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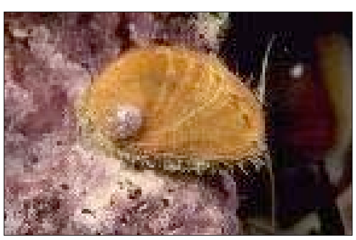
ASSESSMENT OF COASTAL WATER RESOURCES AND WATERSHED CONDITIONS AT CHANNEL ISLANDS NATIONAL PARK, CALIFORNIA

Dr. Diana L. Engle



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Assessment of Coastal Water Resources and Watershed Conditions at Channel Islands National Park, California

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WATER RESOURCES DIVISION

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EXECUTIVE SUMMARY

Channel Islands National Park (Park) was created in 1980 and comprises five islands off the coast of southern California (San Miguel, Santa Rosa, Santa Cruz[1], Anacapa, and Santa Barbara Islands) and the marine environment surrounding them from shore to 1 nautical mile seaward. The Northern Channel Islands (San Miguel, Santa Rosa, Santa Cruz and Anacapa Islands) are separated from the mainland by the Santa Barbara Channel. A major international shipping lane traverses the channel and 19 active offshore oil and gas platforms are located in the channel between Point Arguello to the east and Point Mugu to the west. The waters surrounding all five islands of the Park, from the mean high tide line to six nautical miles offshore, constitute the Channel Islands National Marine Sanctuary (Sanctuary), which is administered by the National Oceanic and Atmospheric Administration (NOAA). Subsets of Sanctuary waters are State Marine Reserves (SMRs), in which commercial and recreational fishing are prohibited, or State Marine Conservation Areas (SMCAs), in which limited recreational and/or commercial take is allowed. The SMRs and SMCAs include Park waters. Coastal cliffs, rocky intertidal habitat, sandy beaches, and small embayments make up the islands' coastlines. The nearshore marine environment consists of offshore pinnacles and islets, rocky reefs, kelp forest, eelgrass beds, and soft (mostly sandy) bottom. Anacapa and Santa Barbara Islands have no freshwater features. Freshwater features on the other islands include springs, streams, vernal pools, small coastal wetlands, and small lagoons.

This report is a cooperative effort between the Marine Science Institute, University of California Santa Barbara, and the National Park Service, and provides a summary of the current status of aquatic resources (freshwater and marine) at Channel Islands National Park. The purpose of this report was to examine existing information pertaining to water quality, the condition of aquatic habitats and their biota, sources of point and non-point pollution in the region, avenues of transport of pollutants to Park waters, and threats to aquatic resources stemming from consumptive and non-consumptive uses of Park habitat. In addition, the report identifies current information gaps and makes recommendations for addressing them.

Owing to the availability of freshwater, Santa Cruz, Santa Rosa and San Miguel Islands supported permanent settlements of Chumash Indians dating back further than 10,000 years ago. Starting in the 1800s, the islands were occupied by ranchers and farmers and used for the rearing of sheep and cattle. This activity (and the introductions of rabbits on Santa Barbara I., feral pigs on Santa Cruz I., and elk and mule deer on Santa Rosa I.) profoundly altered land cover on the islands, causing significant upland erosion, damaging riparian zones, replacing much of the native vegetation with introduced grasses, invasive weeds, and non-native trees (such as *Eucalyptus*). During the past 40 years, sheep, cattle, and rabbits have been removed from the islands, eradication of non-native vegetation and feral pigs is underway, and native vegetation and normal stream function is returning in the Park[2]. Although the Park is large, its remote location (~24 km from the mainland to Anacapa I.), and limited public transportation (only two concessionaires land visitors on the islands) keeps visitation low. Annually, about 30,000 visitors land on the islands, and another 60,000 visitors enter the Park only via boat. Popular

[1] Only the eastern 24% of Santa Cruz Island is included in the Park; the remainder is owned by The Nature Conservancy. However, the marine habitat surrounding the entire island is included in the Park.
[2] Stream function has only been formally studied on Santa Rosa Island.

activities at the Park are whale watching, diving, fishing, kayaking, sailing, surfing, camping and hiking.

The Park's rocky intertidal habitat, soft bottom subtidal habitat, subtidal reefs, and kelp forests support well over one thousand species of macroalgae, invertebrates, and fish. The islands straddle the transition zone between two major marine biogeographic zones (Oregonian and Californian). This geographical feature, and the fact that the Santa Barbara Channel is invaded by typically more tropical species of fish and invertebrates during strong El Niños, conspire to increase the overall diversity of marine biota within the Park.

