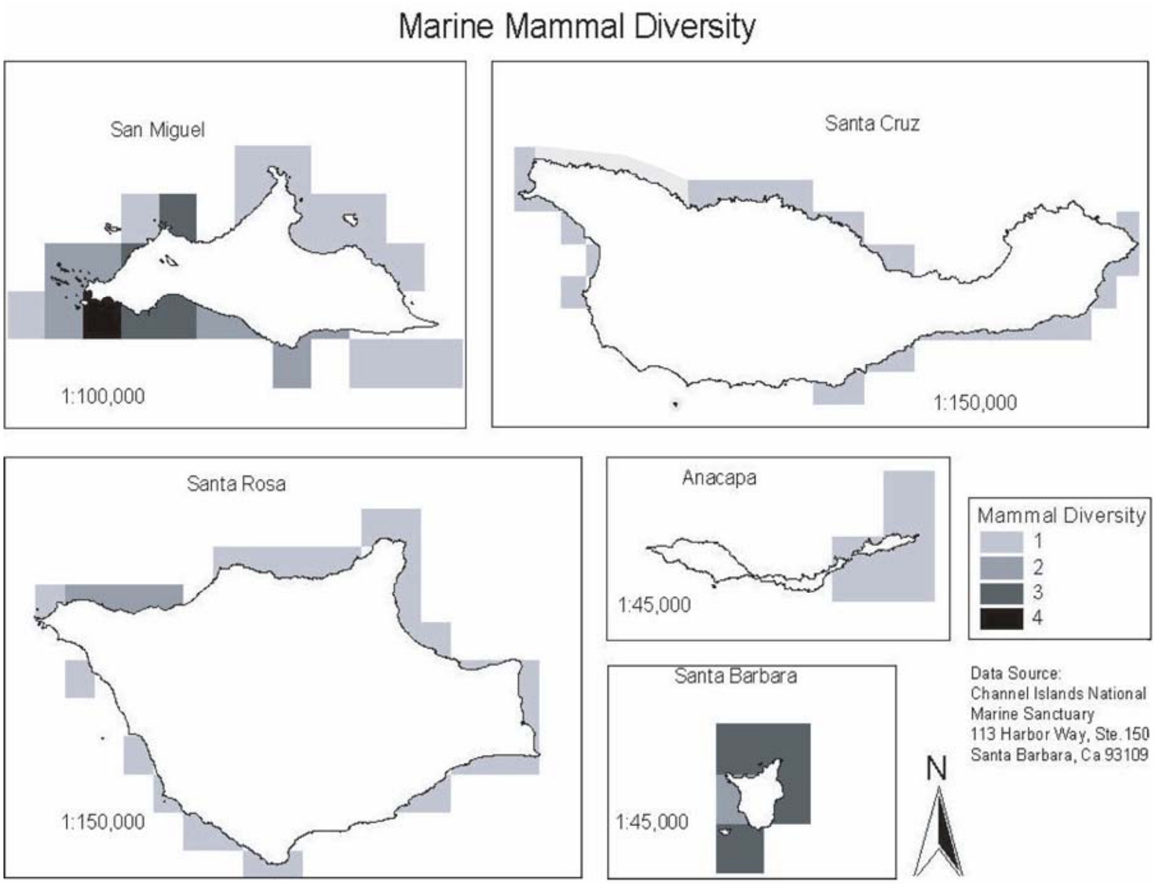

Figure C-5 Distribution of the Number of Marine-Mammal Species Found in Haul-Out and Rookery Sites in the CINMS

1.2.7.1 Cetaceans

At least 33 species of cetaceans have been reported in the region (Leatherwood *et al.* 1982; Leatherwood *et al.* 1987). Most of the reports involve live sightings although a few are known only from strandings. The toothed whales, or odontocetes, number 25 species. Only eight species of baleen whales, or mysticetes, have been reported. Two of these are in their own families. The northern right whale (*Eubalaena glacialis*) is the only representative of the family Balaenidae that has been reported in the CINMS. The California gray whale (*Eschrichtius robustus*) is the sole surviving representative of the family Eschrichtiidae. The other six species are all members of the family Balaenopteridae, more often simply called rorquals.

Of the odontocetes, seven species are commonly seen, either seasonally or year-round. Common species include the long-beaked common dolphin (*Delphinus capensis*), the short-beaked common dolphin (*Delphinus delphis*), the onshore and offshore stocks of bottlenose dolphins (*Tursiops truncatus*), Risso's dolphin (*Grampus griseus*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), northern right whale dolphin (*Lissodelphis borealis*), and Dall's porpoise (*Phocoenoides dalli*). The latter two species are generally associated with colder water masses farther offshore and north and do not often range south of the California-Mexico border (Leatherwood *et al.* 1982).

Odontocetes: Oceanic dolphins

A list of oceanic dolphins present in CINMS is provided in Table C-8.

Table C-8
Cetaceans: Odontocetes—Oceanic Dolphins in the CINMS

Common Species Name (Scientific Name)	Population or Stock Size	Protected Status	Relative Abundance	Seasonality	Normal Habitat
Long-beaked common dolphin *(Delphinus capensis)*	Stock size: 32,238	Protected under MMPA	Common	Year-round	Coastal - up to 50 nautical miles offshore
Short-beaked common dolphin (*Delphinus delphis)*	Stock size: 373,573	Protected under MMPA	Common	Year-round	Up to 300 nautical miles offshore
Bottlenose dolphin *(Tursiops truncatus)* Offshore stock	Stock size: 2,956	Protected under MMPA	Common	Year-round	Shelf, slope and offshore
Bottlenose dolphin *(Tursiops truncatus)* Coastal stock	Stock size: 206	Protected under MMPA	Common	Year-round	Surf zone up to 1km offshore
Pacific white-sided dolphin (*Lageno-rhynchus obliquidens*)	Stock size: 25,825	Protected under MMPA	Sporadically abundant	Usually summer and fall	Shelf to farther offshore
Rough-toothed dolphin *(Steno bredanensis)*	Not available for area	Protected under MMPA	Known only from a few strandings	Warm water months	Pelagic
Striped dolphin (*Stenella coeruleoalba)*	Stock size: 20,235	Protected under MMPA		Warm water months	Pelagic
Long-snouted spinner dolphin *(Stenella longirostris*)	Not available for area	Protected under MMPA	Possible during El Niño events	Warm water months	Pelagic
Spotted dolphin *(Stenella attenuata)*	Not available for area	Protected under MMPA	Known only from strandings	Warm water months	Pelagic
Northern right whale dolphin (*Lissodelphis borealis)*	Stock size: 13, 705	Protected under MMPA	Sporadically abundant	Winter and spring	Continental shelf and slope

Table C-8, Page 1 of 2

Table C-8
Cetaceans: Odontocetes - Oceanic Dolphins in the CINMS (Continued)

Common Species Name (Scientific Name)	Population or Stock Size	Protected Status	Relative Abundance	Seasonality	Normal Habitat
Risso's dolphin *(Grampus griseus)*	Stock size: 16,483	Protected under MMPA	Common	Year-round	Shelf, slope and
Short-finned pilot whale *(Globicephala macro-rhynchus)*	Stock size: 970	Protected under MMPA	Uncommon	Most often summer and fall	Shelf, slope and offshore
Killer whale *(Orcinus orca)* E.N. Pacific offshore stock	Stock size: 285	Protected under MMPA	Uncommon	Year-round	Shelf, slope and offshore
Killer whale *(Orcinus orca)* E.N. Pacific transient stock	Stock size: 346	Protected under MMPA	Uncommon	Year-round	
False killer whale *(Pseudorca cressidens)*	Not available for region	Protected under MMPA	Rare	Warm water months	Shelf to offshore and pelagic

Table C-8, Page 2 of 2
Note: MMPA – Marine Mammal Protection Act of 1972 and its amendments
Source: Carretta *et al.* 2001 and 2002

Long-beaked Common Dolphin (Delphinus capensis)

Two species of common dolphins, the long-beaked and the short-beaked, are found in the eastern north Pacific (Heyning and Perrin 1994). Prior to this time, only one species was recognized, the common dolphin (*Delphinus delphis*). Some authorities recognized the long-beaked common dolphin as the "Baja neritic" form of common dolphin rather than as a separate species. This recent change in taxonomy has presented difficulties in assessing long-term population or stock changes from surveys and censuses made before the change. Some authorities simply group the two species together as *Delphinus* spp., when discussing earlier work (Carretta *et al.* 2002).

Recent estimates place the population of long-beaked common dolphins in the region at 32,239 for animals in California, Oregon, and Washington (1991–1996 average) (Carretta *et al.* 2002). This species ranges from the coast out to 50 NM offshore. It usually frequents water less than 28 degrees C. Its geographic range in the region extends from Point Sal, north of Point Conception, to the tropics. It feeds primarily on Pacific hake (*Merluccius productus*) and northern anchovy (*Engraulis mordax*). Both species reportedly feed extensively at night, following the deep scattering layer (Leatherwood *et al.* 1987) although both species have also been observed feeding during the day.

Short-beaked Common Dolphin (Delphinus delphis)

The short-beaked common dolphin population has been estimated at 373,573 for animals in California, Oregon, and Washington (1991–1996 average) (Carretta *et al.* 2002). This species is more widespread in distribution than the long-beaked common dolphin, ranging up to 300 NM offshore. It feeds on Pacific hake, northern anchovy and market squid (*Loligo opalescens*) (Leatherwood *et al.* 1987).

Bottlenose Dolphin (Tursiops truncatus)

Two stocks of bottlenose dolphins have been distinguished: the California coastal stock and the California-Oregon-Washington offshore stock. The coastal stock ranges from literally in the surf out to approximately 1 kilometer offshore (Carretta *et al.* 2002). During the 1982 to 1983 El Niño event, coastal bottlenose dolphins ventured into central California. They have been reported as far north as San Francisco. Their usual northern limit was once Los Angeles County. Since that time, bottlenose dolphins have remained in the coastal waters of Santa Barbara and San Luis Obispo counties. The southern limit of their range extends at least to Ensenada, Baja California Norte. Despite the extent of their range, the coastal stock is very small, with a mean estimate of only 206 animals (Carretta *et al.* 2002). Coastal bottlenose dolphins feed on fish near the bottom (Leatherwood *et al.* 1987).

In the general region, the offshore stock of bottlenose dolphins frequents the waters off Santa Catalina, San Clemente, and Santa Barbara islands (Carretta *et al.* 2002) as well as the Santa Cruz Basin, which is south of Santa Cruz Island. The offshore stock occasionally ventures into the Santa Barbara Channel, usually in summer. The overall range extends from Mexico to northern California although bottlenose dolphins have been reported off the coasts of Oregon and Washington during influxes of warm water masses to the north.

The overall California-Oregon-Washington stock size is estimated at 956 animals (Carretta *et al.* 2002). The offshore stock feeds on squid as well as fish (Leatherwood *et al.* 1987).

Pacific White-sided Dolphin (Lagenorhynchus obliquidens)

Two forms of Pacific white-sided dolphins have been identified from genetic analyses: a northern form, which usually ranges from Point Conception to Washington and well offshore; and a southern form, which generally ranges from Point Conception to Mexico. Both forms have been found in the SCB, but whether this represents the two forms occupying this area at different times of the year or the two forms intermixing is unknown. Unfortunately, the two forms cannot be distinguished in the field (Carretta *et al.* 2002). At present, both stocks are managed as one.

The population of Pacific white-sided dolphins from Mexico to Washington has been estimated at 25,825 animals in California, Oregon, and Washington (Carretta *et al.* 2002). These dolphins generally frequent waters along the Continental Borderland and slope as well as farther offshore. In the Channel Islands, they are often seen with humpback whales (*Megaptera novaeangliae*), which usually appear in summer and fall. Pacific white-sided dolphins feed primarily on fish (Leatherwood *et al.* 1987).

Striped Dolphin (Stenella coeruleoalba)

The striped dolphin is a pelagic species; that is, it roams far offshore beyond the continental slope some 100 nm seaward of land. The California population may be part of a greater population that extends well into the north Pacific and into Mexico and Central America. The estimated abundance of animals for California, Oregon, and Washington is 20,235 (Carretta *et al.* 2002). The only reports of striped dolphins in Washington and Oregon have been of stranded specimens. The striped dolphin is widely distributed worldwide in tropical to warm temperate waters, often mingling with groups of spotted and spinner dolphins. The best-studied population exists in the eastern tropical Pacific, where incidental takes of these dolphins by the tuna purse seine fleet have been very high (Leatherwood *et al.* 1982; Leatherwood *et al.* 1987).