The Park provides habitat and breeding grounds for a diverse array of marine mammals and seabirds, many of which are federally listed threatened or endangered species. Eleven seabird species commonly breed in the Park, and the islands are crucial breeding grounds for two species in particular: the endangered California brown pelican (*Pelecanus occidentalis californicus*), and Xantus's murrelet (*Synthliboramphus hypoleuca)*. California brown pelicans currently breed at several locations in the Park, but nowhere else on the Pacific coast of the United States. Xantus's murrelets are considered a California species of special concern and are one of the ten rarest seabird species in the North Pacific. Six species of pinnipeds haul out on Park beaches and use Park waters. The four most abundant are the California sea lion, northern elephant seal, Pacific harbor seal and northern fur seal, all of which breed in the Park. Northern (Steller) sea lions and Guadalupe fur seals are observed very infrequently, although Steller sea lions used to breed on San Miguel I.. Ribbon seals have been observed in the Sanctuary on rare occasions. The westernmost beach on San Miguel I., Point Bennett, is the only place in the world where up to six different species of pinnipeds can be found. Thirty-three species of cetaceans have been reported in the Sanctuary. Federally listed endangered cetacea that visit Sanctuary waters (and presumably deeper Park waters) are the Northern right whale, the sperm whale, the blue whale, fin whale, sei whale, and humpback whale.

Since the mid 1980s, monitoring programs for rocky intertidal habitat, kelp forest, sand beaches, lagoons, and sea birds, have been in place at the Park. Pinniped colonies are monitored by the National Marine Fisheries Service, which has jurisdiction over them. The Sanctuary records sightings of cetaceans during weekly overflights as part of the Sanctuary Aerial Monitoring Spatial Analysis Program (SAMSAP).

Notable trends for marine taxa at the Park, and presumed causes (in parentheses), include:

- collapse of black abalone (fishing and disease)
- same, for white abalone - a federally endangered species (fishing)
- near disappearance of ochre sea stars, and declines of other sea stars, during recent El-Niños (bacterial disease)
- elimination of eelgrass beds at Anacapa Island (feeding fronts of white urchins)
- declines in numbers of warty sea cucumbers (mostly commercial harvest)
- declines in harvestable sizes of red urchins (commercial harvest)
- purple urchin population explosions, creating urchin barrens (trophic cascade related to lobster fishing [near term] and loss of sea otters [longer term])
- appearance of a wasting disease affecting purple sea urchins (unnaturally high densities)

- El-Niño related declines in extent of kelp forest (wave damage, higher temperatures, and lower nutrients)
- increasing numbers of typically more southern fish species (regime shift, beginning in 1977)
- decreases in primary productivity and zooplankton abundance (regime shift)
- declines in pelagic sea birds (regime shift)
- declines in commercial and recreational landings, and shifts in size structure, for many nearshore and shelf finfish species (fishing pressure and regime shift)
- occasional sightings of previously locally extinct sea otters (numbers expected to increase since the California Fish & Game Department ceased to relocate Park otters in 2001).
- ongoing recovery of breeding populations of California brown pelicans, peregrine falcons and bald eagles (in concert with reduced exposure to DDT in the marine food chain)

Marine water pollution is virtually unstudied at the Park itself. Concentrations of synthetic organic compounds and trace elements in seawater at the Park have not been measured. PCBs and p,p'-DDE occur in the milk and blubber of the Park's sea lions, but are suspected to originate from fish caught at polluted sites along the mainland coast - notably, the Santa Monica Bay and the Palos Verdes Shelf. It seems reasonable to expect that at least some of the DDT that damaged the reproductive abilities of bald eagles and pelicans at the Park came from contaminated fish caught by these birds within Park boundaries. PAH metabolites were detected in one groundfish species at the Park (Pacific sanddabs) - but it is not known whether the PAHs were from natural sources (oil seeps) or anthropogenic sources (combustion-related, or from offshore oil extraction). The only direct evidence that toxicants in the water column *within the Park* are contaminating marine food chains at the Park stems from analyses of sentinel mussels conducted by the State of California or NOAA. Using this basis, the following constituents resided at least part time in the water column at the Park as recently as 2002: (1) the trace metals Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Se, Zn; (2) DDT and its metabolic byproducts; (3) PCBs; (4) PAHs (at least 23 compounds), (5) biocides such as aldrin, dieldrin, tributyltin, chlordane, lindane, mirex and their metabolic byproducts; and (6) a suite of other organic compounds such as chrysene, hexachlorobenzene, and naphthalene.

Owing to its remote location and lack of development, direct sources of anthropogenic marine water pollution within Park boundaries are, practically speaking, limited to intentional or accidental discharges (i.e., sewage, fuel, bilge water) from private or commercial vessels that use Park waters. For example, bacterial contamination - presumably from sewage releases - is observed in Park anchorages during busy weekends. Natural oil seeps within Park boundaries are a presumed, but natural, source of PAH in the water column of the Park. Other potential sources of anthropogenic water contamination are indirect. They include terrestrial runoff from the mainland (mostly during winter), polluted sediments near the mainland coast, ocean outfalls for mainland wastewater treatment plants, chemical dumps in the ocean, dredge disposal sites, produced water discharges and drilling wastes from offshore oil and gas operations, oil spills, and discharges or spills from marine vessels (including sinkings and groundings). With regard to several sources outside Park boundaries, foraging for fish (primarily) outside of Park boundaries by sea birds and pinnipeds that return to Park islands may be the principal route by which many pollutants enter the marine ecosystem at the Park. Once there, the potential exists for pollutants to circulate among the other compartments of the marine ecosystem. In this report, background information is presented for each of these potential sources of marine pollution, evidence of harmful consequences for marine biota is discussed, and the processes are examined by which distantly generated pollutants may enter the Park's marine ecosystem.

Periodic oceanographic cruises conducted by CalCOFI[3] and the University of California, Santa Barbara[4], provide time series measurements of basic oceanographic parameters (temperature, dissolved nutrients, salinity, chlorophyll-a) for stations near several of the islands. Additionally, continuous measurements of current speed and temperature are made by PISCO[5] using moored instruments near Santa Cruz I., and the Park has temperature logger data, going back to 1985 in some cases, from several kelp forest monitoring sites. No other routine measurements of marine water quality are available from the Park. Seasonal, interannual, and multidecadal variation in oceanographic parameters in Park waters are caused by natural phenomena, including seasonal (and smaller scale) shifts in ocean circulation patterns, El Niños and La Niñas, and regime shift[6]. Consequently, variation in these parameters is not indicative of anthropogenic influences at the Park, and oceanographic data are not evaluated in this report in that context. Instead, selected physico-chemical data from these research programs are used to evaluate the likelihood that mainland storm plumes, and associated pollutants, will spread across the coastal ocean far enough reach Park waters.

Commercial and recreational fishing is allowed by the State in Park waters, except in the areas included in the SMRs. The nearshore waters surrounding the islands, and especially the nearshore kelp beds, are especially well-exploited for market squid, sea urchins, sea cucumber, spiny lobster, red rock crab, rockfish (*Sebastes spp.*), and other nearshore finfish (especially California sheephead). Coastal pelagic species (such as anchovy, sardine, mackerel, and tuna), flatfish, and prawn are commercially important in the Sanctuary, but account for a smaller proportion of commercial harvest within Park waters. Recreational fishing in Park waters (via hook and line, and diving) primarily targets rockfish, barred sand bass, calico kelp bass, white sea bass, ocean whitefish, lobster, and scallops.

Fishing is implicated in the regional declines, in many cases starting in the 1970s, in the stocks of many fish and invertebrates that are harvested within Park waters. The Pacific Fisheries Management Council considers several groundfish species that occur in the Park to be regionally overfished including shelf rockfish spp. (canary, yelloweye, and widow rockfishes, cowcod, and bocaccio), lingcod, and Pacific whiting. California populations of lingcod appear to be less than 25% of their pre-1970s levels. Rockfishes (*Sebastes*) are particularly vulnerable to commercial and recreational fishing because they are long-lived (approximately 13-100 years), grow slowly, mature late (4-12 years), and have unpredictable recruitment. Declines of up to 50% have been observed in recent decades in the length and weight of some rockfish spp. taken in California. Recreational fishing dominates the take of many nearshore species (such as California scorpionfish, kelp greenlings, treefish, and calico, blue, olive, and kelp rockfishes), and recreational landings of nearshore species declined regionally by at least 65% from the 1980s to

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[3] California Cooperative Oceanic Fisheries Investigations
[4] UCSB's Santa Barbara Coastal Long Term Ecological Research Project and Plumes & Plooms Project
[5] Partnership for Interdisciplinary Studies of the Coastal Ocean
[6] *Regime shift* refers to a change in the atmosphere-ocean climate system of the North Pacific, starting in 1976, which led to an increase in mean ocean temperature (~1°C), and persistent decreases in primary and secondary production in the California Current.

the 1990s. Giant seabass have been in decline for several decades, and commercial catch is now prohibited. Catches of pelagic sharks have been in sharp decline since the 1970s. Fishing has altered the abundance and size structure of California spiny lobster populations at the Channel Islands, and populations of warty sea cucumber are also in decline in fished areas. Abalone stocks crashed in recent decades; commercial harvest has been closed in the State since 1997.