Northern Right Whale Dolphin (Lissodelphis borealis)

The northern right whale dolphin is the only oceanic dolphin in the region that lacks a dorsal fin. It frequents waters along the Continental Borderland and slope. It prefers cool temperate waters, generally appearing in the region during La Niña events or in areas characterized by vigorous upwelling of colder waters, such as San Nicolas and San Miguel islands. It is most common in winter and spring when the water is colder. In summer and fall, it can range as far north as Oregon and Washington. Its southern range limit is probably northern Baja California. The California population has been estimated at 13,705 animals for California, Oregon and Washington (Carretta *et al.* 2002). Northern right whale dolphins feed on lanternfish, other mesopelagic fish, and squid (Leatherwood *et al.* 1987).

Risso's Dolphin (Grampus griseus)

Risso's dolphins are found throughout the region year-round in varying numbers. They are generally most abundant in the Santa Barbara Channel, particularly off the north shores of the four northern Channel Islands. They are often seen off the coast north of Point Conception. They are often found along the Continental Borderland, slope, and offshore. They range from at least northern Baja California to Washington. The stock size is approximately 16,483 animals in California, Oregon, and Washington (Carretta *et al.* 2002). A distinctly separate stock appears to exist in the Gulf of California and southern tip of Baja California.

Prior to the El Niño event of 1982 to 1983, Risso's dolphins were relatively uncommon in the region. Following this event, however, they were consistently seen in sizable numbers. At least one researcher has suggested that these animals may have occupied a niche vacated by short-finned pilot whales during the 1982 to 1983 El Niño event or that Risso's dolphins appeared during the El Niño event and competed so successfully that most of the pilot whales left the region (Shane 1994).

Short-finned Pilot Whale (Globicephala macrorhynchus)

As discussed above, short-finned pilot whales disappeared during the 1982 to 1983 El Niño event. Over the past few years, however, progressively more individuals have been seen in the SCB, but they have not returned in their former numbers. At present, the California, Oregon, and Washington population is estimated at 970 individuals (Carretta *et al.* 2002).

Prior to the 1982 to 1983 El Niño event, short-finned pilot whales were reportedly resident off Santa Catalina Island (Shane 1994; Dohl *et al.* 1980). They were also frequently seen in the Santa Barbara Channel, the Santa Cruz Basin, and off Santa Barbara Island. Short-finned pilot whales feed almost exclusively on squid (Leatherwood *et al.* 1987), which may lend some credence to the theory that they were displaced by Risso's dolphins, which also prey heavily on squid (Shane 1994).

Killer Whale (Orcinus orca)

Killer whales found off the California coast are currently referred to as the eastern North Pacific transient stock, the eastern North Pacific offshore stock or the eastern North Pacific resident stock (Carretta *et al.* 2002). The transient and offshore stocks travel as far north as Alaska and as far south as California. At present, the best estimate of the eastern North Pacific transient stock is 336 animals (Carretta *et al.* 2001). The eastern North Pacific offshore stock evidently does not mix with transient and resident stocks that overlap its range. The best estimate of this stock size is 285 animals (Carretta *et al.* 2002).

A stock of resident killer whales exists in the waters of Puget Sound. Until recently, researchers believed these animals stayed in the inland waters of the sound. Some individuals from the inland stock were identified in the company of transient killer whales off the coast, however, clouding the issue of distinctive stocks. These animals have been seen as far south as Monterey Bay (Carretta *et al.* 2001).

Killer whales feed on fish and other marine mammals (Leatherwood *et al.* 1982). Around the Channel Islands, killer whales have been observed feeding on gray whales (*Eschrichtius robustus*), Pacific harbor seals (*Phoca vitulina richardsi*), and California sea lions (*Zalophus californianus c.*). They have also been observed feeding on fish.

False killer whale (Pseudorca crassidens)

False killer whales inhabit tropical to subtropical waters. Their usual northern range limit along the mainland coast is Baja California, although a few individuals have been reported in the SCB. A few stranded specimens have also been reported (Leatherwood *et al.* 1982; Leatherwood *et al.* 1987). False killer whales are rare off California, so no stock estimates have been projected.

Odontocetes: True Porpoises

A list of true porpoises in the CINMS is provided in Table C-9.

Table C-9
Cetaceans: Odontocetes—True Porpoises in the CINMS

Species	Population or Stock Size	Protected Status	Relative Abundance	Seasonality	Normal Habitat	Water Mass Preference
Dall's Porpoise *(Phocoenoides dalli)*	Stock size: 117,545	Protected under MMPA	Uncommon	Winter and spring	Shelf to well off-shore	Subtemperate waters
Harbor Porpoise *(Phocoena phocoena)* Morro Bay stock	Stock size: 932	Protected under MMPA	Uncommon	Year-round	Point Lobos to Point Conception: Shallow coastal waters	Subtemperate waters

Source: Carretta *et al.* 2002.

Dall's Porpoise (Phocoenoides dalli)

Dall's porpoises frequent waters from the Continental Borderland to well offshore. They prefer cooler temperate waters and are seldom seen if the sea surface temperature is above about 19 degrees C (Leatherwood *et al.* 1982). They are most often seen in the SCB in winter and spring when the water is coldest. During La Niña years, they may roam as far south as northern Baja California (Carretta *et al.* 2002).

The California stock has been estimated at 117,545 animals for California, Oregon and Washington (1991-1996 average) (Carretta *et al.* 2002). Dall's porpoises are among the fastest of small cetaceans, reportedly reaching speeds of up to 22 knots. They feed on fish and cephalopods, mainly at night (Leatherwood *et al.* 1982).

Harbor Porpoise (Phocoena phocoena)

Several stocks of harbor porpoises are recognized, more for management purposes than because of distinct geographic boundaries. A good part of the population frequents waters from about 91 meters into very shallow water. The Morro Bay stock, which ranges from Point Lobos, in Monterey County, to Point Conception, is estimated at 932 individuals (Carretta *et al.* 2002). Harbor porpoises are rarely seen south of Point Conception. Harbor porpoises feed on benthic and schooling fish and invertebrates (Leatherwood *et al.* 1982).

Odontocetes: Sperm Whales

A list of sperm whales in the CINMS is provided in Table C-10.

Table C-10
Cetaceans: Odontocetes—Sperm Whales in the CINMS

Species	**Population or Stock Size**	**Protected Status**	**Relative Abundance**	**Seasonality**	**Normal Habitat**
Sperm Whale *(Physeter macrocephalus)*	Stock size: 1,640	Protected, depleted, strategic under MMPA. Endangered under ESA	Rare	April to mid June and August to mid November	Deep sea
Pygmy sperm whale *(Kogia breviceps)*	Stock size: 4,746	Protected under MMPA	Uncommon	Unknown	Deep sea, pelagic
Dwarf sperm whale *(Kogia simus)*	Unknown	Protected under MMPA	Known from three strandings	Unknown	Deep sea, pelagic

Source: Carretta *et al.* 2002.

Sperm Whale (Physeter macrocephalus)

Sperm whales are classified as endangered under the ESA, as a strategic stock under the MMPA, and depleted under the MMPA. For management purposes, the California-Oregon-Washington population is considered one stock, even though sperm whales are distributed as far north as Alaska and the Bering Sea. The California-Oregon-Washington stock is estimated at 1,640 animals (Carretta *et al.* 2002).

Sperm whales inhabit deep ocean waters well offshore and have rarely been reported in the Santa Barbara Channel. At least two strandings of sperm whales have been reported for the northern Channel Islands. One specimen, which washed ashore at San Miguel Island, was entangled in a nylon fishing net. Sperm whales appear to be most abundant from April to mid-June and from late August to mid-November, although they have been reported year-round. At least some individuals are residents in California waters. Another resident population exists in the Gulf of California (Carretta *et al.* 2002). Sperm whales can dive to depths of at least 3,000 meters, staying down over an hour, so they may be under-reported. They feed almost exclusively on squid (Leatherwood *et al.* 1982).

Pygmy sperm whale (Kogia breviceps)

Little is known about this whale because it inhabits deep pelagic waters, with little vessel traffic. Also, the pygmy sperm whale is quite small, reaching only up to 3.4 meters in length and is not conspicuous while on the surface. Finally, it can stay down for considerable periods.

Originally, the California population of pygmy sperm whales was estimated at 2,993. It is very difficult to distinguish between pygmy and dwarf sperm whales (please see below) at any distance, however, so sightings of such animals were simply recorded as *Kogia* sp. The number of dwarf sperm whales was derived from the total sightings of *Kogia* sp. at 1,813. However, no dwarf sperm whales have been reported since the early 1970s in California, so researchers now assume that the 1,813 animals listed as dwarf sperm whales were very likely pygmy sperm whales, bringing the total to 4,746 animals (Carretta *et al.* 2002).

At least two pygmy sperm whales have stranded within the study area. Strandings have also been reported along other parts of the California coast as well as in Oregon and Washington.

Pygmy sperm whales feed on squid, crabs and benthic fish beyond the Continental Borderland (Leatherwood *et al.* 1982)

Dwarf sperm whale (Kogia simus)

The dwarf sperm whale was recognized as a different species from the pygmy sperm whale in 1966 (Handley 1966), thus observations made before then do not differentiate between the two species. In any case, no recent observations of this species have been recorded. Only three strandings have occurred in California, all many years ago.

The dwarf sperm whale occupies the same deepwater realm as the pygmy sperm whale and feeds on the same type of organisms (Leatherwood *et al.* 2002). Because of its small size, long submergence periods and cryptic behavior while on the surface, very little is known of this species even in areas where it regularly occurs.

Odontocetes: Mesoplodont Beaked Whales

A list of mesoplodont beaked whales in the CINMS is provided in Table C-11.

Five species of beaked whales of the Genus *Mesoplodon* have been reported in the region. All are deepwater species that are cryptic in their behavior. Moreover, they remain submerged for long periods. Finally, they are virtually impossible to distinguish in the field. Most positive identifications have come from specimens killed in domestic drift nets and from stranded specimens. Considering these difficulties, all five species are treated as one unit for management purposes. Although the management stock is said to include California, Oregon and Washington, the only sightings available are from California waters (Carretta *et al.* 2002). The best estimate of nonspecific mesoplodonts is 3,738 (Carretta *et al.* 2002).

Table C-11
Cetaceans: Odontocetes—Mesoplodont Beaked Whales in the CINMS

Species	Population or Stock Size	Protected Status	Relative Abundance	Seasonality	Normal Habitat
Blainville's beaked whale (*Mesoplodon densirostris*)	Stock size: 360	Protected under MMPA	Uncommon	Unknown	Deep water
Hubb's beaked whale *(Mesoplodon carlhubbsi)*	Collective stock size: 3,738	Protected under MMPA	Uncommon	Unknown	Deep water
Ginkgo-toothed whale (*Mesoplodon ginkgodens*)	Collective stock size: 3,738	Protected under MMPA	Uncommon	Unknown	Deep water
Perrin's beaked whale (*Mesoplodon perrini*)	Collective stock size: 3,738	Protected under MMPA	Uncommon	Unknown	Deep water
Stejneger's beaked whale (*Mesoplodon stejnegeri*)	Collective stock size: 3,738	Protected under MMPA	Uncommon	Unknown	Deep water

Source: Carretta *et al.* 2002.

Blainville's beaked whale (Mesoplodon densirostris)

An estimate of the California-Oregon-Washington stock of Blainville's beaked whale has been made for 360 animals (Carretta *et al.* 2003). One Blainville's beaked whale stranded in Ventura, within the study area (NOAA Fisheries 2003). Another stranded in San Mateo County, California (Leatherwood *et al.* 1982).

Hubb's beaked whale (Mesoplodon carlhubbsi)

One Hubbs' beaked whale stranded in Santa Barbara, within the study area (NOAA Fisheries 2003). Hubbs' beaked whales have stranded from San Diego, California to British Columbia, however, so it is likely that they may be found within the study area. Five Hubbs' beaked whales were observed killed in drift nets during the period 1991-1995 (Carretta *et al.* 2003).

Ginkgo-toothed whale (Mesoplodon ginkgodens)

The ginkgo-toothed beaked whale is known from two strandings: one in Baja California, the other at Del Mar, California (Leatherwood *et al.* 1982). Its presence in the study area is extremely unlikely.