In 2003, the State designated 12 areas surrounding Park islands as Marine Protected Areas (MPAs); ten are State Marine Reserves (SMRs) and two are State Marine Conservation Areas (SMCAs). The SMRs are no fishing zones. The SMCA at Santa Cruz I. allows limited recreational fishing, and the SMCA at Anacapa I. allows limited recreational and commercial catch. The establishment of the reserves, combined with two decades of data from the Park's intertidal and kelp forest monitoring programs, has created an opportunity to evaluate whether fishing is responsible for some of the recent changes in nearshore communities at the Channel Islands (as opposed to natural phenomena, such as El Niños, and longer-scale regime shift). So far, comparison of monitoring data from inside versus outside the fishing refugia at the Park has revealed that (1) rocky reefs inside protected areas are more likely to support kelp forest than rocky reefs in fished areas, (2) harvest of lobsters indirectly increases epidemics in sea urchins; and (3) a commercial dive fishery has caused 33-83% of the declines in warty sea cucumbers at the Channel Islands.[7]

A review of the science of marine reserves, or of the anticipated ecological consequences of establishing the MPAs at the Channel Islands, is not provided in this report. Instead, an overview of commercial and recreational fishing in the Park is provided to address three questions concerning Park habitat where fishing still takes place:

(1) which Park species are harvested,
(2) where, within the Park, is fishing effort likely to be concentrated, and
(3) which regulations pertain to particular target species.

Information on statewide and local landings is used to rank commercially and recreationally harvested species. Spatial patterns of fishing effort within the Sanctuary, evaluated by NOAA shortly before the creation of the MPAs, are presented. State regulations pertaining to particular species, and groups of species, as contained in the California Code of Regulations, and the California Fish & Game Code, are assembled into tabular tools provided as Appendices. Detailed descriptions of the pertinent fisheries were available outside this report; links to these sources are provided in the body of the report and in appendices.

The freshwater resources at the Park are less well studied than the marine resources. Information about the condition of freshwater resources at the Park comes primarily from monitoring of basic water quality parameters in three streams on one island (Santa Rosa I.) starting in the 1990s, a twice-conducted study of riparian zone vegetation and hydrologic functioning for ten stream reaches on one island (Santa Rosa I.), routine water quality measurements and biological observations at three coastal lagoons on one island (Santa Rosa I.), and a one-time survey of two coastal wetlands on Santa Cruz I.. With the exception of the lagoon monitoring, these studies were motivated primarily by the need to to describe adverse affects caused by livestock grazing (streams on Santa Rosa I.), or alterations of wetland habitat (dredging, fill, grading) caused by

[7] In this case, the reserve utilized was a protected area at Anacapa Island that predated the establishment of the Anacapa SMR and SMCA.

past ranching operations (Santa Cruz I.), and to monitor recovery of stream habitat after livestock removal (Santa Rosa I.). Streams on Santa Cruz I. are virtually unstudied with respect to fauna, flora, or water quality, although they have surely been affected by the upland erosion and exotic plant invasions that accompanied the grazing of cattle and sheep in the past, and that have been exacerbated during the occupation of the island by feral pigs. Macroinvertebrate fauna and water quality in vernal pools on Santa Rosa were surveyed once, in 1995. Eighteen shallow ground water monitoring wells were installed at one of the altered coastal wetlands on Santa Cruz I. in 2005. Otherwise, groundwater is virtually unstudied in the Park. There is no logical reason to expect that groundwater quality on any of the islands has been compromised, but the influence of non-native *Eucalyptus* groves, and other non-native trees, on water balance in riparian corridors and coastal wetlands merits study.

Following cattle removal in 1998, there has been a substantial recovery of the riparian corridors on Santa Rosa I. Water quality has improved and stream beds have evolved from sediment-choked, braided channels with unvegetated banks to narrower, deeper, meandering channels with well developed floodplains and point bar development. Reestablishment of native woody riparian species has been impeded, presumably owing to a lack of seed sources in many reaches, and browsing of seedlings by the elk and deer that remain on the island. Elk and deer are slated for removal from Santa Rosa I. by 2011. Ongoing threats to freshwater resources in the Park are the spread of non-native weeds and shubs into coastal wetlands, vernal pool sites, and riparian corridors, and damage to streams and wetlands by road crossings that lack effective culverts.

Nonconsumptive use of aquatic resources in the Park include kayaking, whale watching, sailing, surfing, diving, beach and upland camping, and hiking. The Park protects important seabird and pinniped habitat through permanent and seasonal closures of certain trails, beaches, sea caves and sea cliffs. In addition, all access to offshore rocks and pinnacles is prohibited. Limited opportunities for primitive camping and hiking occur on all five Park islands. According to Park staff, kayakers, hikers and campers generally comport themselves in a manner which does not damage aquatic resources. During busy holiday weekends, illegal releases of sewage from private boats may be leading to short-term bacterial contamination in Park anchorages.

The known and suspected problems affecting aquatic resources at the Park are summarized in Table i. Recommendations for addressing information gaps are as follows:

- Continue all aspects of the Park's existing monitoring programs.
- Digitally map the coastal wetlands and lagoons in the Park.
- Rigorously monitor beaches, coastal wetlands and stream mouths for recruitment of highly invasive exotic plant species that directly affect aquatic habitats, such as *Arundo*.
- Discover the post-grazing status of vernal pools on Santa Rosa I.
- Evaluate stream function and riparian zone condition on Santa Cruz I.
- Prepare a strategy for enhancing recovery of native woody riparian vegetation on Santa Rosa and Santa Cruz Islands.
- Expand baseline data in anticipation of restoration work at Prisoner's wetland and in its watershed, Cañada del Puerto.
- Conduct a thorough survey of road crossings of water bodies.

- Better exploit sentinel mussels to map spatial variation and temporal changes in seawater contamination in the Park.
- Compare sediment loads of priority contaminants at sites within the Park reflecting different chronic exposure levels to potential sources such as ship traffic, mainland runoff, and seabird and pinniped colonies.
- Measure pollutants in the water column at the Park using moorable *in-situ* exposure samplers.
- Utilize NOAA's SAMSAP[8] data to map current patterns of fishing effort at the Park outside MPAs.
- Prioritize the synthesis of time series data from the Park's monitoring programs to discover the impacts of fishing on Park biota.

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[8] Sanctuary Aerial Monitoring and Spatial Analysis Program

Table i. Existing and hypothesized degradations of aquatic resources at Channel Islands National Park. Codes are as follows:
EP - existing problem based on direct evidence; PP - potential and likely problem; OK - not currently, or expected to be, a problem;
Shaded - evidence is lacking, limited, or indirect; ? - not enough information available to categorize threat level; blank - not applicable

	Streams/Riparian Habitat			**Vernal Pools**			**Coastal wetlands**		**Lagoons**		**Ground-water**	**Rocky inter-tidal**	**Subtidal, Reefs, & Kelp**	**Seabirds, Pinnipeds**
Stressor	S.Mig.	S.Rosa	S.Cruz	S.Mig.	S.Rosa	S.Cruz	S.Rosa	S.Cruz	S.Rosa	S.Cruz				
Water Quality														
high N & P	OK	OK	PP	?	?	?	OK	?	OK	OK	?			
Low DO	OK	OK	OK	OK	OK	OK	?	?	OK	OK				
Turbidity	?	EP	PP	PP	PP	PP	?	?	OK	OK				
Water Quantity														
Altered depth/duration of flow	PP	PP	PP	?	?	?	PP	PP	OK	OK	?			
Pollutants														
Fecal bacteria	OK	OK	PP	OK	OK	PP	OK	PP	OK	PP	OK	OK	EP[1]	
Heavy metals/trace elements	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	EP	PP	PP
Pesticides & other organics	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	EP	PP	EP
Physical Disturbance														
Feral pigs (rooting)			EP			PP		PP		PP				
Lingering effects of past cattle & sheep	PP	EP	EP	PP	EP	PP	PP	EP	PP	PP				
Dredging/fill			EP					EP						
Road crossings	OK	EP	EP				EP	EP						
Watershed erosion	PP	EP	EP				EP	EP	EP					
Other														
Non-native flora or algae	PP	EP	EP	PP	EP	PP	PP	EP	PP	PP		PP	OK	
Elk & deer browsing		EP			PP		PP		PP					
Fishing - Direct												PP	EP	
Fishing - Indirect												PP	EP	EP[3]
El Niños	PP[2]	PP[2]	EP[2]				PP[2]	PP[2]				PP	EP	EP
Regime Shift												PP	EP	EP
Absence of sea otters													EP	
Disease												EP	EP	OK

[1]Refers to bacterial contamination at anchorages

[2]Refers to El Niño related floods, erosion, and landslides

[3]Refers to disruption of nocturnal seabird activity from squid boats (although ingestion of hooks and entanglement with gear is applicable, but not addressed in this report)