Perrin's beaked whale (Mesoplodon perrini)

Perrin's beaked whale is known from several strandings in Southern California. It has also been reported twice off the Southern California Bight: once near Santa Catalina Island, the other time off San Clemente

Island (Leatherwood *et al.* 1982). No other sightings or strandings have been reported, so the presence of this mesoplodont in the Study Area is extremely unlikely.

Originally, the strandings and sightings were attributed to Hector's beaked whale (*Mesoplodon hectori).* Recent studies of the DNA of the stranded specimens revealed marked differences from Hector's beaked whale, however, leading marine mammalogists John Heyning and James Mead to conclude that the strandings represent a new species of beaked whale that they named Perrin's beaked whale (*Mesoplodon perrini*) (Heyning and Mead 2002).

Stejneger's beaked whale (Mesoplodon stejnegeri)

No Stejneger's beaked whales have stranded south of Monterey, so their appearance in the study area is extremely unlikely. One Stejneger's beaked whale was killed in a drift net off California in 1994 (Carretta *et al.* 2002).

Odontocetes: Other Beaked Whales

A list of other beaked whales in the CINMS is provided in Table C-12.

Table C-12
Cetaceans: Odontocetes—Other Beaked Whales in the CINMS

Species	Population or Stock Size	Protected Status	Relative Abundance	Seasonality	Normal Habitat
Baird's beaked whale (*Berardius bairdii*)	Stock size: 370	Protected under MMPA	Uncommon	Unknown	Slope
Cuvier's beaked whale (*Ziphius cairostris*)	Stock size: 5,870	Protected under MMPA	Uncommon	Unknown	Deep water

Source: Carretta *et al.* 2002

Baird's beaked whale (Berardius bairdii)

Baird's beaked whales are found along the slope and deep waters of the eastern North Pacific. They have been seen most frequently from late spring to early fall, leading researchers to theorize that they may venture farther offshore or to other regions for the winter. These whales are deep divers, staying down for considerable periods, thus it is not surprising that they are sighted only infrequently. Unlike the mesoplodonts, however, Baird's beaked whales are sizable creatures, attaining some 12 meters in length. Perhaps because of this, sightings of Baird's beaked whales, though uncommon, are still more numerous than mesoplodont sightings. The population of the California-Oregon-Washington stock is estimated at 370 animals (Carretta *et al*. 2002).

Baird's beaked whales enjoy a cosmopolitan diet of deep-sea fish and cephalopods, as well as rockfish, mackerel, sardines, crustaceans, and sea cucumbers (Leatherwood *et al.* 2002).

Cuvier's beaked whale (Ziphius cavirostris)

Like the mesoplodonts, Cuvier's beaked whales inhabit offshore waters along the slope and deep ocean. They are deep divers, staying down for extended periods. Cuvier's beaked whales can grow larger than the mesoplodonts found in the region, but other than that, they are difficult to positively identify unless the observer is reasonably close, in good sea conditions. The best estimate of the California-Oregon-Washington population is 9,163, but this is based on sightings in California only and is likely conservative (Carretta *et al.* 2002).

Cuvier's beaked whale preys primarily on deep-sea fish and squid (Leatherwood *et al.* 2002).

Mysticetes: Right Whales

A list of right whales in the CINMS is provided in Table C-11.

Table C-13
Cetaceans: Mysticetes—Right Whales in the CINMS

Species	**Population or Stock Size**	**Protected Status**	**Relative Abundance**	**Seasonality**	**Normal Habitat**
Northern right whale *(Eubalaena glacialis)*	Not available for region	Protected, and strategic under MMPA Endangered under ESA	Extremely rare	Unknown	Coastal

Note: ESA – Endangered Species Act
MMPA – Marine Mammal Protection Act
Source: Angliss *et al.* 2001

Northern Right Whale (Eubalaena glacialis)

Right whales are the most endangered of all the world's whales, having been hunted relentlessly in the seventeenth, eighteenth and nineteenth centuries. They are currently listed as endangered under the ESA, and depleted, protected, and strategic under the MMPA. The historic range of this species was thought to be the entire West coast, from the Bering Sea to Baja, Mexico. The pre-exploitation size of the stock was 11,000 animals. A current population estimate for the entire North Pacific is 100-200 animals (Kreitman and Schramm 1995), and it is doubted whether the species will remain extant. Recent sightings have ranged from Baja, Mexico, to Bristol Bay, Alaska, and there has been one sighting reported in the Santa Barbara Channel in 1981 (Scarff 1986).

Northern right whales are baleen whales and feed primarily on the surface by skimming zooplankton-rich patches of surface water. They have occasionally been seen bottom feeding in shallow water (Kreitman and Schramm 1995).

Mysticetes: Gray Whales

A list of gray whales in the CINMS is provided in Table C-14.

Table C-14
Cetaceans: Mysticetes—Gray Whales in the CINMS

Species	Population or Stock Size	Protected Status	Relative Abundance	Seasonality	Normal Habitat
California gray whale *(Eschrichtius robustus)*	Population: 26,635	Protected under MMPA	Common	December through May; rarely rest of year	Coastal

Notes: MMPA – Marine Mammal Protection Act
Source: Rugh *et al.* 1999**.**

California Gray Whale (Eschrichtius robustus)

Of the large baleen whales, the California gray whale is the only species that has been delisted from the Federal Endangered Species List; this occurred in 1994. Its population was last estimated in 1998 at 26,635 animals (Rugh *et al.* 1999).

Every year, the California gray whale migrates south from its winter feeding grounds in Alaska and the Bering Sea. Small numbers sometimes straggle from the Bering or Chukchi seas down the coast of Asia. In the past, such animals were considered a separate stock called the Korean or western Pacific stock (Leatherwood *et al.* 1982).

The vast majority of the California gray whale population begins to appear in the SCB in late December. However, individuals or small groups are often seen migrating south as early as October and November. Most of the southbound whales have passed the region by the end of February, but a few stragglers are sometimes seen later.

The northbound migration begins in February, and by the middle of the month, both south- and northbound animals may be seen in the SCB. When the northbound migration is in full swing, killer whales are most often seen in large numbers in the region. Attacks on gray whale calves and juveniles have been documented during this period. The northbound migration generally continues into May, with mother-calf pairs becoming most abundant in April. In the SCB, California gray whales are believed to utilize two main migration corridors, with several smaller corridors. The majority of both north- and southbound whales pass among the Channel Islands during both migrations. Smaller numbers pass near the mainland coast of the SCB, with greater numbers being seen during the northbound migration (Carretta *et al.* 2000; Howorth 1998). Gray whales have been reported for every month of the year, with occasional individuals lingering in the area over the summer.

Gray whales have been seen by several reliable observers feeding in drifting patches of giant kelp offshore, on isopods in established kelp beds, on mole crabs (*Emerita analoga*) in the surf, and on amphipods off shallow sandy sea floors (Anderson 1998, DeLong 1998). Still, such feeding seems largely opportunistic, and the whales generally keep moving as they feed. Migrational feeding activities are more often observed during the northbound migration, perhaps because more whales pass close to the mainland coast where they can be more readily observed.

Mysticetes: Rorquals

A list of rorquals in CINMS is provided in Table C-15.

Table C-15
Cetaceans: Mysticetes—Rorquals in the CINMS

Species	Population or Stock Size	Protected Status	Relative Abundance	Seasonality	Normal Habitat
Blue whale *(Balaenoptera musculus)*	Stock size: 1,940	Protected, depleted and strategic under MMPA Endangered under ESA	Common in season	June to September; occasionally through November	Shelf and slope
Fin Whale *(Balaenoptera physalus)*	Stock size: 1,851	Protected, depleted and strategic under MMPA Endangered under ESA	Uncommon	Summer, fall; possible year-round	Shelf and slope
Sei whale *(Balaenoptera borealis)*	Not available for region	Protected, depleted and strategic under MMPA Endangered under ESA	Very rare	No longer known	Oceanic
Bryde's whale *(Balaenoptera edeni)*	Stock size: 12	Protected under MMPA	Rare	Warm water months	Shelf and slope
Minke whale *(Balaenoptera acutorostrata)*	Stock size: 631	Protected and strategic under MMPA	Uncommon	Year-round; Most abundant in summer and fall	Coastal to slope
Humpback whale *(Megaptera novaeangliae)*	Stock size: 856	Protected, depleted and strategic under MMPA Endangered under ESA	Common in season	May to September	Shelf and slope

Note: ESA – Endangered Species Act
MMPA – Marine Mammal Protection Act
Source: Carretta *et al.* 2002.

Blue Whale (Balaenoptera musculus)

Blue whales are listed as endangered under the ESA. They are considered depleted, and the California-Mexico stock is listed as strategic under the MMPA.

A best estimate of this stock size is 1,940 animals, based on line transect aerial surveys and mark-recapture studies in which identification photographs are taken of individual whales over time (Carretta *et al.* 2002). Since 1989, blue whales have been appearing in numbers in the Santa Barbara Channel. Prior to that time, blue whale sightings were sporadic. Although blue whales have been reported at or near the region every month of the year, they generally arrive in early to mid-June and remain until August or September. Sometimes a number of individuals linger as late as November or even December. When blue whales are present in numbers in the Santa Barbara Channel, some 100 individuals may be in the area at one time. These animals seem to stay for several days or more than a week, then move on as others fill their place. The Santa Barbara Channel has prodigious quantities of krill, mainly *Euphausia pacifica*, upon which the blue whales feed.

Blue whales also frequent the Gulf of the Farallones and areas offshore from Monterey Bay in the latter part of summer and early fall. Some individuals travel into Oregon and Washington, but the California-Mexico stock does not appear to journey to Alaska. In late fall and winter, the California-Mexico blue whale stock stays off the coast of Mexico and Central America. Some venture into the Gulf of California, while others travel to the oceanic islands and to the Costa Rica Dome (Calambokidis and Steiger 1997). Little is known about the migration route from Central America and Mexico to California and back. From very limited observations and from a few satellite tags, it appears as though blue whales travel across wide expanses of deeper water offshore, then appear from west of San Nicolas Island across to Santa Rosa and San Miguel islands, entering and leaving the Santa Barbara Channel from the west.

Fin Whale (Balaenoptera physalus)

Fin whales are listed as endangered under the ESA. They are considered depleted and strategic species under the MMPA. The California-Oregon-Washington management stock is considered strategic. Population estimates of fin whales vary, but based on 1991 and 1993 ship surveys, an estimate has been made of 1,851 fin whales for this stock (Carretta *et al.* 2002). At least 148 fin whales have been photo-identified in the Gulf of California. Whether these animals are resident or are part of the California-Oregon-Washington stock is unknown at this time. Fin whale abundance dwindles off the coasts of California and Oregon in winter and spring, while it increases during the same period in the Gulf of California. This may be coincidence, however (Carretta *et al.* 2002). At least part of the population appears to spend winter and spring well off the southern California coast down to Mexico.

Fin whales are more cosmopolitan in their diet, feeding on krill, copepods, squid, and even small schooling fish (Leatherwood *et al.* 1982). They have been observed in the Santa Barbara Channel near feeding aggregations of blue and humpback whales. These individuals were feeding on the same prey, *Euphausia pacifica*, a species of krill.

Sei Whale (Balaenoptera borealis)

Sei whales are listed as endangered under the ESA and are considered depleted and strategic under the MMPA. Once commonly taken by whalers off the California coast in the 1950s and 1960s, sei whales are now quite rare (Daugherty 1985). Several extensive aerial and ship surveys from 1991 through 1993 revealed only one confirmed sighting of a sei whale (Carretta *et al.* 2002).

Bryde's Whale (Balaenoptera edeni)

Bryde's whales are common throughout the eastern tropical Pacific and are the most common balaenopterid in the Midriff region of the Gulf of California. There, 140 individuals have been photo-identified. During extensive ship and aerial surveys off California from 1991 through 1994, five possible observations of Bryde's whales were made. Bryde's whales are rare off California. The population is estimated at 12 individuals in California, Oregon, and Washington coastal waters (Carretta *et al.* 2002). The minimum overall population in the eastern tropical Pacific has been estimated at 11,163 animals.

Bryde's whales seem to prefer small schooling fish in their diet, including pilchards, anchovies, herring, and mackerel. They also feed on euphausiids (Leatherwood *et al.* 1982).

Minke Whale (Balaenoptera acutorostrata)

Minke whales are not listed under the ESA, nor are they considered depleted under the MMPA. The stock size is estimated at 631 individuals based on ship surveys in 1991, 1993, and 1996 (Carretta *et al.* 2002). Minke whales occur year-round in the region, from relatively shallow coastal areas to shelves off the north shore of the four northern Channel Islands. They appear to be most abundant from late spring through late summer although they are never seen in large numbers. Feeding activities are generally associated with small schooling fish, although they may also eat euphasiids.