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ABLM	Ambient Bay and Lagoon Monitoring Program
ASBS	Areas of Special Biological Significance
AVHRR	Advanced Very High Resolution Radiometer
Bight	Southern California Bight
BOD	Biological Oxygen Demand
BPTCP	Bay Protection and Toxic Cleanup Program
Cal EPA	California Environmental Protection Agency
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CA-SMWP	California State Mussel Watch Program
CCC	California Coastal Commission
CCR	California Code of Regulations
CF&G	California Department of Fish and Game
CFR	Code of Federal Regulations

Commission	California Fish and Game Commission
CPFV	Commercial Passenger Fishing Vehicle
CTD	conductivity/temperature/density instrument
CZMA	Coastal Zone Management Act
DDD	Dichloro-diphenyl-dichloroethane
DDE	Dichloro-diphenyl-dichloroethylene
DDT	dichloro-diphenyl-trichloroethane
DMT	Donnan membrane technique
DGT	diffusion gradient thin-film gel
DO	Dissolved Oxygen
EEZ	United States Exclusive Economic Zone
ERL	Effects Range Low
ERM	Effects Range Medium
FACs	Fluorescent aromatic compounds
FGC	Fish & Game Code
HCH	hexachlorocyclohexane
HFPLM	hollow fiber permeation liquid membranes
HU	Hydrologic Unit
JWPCP	Joint Water Pollution Control Plant
LTER	Long Term Ecological Research Project
LwN(555)	Normalized water-leaving radiance at 555 nm
MEP	Maximum Extent Practicable
MGD	Million Gallons per Day
MLPA	Marine Life Protection Act
MLMA	Marine Life Management Act
MMS	U.S. Mineral Management Service
MODIS	Moderate Resolution Imaging Spectroradiometer
MPA	Marine Protected Area
MRPA	Marine Resources Protection Act
MS4	Municipal Separate Storm Sewer System
MTRL	Maximum Tissue Residue Level
Navy	U.S. Navy
nm	nautical mile
NMFS	NOAA National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration

NOAA-MWP	NOAA Mussel Watch Project
NPDES	National Pollution Discharge Elimination System
NPS	National Park Service
NRT	Natural Resources Trustees
NS&T	National Status and Trends
OCS	Outer Continental Shelf
PAH	Polycyclic aromatic hydrocarbons
Park	Channel Islands National Park
PCB	polychlorinated biphenyl compounds
PFMC	Pacific Fishery Management Council
PISCO	Partnership for Interdisciplinary Studies of Coastal Oceans
PnB	UCSB Plumes & Blooms Project
POTW	Publically Owned Treatment Plant
ppb	parts per billion
ppt	parts per thousand
PSMFC	Pacific States Marine Fisheries Commission
psu	practical salinity unit
RWQCB	Regional Water Quality Control Board
SAMSAP	Sanctuary Aerial Monitoring Spatial Analysis Program
Sanctuary	NOAA Channel Islands National Marine Sanctuary
SCB	Southern California Bight
SCCWRP	Southern California Coastal Water Research Project
SeaWiFS	Sea-viewing Wide-Field-of-View sensor
SLC	California State Lands Commission
SRM	State Marine Reserve
SMCA	State Marine Conservation Area
SMWP	State Mussel Watch Program
SPMD	semi-permeable membrane device
SST	sea surface temperature
State Board	California SWRCB
SWMP	Storm Water Management Plan
SWRCB	State Water Resources Control Board
SWQPA	State Water Quality Protection Area
TBT	Tributyltin
TDS	Total Dissolved Solids

TNC	The Nature Conservancy
TMDL	Total Maximum Daily Load
TN	Total nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
UCSB	University of California, Santa Barbara, CA
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
WMA	Watershed Management Area

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I. PARK DESCRIPTION

A. BACKGROUND

A.1. Location and Key Features

Channel Islands National Park (Park) was created in 1980 and comprises five islands off the coast of southern California (Figure 1) and the marine environment surrounding them from shore to 1 nautical mile seaward. San Miguel, Santa Rosa, Santa Cruz, and Anacapa Islands (hereinafter, San Miguel, Santa Rosa, Santa Cruz and Anacapa) form the southern boundary of the Santa Barbara Channel (Channel), and are referred to as the Northern Channel Islands. The Northern Channel Islands are a structural element of the Western Transverse Ranges Province and are considered an extension of the Santa Monica Mountains to the south. They are a mix of volcanic and volcaniclastic sediments of Miocene age and pre-Cretaceous crystalline basement, which are typically overlain by marine and non-marine sedimentary and volcaniclastic Tertiary deposits (Dibblee 1982; Jones and Grice 1993). Santa Barbara Island (hereinafter, Santa Barbara) was formed by underwater volcanic activity, and lies south of the other islands of the Park, approximately 40 miles from the mainland. The waters surrounding all five islands of the Park, from mean high tide to six nautical miles offshore, constitute the Channel Islands National Marine Sanctuary (Sanctuary), which is administered by the National Oceanic and Atmospheric Administration (NOAA). Subsets of Sanctuary waters are State Marine Reserves (SMRs) , in which all fishing is prohibited, or State Marine Conservation Areas (SMCAs), in which limited recreational or commercial take is allowed.