Humpback Whale (Megaptera novaeangliae)

Humpback whales are endangered under the ESA and depleted and strategic under the MMPA. This particular stock is officially called the California-Oregon-Washington-Mexico stock. In reality, this stock ranges from at least Costa Rica to British Columbia. It does not mingle with the Alaska stock. Various estimates have been made for the California-Mexico stock. The most reliable estimate, obtained by mark-recapture photo-identification methods, was 856 animals (Carretta *et al.* 2002).

In winter, this stock congregates near oceanic islands off Mexico and Central America, with at least some individuals at the Costa Rica Dome. Humpback whales usually begin to appear in the region by late May and early June (Calambokidis *et al.* 2000). They generally stay until August or September. Humpback whales may stay as late as November in the western reaches of the Santa Barbara Channel. Like the blue whales, the humpback whales travel into central California in summer and early fall, occupying much the same areas. Little is known about the movements of humpback whales between Central America and Mexico to the western coastal United States, but their movements may be similar to those of the blue whales.

Although humpback whales in the region feed primarily on krill, particularly *Euphausia pacifica*, they have also been observed feeding on northern anchovies (*Engraulis mordax*), Pacific sardines (*Sardinops sagax coeruleus*), and on various small fish and amphipods in drifting patches of giant kelp (Leatherwood *et al.* 1982; Croll *et al.* 1999).

1.2.7.2 Pinnipeds

Historically, six species of pinnipeds have occurred in the northern Channel Islands. These include four members of the family Otariidae and two representatives of the family Phocidae. Two of the six species that have occurred in the Sanctuary are listed as threatened under the ESA.

Of the otariid seals, the California sea lion (*Zalophus californianus c.*) is the most abundant (Carretta *et al.* 2002). The Steller sea lion (*Eumetopias jubatus*) had two rookeries on San Miguel Island, but these rookeries have not been occupied since the 1982 to 1983 El Niño event. The eastern stock of Steller sea lions is listed as threatened under the ESA. The northern fur seal (*Callorhinus ursinus*) has two rookeries on San Miguel Island. The Guadalupe fur seal (*Arctocephalus townsendi*) has been reported on San Nicolas and San Miguel islands in very small numbers, usually from one to three individuals. A few strandings have occurred along the mainland coast (Hanni *et al.* 1997). The Guadalupe fur seal is listed as threatened under the ESA and CESA and is also fully protected under the Fish and Game Code (Section 4700).

Of the phocid seals, the northern elephant seal (*Mirounga angustirostris*) is the most common, with rookeries at San Miguel, Santa Rosa, San Nicolas, and Santa Barbara islands (Carretta *et al.* 2002). The Pacific harbor seal (*Phoca vitulina richardsi*) is common throughout the Channel Islands, with numerous haulout and rookery sites throughout the Channel Islands and along the mainland coast (Carretta *et al.* 2002). The ribbon seal (*Histriophoca fasciata*), an arctic species, has been reported twice in California (Daugherty 1985; Santa Barbara Museum of Natural History 2003).

Otariids

A list of otariids in CINMS is provided in Table C-16.

Table C-16
Pinnipeds: Otariids—Eared Seals in the CINMS

Species	**Population or Stock Size**	**Protected Status**	**Relative Abundance**	**Seasonality**	**Normal Habitat**	**Water Mass Preference**
California sea lion *(Zalophus californianus c.)*	Stock Size: 204,000 to 214,000	Protected under MMPA	Common	Year-round	Coastal	Tropical to temperate
Steller sea lion *(Eumetopias jubatus)*	31,005	Protected and strategic under MMPA Threatened under ESA	Now extremely rare	Formerly summer and fall	Coastal	Subtemperate to subpolar
Northern fur seal *(Callorhinus ursinus)*	Stock size: 4,336	Protected under MMPA	Uncommon	May to November	Pelagic	Subtemperate to subpolar
Guadalupe fur seal *(Arctocephalus townsendi)*	Population: 7,408	Protected, depleted, and strategic under MMPA Threatened under ESA	Rare	Summer and fall	Pelagic	Subtropical to temperate

Note: ESA – Endangered Species Act
MMPA – Marine Mammal Protection Act
Source: Carretta *et al.* 2002.

California Sea Lion (Zalophus californianus c.)

The California sea lion consists of three subspecies: *Zalophus californianus japonicus*, which occurred off Japan and is now thought to be extinct; *Zalophus californianus wollebaeki*, found at the Galapagos Islands; and *Zalophus californianus californianus*, found from Baja California to British Columbia. The latter population is divided into three stocks. The range of the Gulf of California stock is as indicated by the name; the western Baja California stock extends from the southern tip of Baja California to the California border; and the U.S. stock ranges from California through Washington. The United States stock size has been estimated at 204,000 to 214,000 animals (Carretta *et al.* 2002).

California sea lions have two main rookeries at the Channel Islands, one at San Miguel Island, the other at San Nicolas Island. Other rookeries exist at Santa Barbara and San Clemente islands. Several haul-out sites exist on Santa Cruz and Anacapa islands. California sea lions are a coastal species, seldom venturing much past the Continental Borderland. Adult male California sea lions usually haul out from May into early August to defend their beach territories and breed. After mating, they head north, some reaching as far as British Columbia. The females linger with their pups, which are weaned at 4 to 10 months. Some continue to nurse for up to a year.

The females generally stay at the island haulout sites or near the mainland coast as far north as Monterey, as do the juveniles. A few adult males also linger in this region. California sea lions feed on small schooling fish and market squid (*Loligo opalescens*).

Steller Sea Lion (Eumetopias jubatus)

Steller sea lions were reclassified into two separate stocks within United States waters in 1997: the eastern stock, including animals east of Cape Suckling, Alaska (144 degrees west longitude); and the western stock, including animals at and west of Cape Suckling. The eastern stock of Steller sea lions is threatened under the ESA, while the western stock is endangered because of major population declines. Both populations are now considered strategic and depleted. Reduced prey stocks from overfishing during critical times and locations resulted in the decimation of the western population (NMFS 2000). Regionally, the 1982–1983 El Niño event may have contributed to the decline of this species (Angliss *et al.* 2001).

The most recent abundance estimate of the eastern stock of Steller sea lions is based on combined surveys conducted in Southeast Alaska (15,173 animals), British Columbia (9,277), and Washington, Oregon and California (6,555). Combining the total count for the three regions results in a minimum estimated abundance of 31,005 Steller sea lions (Angliss *et al*. 2001). Trends in Steller sea lion abundance for the three regions have been slightly variable over the past two decades. Steller sea lion numbers in California, especially southern and central California, have declined considerably, from 5,000 to 7,000 non-pups from 1927–1947 to 1,500 non-pups between 1980 and 1998 (Angliss *et al.* 2001).

Critical habitat for the Steller sea lion was established in 1993 (58 FR 45269) and includes all major rookeries for the eastern stock. In California, rookeries at Año Nuevo Island, Southeast Farallon Islands and Sugarloaf Island, off Cape Mendocino, are considered critical habitat (NMFS 2000). Año Nuevo Island, the closest critical habitat to the SCB and the southernmost breeding site for this species, is hundreds of miles to the north in Santa Cruz County. No critical habitat exists for this species in the SCB (NMFS 2000).

The Steller sea lion was last reported at San Miguel Island during the 1982–1983 El Niño (NMFS 1992 and 2000). Historically, Steller sea lions have been seen occasionally at San Nicolas Island but have not been observed there for decades (Bartholomew 1951; Bartholomew and Boolotian 1960). Steller sea lions once appeared in early summer and remained into the fall at San Miguel Island. A similar pattern continues at the Año Nuevo Island colony. Steller sea lions prefer cold temperate waters.

Steller sea lions feed on a variety of fish, including the walleye pollock or black cod *(Theragra chalcogramma)*, once a major prey item (Angliss *et al.* 2001; NMFS 1992 and 2000).

Northern Fur Seal (Callorhinus ursinus)

The northern or Alaskan fur seal has two rookeries of approximately 4,500 animals at San Miguel Island. These were reestablished in the late 1950s. The two rookeries have grown over the years to an estimated

4,336 animals (Carretta *et al.* 2002). At San Miguel Island, adult males usually arrive in May and stay through August. Some will stay as late as November, along with the females, although they will not maintain territories much beyond August. By November, most adults have left for the open ocean, where they will spend the next seven to eight months. Many pups will spend the next 22 months at sea after they have been weaned, finally returning to the rookeries where they were born. Northern fur seals are pelagic, frequenting offshore waters in search of fish and squid.

Guadalupe Fur Seal (Arctocephalus townsendi)

The Guadalupe fur seal is listed as threatened under the ESA. It is considered depleted under the MMPA and is also fully protected under Fish and Game Code (Section 4700). The California-Mexico stock is considered strategic under the MMPA. The latest estimate of this population is 7,408 animals (Carretta *et al.* 2002), virtually all of which are found in Mexican waters at Guadalupe Island. A pup was born on San Miguel Island in 1997 (Melin and DeLong 1999).

Phocids

A list of phocids is provided in Table C-17.

Table C-17
Pinnipeds: Phocids—True Seals in the CINMS

Species	Population or Stock Size	Protected Status	Relative Abundance	Seasonality	Normal Habitat
Northern elephant seal (Mirounga *angustirostris)*	Stock size: 101,000	Protected under MMPA	Common in season	December to August	Deep benthic
Pacific harbor seal *(Phoca vitulina richardsi)*	Stock size: 30,293	Protected under MMPA	Common	Year-round	Coastal
Ribbon seal *(Histriophoca fasciata)*	Not applicable	Protected under MMPA	Extremely rare	Not applicable	Arctic

Note: MMPA – Marine Mammal Protection Act
Source: Carretta *et al.* 2002, Santa Barbara Museum of Natural History 2003, Daugherty 1985.

Northern Elephant Seal (Mirounga angustirostris)

The California population is considered a separate stock (Carretta *et al.* 2002). Northern elephant seals have two large rookeries on San Miguel and San Nicolas islands. Smaller rookeries are found on Santa Barbara and Santa Rosa islands. They have also been reported at Santa Cruz and Anacapa islands but have not established rookeries there. The California stock was estimated at 101,000 animals in 1996 (Carretta *et al.* 2002).

Northern elephant seals migrate to California twice from feeding grounds as far north as the Aleutian Islands and the Gulf of Alaska (for the males) and to areas off the Oregon coast (for the females). They migrate once to bear their young and breed, then a second time to molt. The pupping and breeding season extends from December through March. The molting season is between March and August. Males generally arrive later than the females. Northern elephant seals feed on deepwater organisms including bony fish, sharks, skates, rays, and squid, and octopus.

Pacific Harbor Seal (Phoca vitulina richardsi)

Two subspecies of harbor seals exist in the Pacific, *Phoca vitulina stejnegeri*, which is found in the western Pacific and in northern Japan and *Phoca vitulina richardsi*, which ranges from the Pribilof Islands in the Bering Sea to Baja California. The Pacific harbor seal is well distributed in California, with 400 to 500 haulout sites along the mainland coast at river mouths, estuaries, beaches, offshore rocks, and islands, including San Francisco Bay, as well as at the Channel Islands. Harbor seals usually do not roam far from their haulout and rookery areas, although a few individuals may wander a few hundred kilometers. The best estimate of the California stock is 30,293 animals (Carretta *et al.* 2002).

Harbor seals pup from February through May. Some pups have been reported in December and January at several rookeries. The most animals can be seen ashore at the Channel Islands during the molting season, which peaks from late May to early June. Harbor seals prey mostly on various species of bottom fish and octopi.

Ribbon seal (Histriophoca fasciata)

Please see note under Pinnipeds, above.

Carnivores: Mustelids

A list of mustelids in the CINMS is provided in Table C-18.

Table C-18
Carnivores: Mustelids – Sea Otters in the CINMS

Species	Population or Stock Size	Protected Status	Relative Abundance	Seasonality	Normal Habitat
Southern sea otter *(Enhydra lutris nereis)*	Stock size: 2,505	Protected, depleted, and strategic under MMPA Threatened under ESA	Most abundant in spring in region	Year round	Coastal

Note: ESA – Endangered Species Act
MMPA – Marine Mammal Protection Act
Source: USGS 2003.

Southern Sea Otter (Enhydra lutris nereis)

The southern sea otter is listed as threatened under the federal ESA and is considered depleted and strategic under the MMPA. In general, the California population has been slowly but steadily increasing since the discovery of a remnant colony off Bixby Creek in central California in 1937. Some declines have occurred following El Niño events, however (U.S. Geological Survey [USGS] 1999 and 2001). Recent spring counts reflect these fluctuations: in 1998, the count was 2,114; in 1999, it was 2,090; in 2000, 2,317; in 2001, 2,161; in 2002, 2,139; and in 2003, 2,505, the highest count recorded since modern census techniques were developed for the sea otter (USGS 2003). The data suggest a gradual but statistically significant population increase of about 0.9% a year since 1998, although the latest count, conducted in good observation conditions, may have skewed the data (USGS 2003). While no single year's survey result is indicative of a population change, researchers and managers remain concerned at the overall slow rate of growth for the threatened California sea otter. Cooperative research efforts are ongoing to try to understand why the otter's recovery has been so slow.

The California stock of sea otters ranges from Point Conception north to Año Nuevo Island, in Santa Cruz County. This population is concentrated near the coast in waters up to about 20 meters deep, although some otters can be found out to about 40 meters of water depth. Few otters have been sighted north of Año Nuevo Island, where the northward spread seems to have stopped. Predation by great white sharks *(Carcharodon carcharias)* likely has contributed to the cessation of range expansion to the north (Ames *et al.* 1996).

From 1987 to 1990, the USFWS, which has primary jurisdiction over sea otters, translocated 139 otters to San Nicolas Island. The translocation effort has not been considered a success. In 2003, 33 animals were reported there. Whether these animals are part of the translocated stock, offspring from the translocated stock, others that have moved there, or a combination of these possibilities, is unknown (Sanders 2003).

Southern sea otters eat certain mollusks, crustaceans, and echinoderms. Unlike Alaskan otters, they do not appear to eat fish.

1.2.7.3 Special-Status Marine Mammal Species

The federal Endangered Species Act (ESA) provides measures to conserve and recover listed species. NMFS is charged with implementation of the ESA for all marine mammals in the SCB except the southern sea otter, which is handled by the USFWS. Section 7 of the ESA requires that federal agencies ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species. Likewise, the California Endangered Species Act prioritizes the protection and recovery of listed endangered or threatened species and their habitats. The ESA requires NMFS and the USFWS to develop recovery plans for species added to the list of Threatened and Endangered (T&E) species. The Recovery Plans describe conservation measures to ensure recovery of the listed species.

The State also designates protection to one marine mammal under the California Endangered Species Act (CESA). In addition, the California Fish and Game Code (Section 4700) designates several marine mammal species as fully protected (northern elephant seal, Guadalupe fur seal, Pacific right whale, and southern sea otter). Fully protected mammals may not be taken or possessed at any time, and no provision may be made to allow incidental take.

Under the ESA, an endangered species is defined as "any species which is in danger of extinction throughout all or a significant portion of its range." Six whale species occurring in California waters are listed as endangered. A threatened species is "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The Steller sea lion, Guadalupe fur seal, and southern sea otter are the only marine mammal species occurring in California waters that are listed as threatened. The Guadalupe fur seal is also listed under the CESA as threatened.

A candidate species is "any species being considered by the Secretary for listing as an endangered or threatened species, but not yet the subject of a proposed rule." There are no candidate marine mammal species found in California waters.

All marine mammals are protected under the Federal Marine Mammal Protection Act (MMPA 1972, amended 1994) administered by NMFS and the USFWS. In addition, NMFS and the USFWS grant at-risk marine mammal stocks additional protection under the ESA with endangered, threatened, and depleted status designations. The MMPA also provides designations for at-risk marine mammal stocks. A species or a stock of a species is designated as depleted when it falls below its Optimum Sustainable Population (OSP) or, if the species is listed under ESA. Six whale species and the southern sea otter are considered depleted. The MMPA also lists a stock as strategic if: 1) it is listed as a T&E species under ESA; or 2) the stock is declining and likely to be listed as threatened under the ESA; or 3) the stock is listed as depleted under the MMPA; or 4) the stock has direct human-caused mortality which exceeds that stock's Potential Biological Removals (PBR) level. The term PBR is defined as "the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its OSP" (Carretta *et al.* 2002). As mandated in the 1994 amendments to the MMPA, NMFS develops estimates of PBR's for each marine mammal stock in U.S. waters.

NMFS issues permits through the Marine Mammal Authorization Program (MMAP) to provide an exception for commercial fishers from the general taking prohibitions of the MMPA. The owner of a vessel or non-vessel gear participating in a Category I or II fishery must obtain authorization from NMFS in order to lawfully incidentally take a marine mammal in a commercial fishery, while those participating in Category III fisheries may incidentally take marine mammals without registering for or receiving an authorization (NMFS/NOAA/OPR 2001). For those species under NMFS' jurisdiction, permits may be issued for the incidental, but not intentional, taking of marine mammals listed as T&E under the ESA. With the 1994 amendments to the MMPA, intentional takes of marine mammals are now illegal except when imminently necessary in self-defense or to save the life of another person.

2.0 HISTORICAL/CULTURAL RESOURCES

Historical/cultural resources in the Study Area are discussed below including existing data sources and key threats to the resources

2.1 DATA SOURCES

2.1.1 Historical Research

Prior to 1976, when a paper was published by Hudson on marine archaeology in the region, little work had been done in this area. Before the 1950s, probably all the marine finds were made in the intertidal region, and few of these were likely reported (Hudson 1976). The earliest known stone artifact was made by an American Indian, and found by Orr in a cemetery on Santa Rosa Island; he dated the artifact at about 4,000 years B.P. (1968). It was riddled with borings from marine organisms, both inside and out, indicating that it had been manufactured, somehow deposited in the sea, then later recovered.

In the 1870s, a stone vessel was found during a very low tide near the site of the Chumash village of Syuxtun, near what is now the foot of Bath and Chapala streets in Santa Barbara. This was the first recorded marine discovery in the region. Other artifacts were later found there, eroded out of nearby cemeteries and middens.

In 1928, another vessel was found in Carpinteria, followed 2 years later by yet another, recorded by Wallace and Kritzman (1956). In 1944, the late Campbell Grant, well-known for his work on Chumash rock art, recovered a bowl at Rincon Point. Two grooved stones were found in Montecito in 1934 and 1937. Other finds were undoubtedly made but never reported (Hudson 1976).

From 1950 on, numerous finds were made throughout much of the Study Area by recreational scuba divers and commercial abalone and sea urchin divers. These finds were enumerated in several comprehensive studies (Hudson 1976; Hudson and Howorth 1985; Howorth and Hudson 1993). During the first study, 26 sites were identified along the mainland coast of the Study Area, and 6 at the four northern Channel Islands. Artifacts from all sites totaled 92 (Hudson 1976).

In the next study, which built on the earlier work, the number of artifacts totaled over 150, while the number of mainland sites had increased to 35. Island sites had increased to 17, not counting an additional 4 sites at San Nicolas Island, which is not in the existing Sanctuary or Study Area (Hudson and Howorth 1985). In the last study, confined to the existing Sanctuary, 18 sites were recorded (Howorth and Hudson 1993). Since then, an additional site was found at the northern Channel Islands. To date, no marine archaeological sites have been found at Santa Barbara Island. Another site was reported for the mainland coast of the Study Area.

Most submerged archaeological finds to date have been fortuitous rather than systematic. Such finds have been made mainly by divers who are not trained archaeologists. Not surprisingly, stone vessels, which are large, relatively indestructible and easily recognizable, comprise the majority of finds. In Hudson's 1976 study, a sampling of 68 artifacts revealed 56 stone vessels, vessel blanks, or basket hopper mortars. Six of the remainder were grooved stones; the others consisted of metates, pestles, donut stones, and scrapers.

In 1961, divers from Scripps Institution of Oceanography investigated a site off Santa Rosa Island and found a large concentration of bowls. In 1974 and 1975, two undersea archaeological expeditions were undertaken in the Study Area through the Santa Barbara Museum of Natural History (Hudson 1976; Hudson and Howorth 1985). The first expedition was to see if a helmet-mounted video camera could allow a topside archaeologist to monitor a systematic diver search of the sea floor. In 1975, a qualified archaeologist, investigating a known submerged archaeological site, did find an artifact. The object was a unifacially worked sandstone tool that a diver not trained in archaeology would have missed (Hudson 1976).

In 1977, a diver-archaeologist performed a systematic search of an area near Point Conception proposed for a liquefied natural gas port, using a line transect survey method. He did not find any artifacts. Later, however, a marine biologist recovered a charmstone from the same area (Hudson 1976; Hudson and Howorth 1985).

These studies show that even trained archaeologists will not necessarily locate artifacts during surveys. The problems of sand or algae covering the material, limited underwater visibility, and numerous other factors limit undersea archaeology.

Hudson (1976) concluded that the sampling of submerged cultural resource sites was biased, based on the following observations:

- The distribution of sites was dependent upon the frequency of diving activities or beachwalkers at low tides;
- Fewer people walked beaches at the Channel Islands;
- Shallow, nearshore areas were visited more frequently by divers than deep-water sites;
- Deep sites were rarely visited because of limited dive times;

- Finds were haphazardly reported;
- Little data were available on geomorphology, such as the presence of ancient streambeds;
- No systematic surveys had been undertaken, at least within the Sanctuary; and
- Remote sensing equipment had not located any submerged sites.

Despite the sampling bias, however, a considerable volume of previously unpublished data on submerged cultural resources sites was revealed in Hudson's 1976 study and in subsequent studies (Hudson and Howorth 1985; Howorth and Hudson 1993).

2.1.2 Contemporary Research

A preliminary search of primary source material, contemporary newspaper accounts, survivor diaries, oral interviews, published databases and reports, and popular literature on shipwrecks was conducted. In addition to documenting the shipwreck events, the maritime activities associated with these historic resources must be put into context. Lima (1994) described the process in five steps: (1) identifying vessels lost in an area; (2) gathering data about the vessels; (3) identifying and documenting actual wreck sites; (4) interpreting the research findings; and (5) disseminating the research findings. This same process can be applied to other historic resources, such as aircraft and historic land use sites.

In 1985, research was completed and a report was published by Hudson and Howorth. This report included a review of earlier findings by Pierson and Stickel (1977) Pierson (1980), and Pierson et al. (1987). It also included many new findings made by Hudson and Howorth. An updated report was prepared in 1993 (Howorth and Hudson), which listed a total of 105 shipwrecks in the CINMS.

In 1996, Morris and Lima published a submerged cultural resources assessment for CINP. Although this assessment addressed shipwrecks and aircraft losses in Sanctuary waters from 1853 to 1980, it did not include the Study Area, nor did Hudson and Howorth's earlier studies (1985 and 1993). Lima (1999) provided a shipwreck study for publication in an EIS prepared for the U.S. Navy at Point Mugu, California. This publication addressed the complete Study Area, but it only provided each vessel's name, rig, date built, date lost, and how the vessel was lost. It did not include a historical profile for each vessel or detailed circumstances surrounding each loss. Gearhart *et al.* (1990) provided broad historic narratives of the Study Area with some discussion on regional losses, but it did not represent a full assessment of the resources. Four government shipwreck databases provided vessel listings but only limited information on the historical significance of these resources (California State Lands Commission 2000; NOAA 2000a, b; U.S. Navy 2000). Schwemmer and Gamble's shipwreck database (2000) represents an ongoing study of ship and aircraft casualties for the four western states.

2.2 THREATS TO SUBMERGED HISTORICAL/CULTURAL RESOURCES

With the development of underwater technologies that bring the public physically and virtually closer to the marine environment, there is increasing interest in submerged historical/cultural resources (SCRs). Protection and management of these historically significant resources can provide the public with a variety of education, research and recreation opportunities. The continuing discovery, exploration, documentation and study of these resources provide a richer understanding of the region's maritime community, which is an important component of the larger ecosystem the CINMS is protecting. SCRs provide an excellent historical record to past human behavior patterns and uses in the Sanctuary.

SCRs are subject to irreversible damage and can be severely compromised by human and environmental impacts. Although the Sanctuary allows certain compatible activities, its overriding responsibility is to protect both historical/cultural and natural resources for current and future generations.

To gain a better understanding of the past, researchers strive to study SCRs in their original context. The relationship of one artifact to another is important and if an artifact is moved or altered, it can affect the way researchers understand and interpret an SCR site.