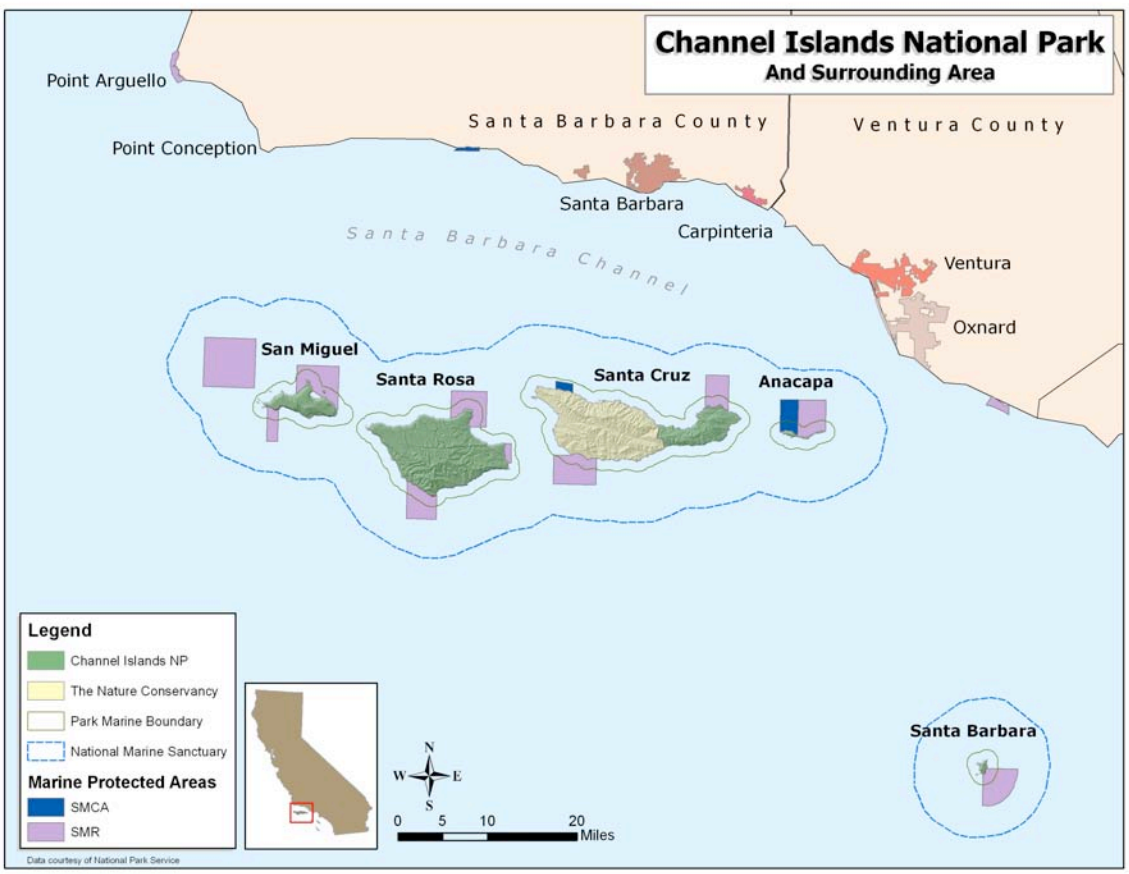


Figure 1. Channel Islands National Park and its environs.

San Miguel. Fifty-five miles from the city of Ventura, San Miguel (9,325 acres) is the farthest west of the Channel Islands. Because of its location in the open ocean, it experiences high winds and lots of fog. The island is mostly a tableland with 27 miles of jagged, rocky coastline interspersed with sandy white beaches. The westernmost of these beaches, Point Bennett, is the only place in the world where up to six different species of pinnipeds (seals and sea lions) can be found. Principal land covers on San Miguel are grassland, haplopappus scrub, coastal sage scrub, and unstabilized sand dunes (Figure 2a). The U.S. Navy owns San Miguel, however, the NPS manages the island.