There are two principal threats to SCRs: human behavior and natural phenomenon. While little can be done to minimize the damage from natural events (with the exception of removing delicate artifacts for conservation and research), human behavior may be managed through education, adequate regulations and effective enforcement. Evaluating the threats to SCRs of the Sanctuary requires further research because so few sites have been located and thoroughly surveyed. As such, NOAA's policy is *in situ* preservation but recognizes that the removal of historical/cultural artifacts is sometimes necessary. The conditions in which removing an artifact may be necessary include:

- Protecting artifacts from harsh environmental conditions;
- Protecting artifacts from human impacts such as looting;
- Conducting research in a controlled environment; and
- Making artifacts more readily available to educate the public.

2.2.1 Human Threats

Site looting (where objects are intentionally pilfered from submerged sites) is the single largest threat to SCRs. This act has the potential to be more damaging than controlled salvage since it is an act of wanton destruction and theft. Artifacts that are small and light enough for divers to carry are pilfered most often. Larger structures of shipwrecks are less likely to be stolen, but may be vandalized, intentionally defaced, or destroyed in search of recoverable artifacts. Most events go unnoticed, while some cases occurring in the Sanctuary have been documented with evidence for successful prosecution.

Sometimes through the process of recovery, important archaeological contexts are destroyed. Attempted conservation by over-zealous cleaning may remove important evidence about the artifact, its usage and the associated site, or destroy the protective coatings that enabled it to survive in the first place. Some artifacts are discarded when they are found to have little or no monetary value and/or the novelty of discovery has worn off, while others are neglected and allowed to fall into decay (Robinson 1998).

Divers who may not have any intentions to loot or vandalize artifacts may still cause damage through poor diving techniques or tampering. Divers may inadvertently harm resources by kicking up sand from the bottom, holding onto artifacts or accidentally breaking fragile resources when striking them with scuba tanks. Even if the intent was not to steal or damage the resources, permanent destruction to non-renewable artifacts can be inflicted.

Vessel activity can also cause serious damage to SCRs. An anchor dropped on an artifact can result in serious and permanent damage or drag it away from the context of its original site location. Seabed disturbance by mobile bottom fishing gear has emerged as a concern due to the damaging effects of heavy trawl doors and nets dragging through archaeological sites.

Modern ship groundings can have seriously impacted SCRs in the various sites worldwide. A large vessel that grounds on an archaeological site may destroy and permanently bury historical/cultural artifacts under tons of modern steel and debris. The impacts of oil spills from bunker fuels and petroleum cargoes covering historical resources have largely been overlooked. Petroleum products that sink can physically smother resources. Due to the increase in carbon, oil contamination from a modern shipwreck may also impede the radiocarbon dating processes.

The process of trenching communications cables can have permanently damaging effects to submerged archaeological resources during grappling and (sea) cable installation. To mitigate such a threat, qualified archaeologists are required to conduct historical resources inventories and avoidance plans with supervised magnetometer and side-scan surveys of the proposed regions.

The laying of oil pipelines and other structures that support offshore oil and gas processing facilities can destroy historical resources. Dredging operations to clear harbor entrances can destroy and/or dislodge submerged archaeological resources, thus losing important clues to their history.

2.2.2 Natural Threats

Although there is little that can be done to protect artifacts from natural processes, the Sanctuary staff recognize these threats and, when possible, will attempt to mitigate their impacts. Most damage to shipwrecks occurs in the first few decades of their sinking. Shipwrecks tend to stabilize with the environment (sustaining fewer damaging effects) after twenty or thirty years.

Shipwrecks in shallow water environments within higher energy zones are much more likely to be subjected to damage by waves, shifting sands and strong currents. Wave action carries a tremendous amount of energy that can easily break up a shipwreck and physically pull it apart, whereas shipwrecks in deeper and calmer waters are generally in a more stable environment, therefore limiting physical effects. Cold and deep-water environments tend to have fewer biological processes that accelerate ship degradation as that found in shallower sites.

Shipworms (*Teredo diegensis*) inhabit and burrow through wood material, rapidly destroying its structure. Evidence of these shipworms is common among wooden shipwrecks in the Sanctuary. Sea urchins secrete acid that dissolves small, cup-shaped depressions into rocky reef ledges. Creatures living on the surface of historical resources also have the potential to inflict damage. Rock-boring clams, tubeworms and other organisms can have destructive results, even on stone artifacts.

2.3 OVERVIEW OF HISTORICAL/CULTURAL RESOURCES IN STUDY AREA

Submerged historical/cultural resource sites are abundant within the Study Area. Several theories explain the presence of such sites and are presented in the next section. Erosion is the single largest factor that continues to deposit archaeological material into the marine environment. Wave and streambed erosion, and cliff retreat from wind, runoff and even earthquakes, all result in the deposition of archaeological material into the sea. On the four northern Channel Islands, where such material is abundant in blufftop middens and in burial grounds, the process is inevitable. Given the almost continuous length of insular coastline capped by archaeological remains, one should expect the presence of marine finds almost everywhere offshore of these islands (Hudson and Howorth 1985; Howorth and Hudson 1993). This process also occurs, although to a lesser extent, along the mainland coast of the Study Area south of Point Conception. From Point Conception north, such sites are quite abundant (Lebow 2000). (Hudson and Howorth 1985; Hudson 1976). Throughout the Study Area, such sites are probably under-reported.

Along the mainland coast, most eroding sites lead directly to the intertidal zone, which is subject to the weathering effects of sun, windblown sand, scouring from wave-driven sand, pounding by rock rubble, and direct surf action, in addition to the effects of rock-boring clams and other organisms. Some island sites are also characterized by the same influences. For these reasons, only the hardiest of artifacts, such as stone vessels and pestles, usually survive over time in such areas.

Along some sections of the Channel Islands, however, eroding coastal bluffs are perched over relatively deep, semi-protected waters. Material falling into the sea from such sites is subject only to damage while falling. Once submerged, the material is more prone to damage from biological organisms than from physical impacts. This may account for one diver's find of two vessels, a doughnut stone, a scraper, and some human bones (Hudson 1976).

A few other areas have yielded small concentrations of artifacts. At Santa Cruz and Santa Rosa islands, a number of stone vessels were reported in two separate sites (Hudson 1976; Morris 2000). Along the mainland coast, repeated finds have been made in two intertidal and four subtidal sites (Anderson 2000; Hudson 1976; Hudson and Howorth 1985). The remainder of finds has been widely dispersed and almost always involved single artifacts (Hudson 1976; Hudson and Howorth 1985).

Historical/cultural resources include shipwrecks, aircraft wrecks, and material associated with ocean piers. In many of the historical/cultural resources reported as total losses, some portion of the hull remains in position. Exposure to currents, tides, and sediment movements in high-energy beach and nearshore waters greatly reduce the potential of preservation, however. In addition, vessels located in shallow waters are more susceptible to commercial salvage and modern-day souvenir hunters. Submerged remains found in deep water are in a more stable environment and are in a better state of preservation. Vessels and aircraft built of metal construction have a greater potential for preservation than wood or composite (metal and wood) resources (McClelland Engineers, Inc. 1985).

Caution must be applied when reviewing casualty reports. When reporting vessel and aircraft casualties, the most prominent land area, island, harbor, or port is given as the location of the loss. This practice continues to this day. In many cases, the actual location of the loss site may be many miles from the geographic location given. Several vessels have been reported lost off Point Arguello and Point Conception, where in reality they were not lost there (Schwemmer and Gamble 2000).

Within certain regions in the Study Area, shipwrecks have concentrated in a relatively small geographic area. Point Pedernales, to the north of Point Arguello, is one such example. This region of the coast is frequently shrouded in fog, which prevented early mariners from spotting the dangers of this rugged shoreline. At Point Pedernales, several ships, representing the various coastal trades, ran aground on the treacherous reefs. The Gold Rush passenger side-wheel steamer *Yankee Blade* was lost in 1854 after striking one of the submerged rocks in fog. Just north of the point, the passenger steamer *Santa Rosa* was lost in 1911, and 20 years later another passenger steamer, the *Harvard*, became stranded. Also victims of fog were nine U.S. naval destroyers that struck the rocks in 1923. Seven warships became total losses: USS *Delphy*, USS *Chauncey*, USS *Young*, USS *Woodbury*, USS *Fuller*, USS *S.P. Lee*, and USS *Nicholas*. Ten years later, the Japanese freighter *Nippon Maru* came to rest on the rocks, a total loss. On the same day that the destroyers were stranded in 1923, the passenger-cargo steamer *Cuba* stranded in fog at Point Bennett, San Miguel Island. Point Bennett is located at the west end of the island and marks the southern boundary of the entrance into the west Santa Barbara Channel, with Point Conception marking the northern boundary. Several vessel casualties have occurred on the outlying reefs of Point Bennett. In the same year the *Cuba* was lost, the four-masted schooner *Watson A. West* stranded. The sealing schooner *Leader* was lost in 1876. The two-masted schooner *G.W. Prescott*, carrying a load of railroad ties, was lost in 1879. In 1905, another lumber carrier, the three-masted schooner *J.M. Colman*, was lost. During the filming of "Mutiny On The Bounty" in 1935, the movie barge *W.T. Co. No. 3* foundered off the point.

In more recent years, the 1957 transpacific yacht race winner *Legend* became stranded in 1967. Near Point Bennett lie the remains of still more vessels, including the three-masted schooner *Comet*, lost in 1911. Two larger steamers, the tanker *Pectan* (1914) and cargo carrier *Anubis* (1908), stranded near Point Bennett, but they were ultimately re-floated (Morris and Lima 1996). As late as 1997, the commercial fishing vessel *Lady Christine* stranded near the point and was re-floated several months later.

2.4 HISTORICAL/CULTURAL RESOURCES IN THE STUDY AREA

2.4.1 Submerged Historical/Cultural Resource Sites

2.4.1.1 Cultural History

Numerous concepts have been proposed for dividing American Indian people in this region into various cultures spanning different time periods. The designation "Arlington Springs Man," mentioned by Orr (1968) is still in use today but refers to a specific site on the northwest coast of Santa Rosa Island. This site, now known as the "Arlington Springs Woman," has been dated at 13,000 years Before Present (B.P.) On San Miguel Island, eelgrass matting from a cave was examined and found to be approximately 11,000 years old. This cave was occupied more or less continually for 11 millennia (Morris 2000). At Vandenberg AFB, within the Study Area, another site was dated at 9,000 years B.P.

These early sites represent part of what has been called the Paleoindian Period, which dates from about 13,000 to 8,500 years B.P. This is the first of six periods currently recognized by most archaeologists. During the Paleoindian Period, people lived in small groups, collecting intertidal organisms and seeds. The earliest people may have encountered island pygmy mammoths, possibly hunting them to extinction. The climate was cool and wet at this time, supporting large pine forests.

The next period, known as the Oak Grove in earlier literature, existed from 8,500 to 6,500 years B.P. This is now called the Initial Early Period or Millingstone Horizon because of the prevalence of millingstones in the archaeological record. These stones consisted of basin metates and manos (grinding stones) used for grinding seeds into meal. Intertidal shellfish supplied protein, since hunting and fishing were not particularly important. The climate remained cool and moist, with abundant pine forests.

Little is known about the Altithermal Period, which extended from 6,500 to 5,000 years B.P. During this time, the climate became considerably warmer and drier and the pine forests declined severely. The human population seems to have been markedly reduced.

The Terminal Early Period, occurring from 5,000 to 3,200 years B.P., showed many changes, heralded by increased populations, use of large stone bowls to grind acorn meal, and tools for hunting large mammals, even though shellfish remained a staple part of the diet. This culture spoke a "proto-Chumash" language. The connection of this culture to earlier cultures is unknown.

At the Channel Islands, four submerged archaeological sites yielded artifacts that Hudson dated at between 4,000 to 9,000 years B.P. (Howorth and Hudson 1993; Hudson and Howorth 1985). Along the mainland coast, eight sites produced artifacts from this same range of time. Determination of this time frame was based on two approaches: first, that these sites represented submerged village sites at locations that were once above water; second, that artifacts at these sites could be dated by comparing them with comparable artifacts recovered from terrestrial sites for which more accurate dating methods were available. Vessel types made during this time frame apparently spanned several currently accepted cultural time periods.

During the Middle Period, from 3,200 to 800 years B.P., reliance on fish and marine mammals became more significant. With the invention of the planked canoe or tomol about 2,000 years B.P., maritime activities and inter-island and island-mainland trade became far more prolific. During the same time, coastal communities flourished. Two droughts resulted in decreased resources and increased warfare between various groups in the region.

The Late Period extended from 800 years B.P. to the missionization of the Chumash. This period was marked by increases in fishing activities, notably in the netting of sardines. Terrestrial animals and plants supplemented the marine diet. Selective burning of coastal plant communities augmented seed production. Money made from purple olive shells (*Olivella biplicata*) helped support coastal communities through trade during lean times although territorial disputes often led to warfare. The name Chumash is derived from the word meaning "makers of shell bead money."

The majority of artifacts discovered in the Study Area represent these last three periods (Howorth and Hudson 1993; Hudson 1976; Hudson and Howorth 1985). This perhaps is not surprising, given that some artifacts are becoming marine even today and that submerged artifacts of great antiquity seem to be comparatively scarcer, as are terrestrial artifacts of great age.

From 1772 to 1822, the Chumash were brought to the missions, profoundly altering their way of life. (The last island Indian, the famous Lone Woman of San Nicolas, was brought to Santa Barbara in 1853. She was Nicoleño, however, not Chumash.)

2.4.1.2 Theories Explaining the Presence of Historical/Cultural Material Underwater

Hudson and Howorth (1985) reviewed ten different possible explanations for the presence of submerged historical/cultural resources:

- Ceremonial deposition;
- Anchors (fishing stations);
- Eustatic changes;
- Cliff erosion;
- Material washed out to sea from coastal streams;
- Earthmoving activities;
- Random loss;
- Cairns;
- Ballast; and
- Coastal subsistence.

Hudson concluded that the first four of these theories were feasible for this region and added "unknown" as a fifth category. He did acknowledge that some of the other theories could be applicable in certain circumstances. For example, intertidal archaeological finds in the vicinity of the Santa Barbara Harbor ceased after the harbor was built and the area became covered with sand as a result of the altered coastline. He also acknowledged that material could have been randomly lost, jettisoned, or sunk from watercraft, including cargoes as well as ballast. This theory was included in a later study (Howorth and Hudson 1993).

Regarding ceremonial deposition, Hudson believed that "supervessels," huge stone vessels up to a meter or more in height, may have been deliberately dropped into the sea. Two such vessels were reported off Anacapa Island, one off Santa Cruz and another off San Miguel. In addition, a concentration of small vessels was found in at least one site off Santa Rosa Island (Howorth and Hudson 1993). Finally, aggregates of stone vessels have been found in at least five sites immediately east of Point Conception, which was known to be sacred to the Chumash (Hudson 1976; Hudson and Howorth 1993). A charmstone was also found in the same area (Hudson 1979; Hudson and Howorth 1985). Six grooved stones, probably representing net anchors, have been found at two mainland coast sites east of Point Conception (Hudson 1976; Hudson and Howorth 1985).

Eustatic changes may account for artifacts found in deeper water representing earlier periods. At the end of the last ice age some 18,000 years ago, huge volumes of water were released as the ice melted, literally raising global sea levels. This process continued until 2,000 to 3,000 years ago (Howorth and Hudson 1993; Hudson 1976; Hudson and Howorth 1985). Coastal village sites representing earlier periods were likely submerged as sea levels rose. Projections of ancient coastlines, established by radiocarbon-dating marine organisms, have been made for the Holocene (12,000 years B.P. to the present). Artifacts found along what is believed to be ancient shorelines were compared to those in dated terrestrial archaeological sites. Hudson concluded that nine sites along the mainland coast and four sites at the islands represented submerged village sites (Hudson 1976; Hudson and Howorth 1985).

As mentioned earlier, erosion of coastal bluffs, both at the Channel Islands and along the mainland coast, undoubtedly results in archaeological material falling into the sea. At least three sites along the mainland coast and two at Santa Cruz Island were the result of erosion (Howorth and Hudson 1993; Hudson 1976; Hudson and Howorth 1985;). Such sites are probably grossly under-reported.

2.4.1.3 Distribution of Submerged Historical/Cultural Resource Sites

A total of 18 submerged historical/cultural resource sites exists off the four northern Channel Islands: three off Anacapa; seven off Santa Cruz; three off Santa Rosa; and five off San Miguel (Howorth and Hudson 1993). A number of artifacts have been recovered from these sites, while others have been reported and left in place. Again, the number of marine archaeological sites caused by erosion is likely to be grossly under-reported, particularly at the Channel Islands, where few people walk the beaches at low tide.

Along the mainland coast of the Study Area, 35 sites exist (Hudson and Howorth 1985). Again, it is likely that marine archaeological sites caused by erosion are under-reported, especially in areas characterized by cliff retreat from erosion. Numerous middens on top of coastal bluffs can be found west of Santa Barbara to the northern limit of the Study Area.

Detailed discussions of both Channel Islands and mainland sites can be found in three documents (Howorth and Hudson 1993; Hudson 1976; Hudson and Howorth 1985).

2.4.2 Submerged Historical/Cultural Resource Sites

2.4.2.1 Shipping History

Submerged historical resources in the Study Area date back to Spanish occupation (1769–1821), through the Mexican period (1822–1846) and into this century. Explorer Juan Rodriguez Cabrillo in 1542 to 1543 made the earliest recorded exploration of this region. Vessel losses for the period have not been documented and are left to speculation by historians, who believe Cabrillo's ship *Victoria* may have grounded briefly at one of the islands. Manila galleons sailed through the area on their southern voyage from northern California to Mexico between 1565 and 1815. During this period at least 10 galleons were lost, their locations still unknown, with the possible exception of the *San Augustin* lost in 1595 in Drakes Bay near San Francisco. It was rumored a galleon was lost off Point Bennett, San Miguel Island, but this has not been substantiated. At the turn of the eighteenth century, ships engaged in the sea otter fur trade hunted at the Channel Islands and mainland coast near Santa Barbara. As the sea otter population became depleted, seals were then hunted for their furs (Morris and Lima 1996). Vessels in the hide and tallow trade frequently called at the Santa Barbara settlement to export the cargo. At least six vessels during the period 1819 to 1846 (pre-American occupation) were reported as lost in the Study Area.

2.4.2.2 Explanation of Vessel Losses

Table C-19 indicates a rise in the rate of casualties reported during the California Gold Rush period (1849 to 1856). This was based on an increase in steam and sailing vessel activity passing through the region and western expansion. Pre-Gold Rush (before 1849) records of casualties are more difficult to locate, therefore the representation of shipwrecks from this earlier period is less accurate.

Table C-19
Total Number of Vessel and Aircraft Casualties Reported Within the Study Area

	Total Loss	Non-Total Loss
1810 - 1819	2	0
1820 - 1829	0	2
1830 - 1839	1	0
1840 - 1849	4	0
1850 - 1859	8	0
1860 - 1869	2	0
1870 - 1879	11	0
1880 - 1889	9	3
1890 - 1899	16	0
1900 - 1909	18	4
1910 - 1919	19	11
1920 - 1929	31	35
1930 - 1939	31	17
1940 - 1949	80	7
1950 - 1959	44	9
1960 - 1969	64	4
1970 - 1979	52	7
1980 - 1989	103	9
1990 - 1999	77	7
2000 -	2	0
Total(s)	**574**	**115**

Notes: Listed by decade from 1810 to 2000. Does not include reported losses where no vessel or aircraft name was available.

The next increase in vessel losses occurred during the 1870s. This was attributed to the increase in commercial fisheries and the transportation of lumber products for building material to southern ports. Lumberyards were established in Santa Barbara, Ventura, and San Pedro during this period (Cox 1974). The expanding railway system also required lumber products that were shipped south from the lumber mills of northern California and the Pacific Northwest. The seagoing lumber trade in the Pacific is one of the most significant and long-lasting maritime economic developments, continuing well into the twentieth century (Gearhart *et al.* 1990). Vessels engaged in island commerce date back to nineteenth century sheep and cattle operations. Today, vessels still travel to the islands, providing public transportation for national park and sanctuary visitors, and employees of island operations.

American military vessels representing the U.S. Coast Survey (renamed the U.S. Coast and Geodetic Survey in 1878) and the Revenue Cutter Service (now the USCG) called at Santa Barbara during the 1850s. In 1849, the three-masted naval auxiliary steam bark *Edith*, en-route to Santa Barbara from Sausalito to transport representatives to the California State Constitutional Convention, was lost at San Antonio Creek, just north of Purisima Point (Schwemmer and Gamble 2000). The *Edith* represents the earliest American steam and naval vessel lost in the western United States and is located in the Study Area. The *Edith* was designed with an Ericsson telescoping propeller shaft; this shipwreck may provide the only surviving artifact of this kind (Nevitt 1941).

During the late nineteenth century, naval vessels frequently called at the ports of San Diego and San Francisco, transiting the nearshore waters between these ports. The protected waters of the Santa Barbara Channel were regularly used for sea trials by military vessels, as in the case of the battleship USS *Oregon* in 1896 (Tompkins 1966). From World War II to present, military aircraft from local bases on the mainland and offshore islands have been flown over the channel for training operations. Both military and civilian aircraft have been lost in the Study Area, including the recent Alaska Airlines crash in early 2000. Military vessel operations still continue in the Santa Barbara Channel, south of the Channel Islands and to the north of Point Conception. This region is currently part of the Naval Air Warfare Center Weapons Division, Point Mugu Sea Range (U.S. Navy 1999). The most recent shipwreck associated with these military operations was the stranding of the USS *Hostile Method 9* in 1999 at Government Point, just south of Point Conception.

In modern times, even with the advent of electronic navigational systems, there has been an increase in the number of casualties, mostly due to errors in judgment, uncharted hazards and unseaworthy vessels. These high numbers are also associated with an increase in recreational vessel use and a heightened awareness of reporting vessel losses by the USCG (Schwemmer and Gamble 2000). Although modern casualties do not represent historic resources, unless the vessel or aircraft was built over 50 years ago or had a unique design, each wreck still reflects the maritime historical landscape of this Study Area. Also, over time such wrecks could become of historic interest. Vessels lost in recent years may represent one-of-a-kind design features unique to this region, not unlike earlier island vessels designed and built for oceangoing cattle transportation. Military surplus vessels from the World War II era are still engaged in commercial coastal work and represent design features unique to a period more than 50 years ago.

2.4.2.3 Distribution of Submerged Historical Resource Sites

The number of shipwrecks and aircraft in the Study Area represents diverse historic resources (Table C-20). These craft were engaged in coastal, military, and in some cases, international trade. Shipwrecks can reflect transitions in construction methods and ship architecture, ranging, for example, from small wooden sloops to steel-hulled, fully rigged sailing vessels. The wooden-hull passenger steamer *Winfield Scott,* built in 1850, and the steel-hulled *Cuba,* built in 1897, are good examples of the evolution of steam propulsion and advancements in hull design over just a 47-year period. The *Winfield Scott* was powered by two side-lever steam engines driving two paddle wheels, whereas the *Cuba* was powered by two triple-expansion engines driving two propellers. Both vessels were engaged in the passenger and cargo trade between Panama and San Francisco and both were owned by the Pacific Mail Steamship Company at the time of their loss (Schwemmer 2000b).

Table C-20
Historic Vessels in the CINMS

Name	***Aggi***	***Comet***	***Cuba***	***Goldenhorn***
Type	Steel full-rigged sail	Wooden schooner	Steel propeller	Iron bark sail
Built	1894	1886	1897	1883
Lost	1915	1911	1923	1892
Historic Theme	International grain trade	Lumber carrier	Cargo-passenger	Bulk cargo carrier
Gross Tonnage	1,898	429	3,168	1,914
Length*	265	144.6	308	268.6
Breadth*	39.1	35.2	42	40.2
Depth of Hold*	23.1	11.4	24.7	23.7

Note: *Dimensions in feet.

Artifacts located at submerged shipwreck sites, such as personal items or tools, provide valuable information about the crew and passengers who once sailed aboard these vessels. Further, shipwrecks can provide insight into the regional commerce of not only the Study Area, but sometimes, international trade (Terrell 1995). Documented submerged shipwrecks and aircraft can be pinpointed to a given day, providing optimal time capsules for archaeologists and historians to study. Submerged land use sites, such as landings, piers, and wharves, can provide historians with valuable information on the broader context of regional, national, and international commerce.

2.4.2.4 Shipwrecks of Historic Importance

Collectively and individually, certain land use sites, shipwrecks, and aircraft in the Study Area are of national historic significance. To date, however, the only two shipwrecks in the Study Area to be nominated and to receive a listing on the National Register of Historic Places (NRHP) are the California Gold Rush era side-wheel steamers *Winfield Scott* and *Yankee Blade* (Delgado 1992).

For a shipwreck to be eligible for listing, the vessel must be significant in American history, architecture, archaeology, engineering, or culture; and possess integrity of location, design, setting, materials, and workmanship. It may also evoke an aesthetic feeling of the past. The association of the vessel to its setting can also be important. The shipwreck should meet one or more of the four NRHP (2000) criteria:

1. Be associated with events that have made a significant contribution to the broad patterns of our history;

2. Be associated with the lives of persons significant in our past;

3. Embody the distinctive characteristics of a type, period, or method of construction, represent the work of a master, possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction; and

4. Have yielded, or may be likely to yield, information important to prehistory or history.

Grouping shipwrecks into a Maritime District rather than as individual sites is another possibility. Maritime Districts make up a geographically definable area possessing a significant concentration, linkage, or continuity of maritime sites, buildings, structures, or objects united by past events or by plan or physical development (Delgado 1992).

The shipwrecks in the Sanctuary (Table C-20) may meet the criteria for listing on the NRHP.

The following accounts briefly describe the history of each ship and its historic importance:

Aggi: Mackie and Thomson built the three-masted full-rigged ship *Aggi* in 1894 at Glasgow, Scotland. This steel-hulled vessel was originally christened *Seerose*, which was later changed to *Sant' Erasmo*, then renamed *Apise*. At the time of loss, *Aggi* was owned by the Norwegian firm of B.A. Olsen and Son.

With a cargo of barley and beans, the *Aggi* departed San Francisco on April 29, 1915, under tow by the steamer *Edgar H. Vance*. En route for the Panama Canal to later sail on to Malmo, Sweden, the two vessels encountered a severe storm, which caused the towing hawser to part. The steamer limped back to San Francisco, leaving the *Aggi* on its own. The cargo shifted, putting the lee rails under water and submerging half the bunks in the forecastle. Although an effort was made to reach Santa Barbara, the vessel was unmanageable and struck Talcott Shoal, Santa Rosa Island. The remains of the *Aggi* lie at the top of the shoal and are scattered into deeper water.

National Register Consideration: The shipwreck site of the *Aggi* represents European advancements in the introduction of steel constructed sailing vessels over iron or wood, in the late nineteenth century. *Aggi*'s final career represents this nation's international grain trade after the opening of the Panama Canal.

Comet: The three-masted lumber schooner *Comet* was built in 1886 at the Hall Brothers' shipbuilding firm at Port Blakely, Washington. It was built of Douglas fir with the exception of its hardwood stem- and sternposts, and had an elliptic stern and billet head. It was equipped with a centerboard and had one deck. Like many of its contemporaries, it was fitted with bow and stern ports for loading lumber. During the *Comet*'s 25-year career, it delivered lumber to many coastal ports along the west coast (Russell 1996).

The *Comet* departed Aberdeen, Washington, destined for San Pedro, with its holds full and decks covered with a cargo of 500,000 board feet of lumber. On August 30, 1911, at 8:00 p.m., while sailing in heavy seas with a thick fog, the *Comet* struck Wilson Rock, 2.5 miles northwest of Harris Point, San Miguel Island. After the vessel struck the rock, it drifted with the current toward San Miguel Island. The crew lowered the sails to ease the strain, then grounded the schooner in Simonton Cove.

Today, the complete bow section of the *Comet* lies partly buried in the sand along the high tide line. The bow section is in a remarkable state of preservation and is possibly the only example of a Hall Brothers-built vessel (Schwemmer 2000a).

National Register Consideration: The *Comet*'s hull design is unique to nineteenth-century Pacific Coast-built lumber schooners, with heavily-fastened, over-built construction of Douglas fur timbering, lumber loading ports, a beamy, shallow hull, and fore-and-aft rigging. The three-masted lumber schooner *C.A. Thayer* was also employed in the Pacific lumber trade and is now a floating historic vessel moored at the National Maritime Museum in San Francisco. Both the *Comet* and *C.A. Thayer* have similar design features, with the *Thayer* representing construction features of shipwright Hans Bendixsen at Fairhaven, California.

Cuba: The German-designed and built steamer *Cuba* was launched as the *Coblenz* at the Hamburg shipyard of Blohm and Voss on March 18, 1897. Blohm and Voss, which survived two world wars and is still in existence today, is recognized for building vessels such as the German battleship *Bismarck* and the sailing vessel *Horst Wessel*, now known as the USCG training ship *Eagle*. *Coblenz* was originally built for the Norddeutscher Lloyd of Bremen as an oceangoing passenger steamer and served this line until seized as a World War I prize in the Philippines. It was admitted to American registry under a joint resolution of Congress on May 12, 1917 and given the name *Sachem*. Pacific Mail Steamship Company purchased the *Sachem* and later changed its name to *Cuba*. Ultimately, the steamer was put on the Panama - San Francisco route. *Cuba*'s power plant consisted of two triple-expansion steam engines, which delivered the relatively high revolutions required to drive the twin propellers (Schwemmer 2000b).

In the early morning darkness of September 8, 1923, the *Cuba* was northbound en route from the Panama Canal to San Francisco. In thick fog for 3 days, the ship navigated blindly up the coast, which led to its stranding on the treacherous reefs of Point Bennett, San Miguel Island. There was no loss of life. The passengers boarded lifeboats and were picked up by passing ships.

The shipwreck site offers an opportunity to study late nineteenth-century ship construction and propulsion design. The triple-expansion steam engines sit upright 14 feet off the sea floor, with the Scott boilers still positioned in front of the engines. The *Cuba* is the most compact and organized of all the major shipwrecks in the sanctuary, with much of its deck equipment in place (Morris and Lima 1996).

National Register Consideration: The shipwreck site of the *Cuba* represents vessels seized in World War I and put into American passenger and cargo service. The *Cuba*'s builder, Blohm and Voss, is still internationally recognized for its achievements in the development of vessels, submarines, and aircraft.

Goldenhorn: The four-masted bark *Goldenhorn* was built for J.R. de Wolf and Son by Russell and Company of Greenock, Scotland, in 1883. The iron-hulled vessel was originally ship-rigged.

On the evening of September 12, 1892, the *Goldenhorn* was en route from Newcastle, New South Wales, Australia, to San Pedro, California, with coal destined for the Southern Pacific Railroad Company. Encountering thick fog off Santa Rosa Island, the bark was becalmed and driven ashore by a strong current and swell at 8:00 in the evening (Schwemmer 1999). The shipwreck scatter of the *Goldenhorn* lies off the southwest coast of Santa Rosa Island. Mapping of this site was started in 1985, and three separate scatters of wreckage were identified, including an 83-foot section of bottom hull (Morris and Lima 1996).

National Register Consideration: The shipwreck site of the *Goldenhorn* represents the European coal trade during America's railroad expansion in the late nineteenth century. Artifacts associated with the shipwreck *Goldenhorn* were used in the establishment of fishing camps during Chinese occupation of Santa Rosa Island.

Within the Study Area but outside Sanctuary boundaries lie a number of shipwrecks of historic significance (Table C-21). Several of these qualify for consideration on the NRHP. Collectively, shipwrecks in the vicinity of Point Pedernales could be included in a Maritime District.

Table C-21
Historic Vessels in the Study Area but Outside the Sanctuary

Name	***Edith***	***Gosford***	**USS *McCulloch***
Type	Wooden aux. steamer	Wooden bark	Composite aux. steamer
Built	1844	1892	1897
Lost	1849	1893	1917
Historic Theme	Naval aux. steamer	Cargo: collier	Naval aux. steamer
Gross Tonnage	407	2,251	869
Length*	121	281.6	210
Breadth*	26.3	42.3	33.4
Depth of hold*	14	24.4	17.1

Note: *Dimensions in feet.

The following accounts briefly describe the history of each ship and its historic importance:

Edith: The three-masted auxiliary steamer bark *Edith* was built in 1844 by Samuel Hall, of East Boston, Massachusetts, for Robert Bennett Forbes. To augment its sail propulsion, it was powered by a John Ericsson-designed, Delamater Iron Works steam engine with a single propeller and shaft. The shaft penetrated the hull at one side of the sternpost. The propeller was carried on a pivoted bracket that could be swung sideways and upward to lift the propeller out of the water. It was built for the opium trade, which was legal then, but lay idle in China because the British underwriters refused to insure it, fearing that the heat from its furnaces would damage the opium. Consequently, the machinery was dismantled and the *Edith* sailed back to America, where the equipment was put back into working order. The *Edith* was purchased by the War Department and was engaged in transporting General Winfield Scott and his troops to the Mexican War (Nevitt 1941).

On March 3, 1849, under Congressional legislation, the *Edith* was transferred to the Department of the Navy and turned over to Commodore Thomas Catesby Jones, Commander-in-Chief of the Pacific Squadron at San Francisco. Lieutenant James McCormick was ordered on 16 June to report on the condition of the steamer. Subsequently, he was placed in command, with orders to transport representatives to the California State Constitutional Convention. En route from Sausalito to Santa Barbara, the *Edith* encountered dense fog on August 23, 1849, grounding south of Point Sal (U.S. Navy 1977).

National Register Future Consideration: Although the site of the *Edith* has not been located, contemporary research provides good documentation on its probable location. The site of the *Edith* would represent the oldest-known steamer and naval vessel to be lost on the west coast of America and may represent the only known Ericsson-designed telescoping propeller shaft.

Gosford: The shipyard of Scott & Company at Greenock, Scotland, built the four-masted, steel-hulled bark *Gosford* in 1892.

In November 1893, *Gosford* was en route from Birkenhead, England, to San Francisco with a cargo of coal. When it was about 300 miles off the California coast, its cargo erupted in fire, an event not uncommon with coal. According to Lloyd's Survey Handbook (1956), all classes of coal are liable to spontaneous combustion and therefore require adequate ventilation of holds. The crew made attempts to extinguish the fire without success as the *Gosford* neared Point Conception. The steam-schooner *Caspar* arrived on the scene and offered to take the bark in tow. Captain William Chatman accepted. The

Gosford was towed to Cojo Anchorage, just southeast of Point Conception. On November 22, 1893, even with other vessels arriving on the scene to render assistance, the *Gosford* succumbed to the fire and foundered at Cojo. Portions of the steel hull and some of its cargo of coal still exist at the site (Schwemmer and Gamble 2000).

National Register Consideration: The shipwreck site of the *Gosford* represents sailing vessels engaged as colliers in the international coal trade during the American industrial revolution.

USS McCulloch: This ship was built in 1897 by William Cramp and Sons of Philadelphia for the Revenue Cutter Service (now the USCG). It was ranked as a first-rate vessel in the Revenue Service in 1898. Its assigned status was "cooperating with Navy" (Revenue Cutter Service 1898). The *McCulloch* was originally rigged as a two-masted barkentine driven by a triple-expansion steam engine. Its composite steel hull was planked with wood. It was the largest revenue cutter of its time (Canney 1995).

The *McCulloch* was on its shakedown cruise at Malta when word was received that the *Maine* had been sunk in Havana Harbor, Cuba. The *McCulloch* was ordered to join Commodore Dewey's Asiatic Squadron, then at Hong Kong. Its white hull was painted gray and additional guns were added. The *McCulloch* arrived at Manila Bay with other ships and silenced a Spanish shore battery. Commodore George Dewey had won a decisive victory, with no losses. As the *McCulloch* sailed for Hong Kong, news was received that the Spanish fleet had been destroyed (Gurney 1973). Transferred to the Navy on April 6, 1917, the *McCulloch* was assigned to patrol operations along the Pacific Coast (U.S. Navy 1969).

On June 13, 1917, the passenger steamer *Governor* was moving forward at a cautious speed through dense fog when its lookout discovered the approaching USS *McCulloch*. The *Governor*'s alarm was sounded just before the two vessels collided off Point Conception. The *Governor* struck the starboard bow of the *McCulloch*, making a large hole, which caused water to pour in so fast that the vessel sank in 35 minutes. The *Governor* took aboard the Navy crew of 110, including one sailor with serious injuries (*Los Angeles Times* 1917).

National Register Future Consideration: Remote sensing surveys of this region have identified the probable submerged site of the USS *McCulloch* (Hunter 1999). *McCulloch*'s naval career played a significant role in American history as part of Commodore George Dewey's Asiatic Squadron.

3.0 APPENDIX C - REFERENCES

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