Santa Rosa. Santa Rosa, the second largest of the Channel Islands (52,794 acres), is 40 miles west of the city of Ventura. It is a diverse island of grass-covered rolling hills, steep canyons, creeks, rocky intertidal areas and sandy beaches. Principal land covers on Santa Rosa are grassland, coastal sage scrub and chaparral (Figure 2b). Vail & Vickers Co., the former owners of the island, have a special use permit, that expires in 2008, to use and occupy 7.6 acres of the island, and to conduct trophy hunts for elk and deer that were introduced to the island. The Park may extend the hunts until 2011.

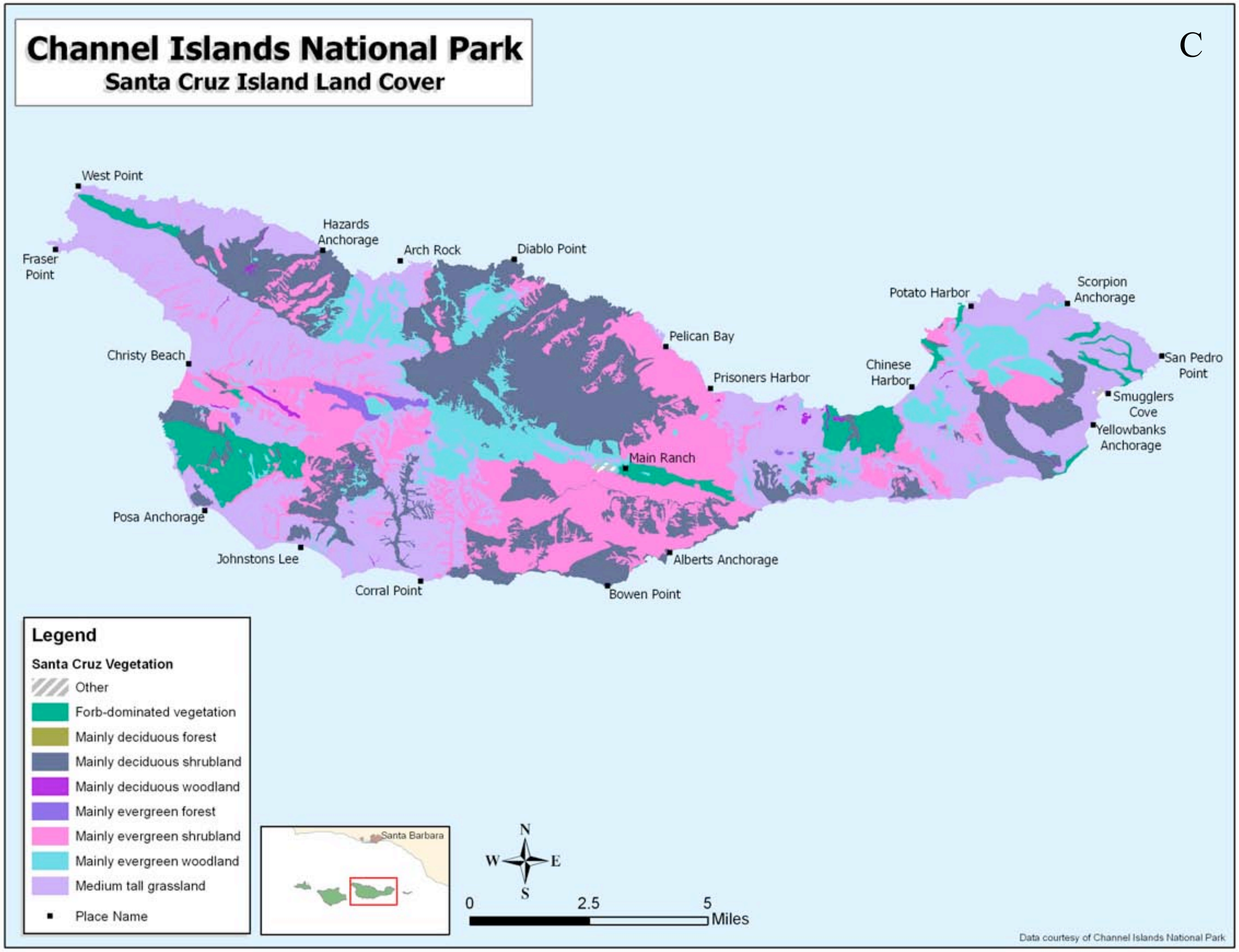
Santa Cruz. Santa Cruz is the largest of all the Channel Islands (60,645 acres), and is also the most diverse. Two east/west trending mountain ranges rise over 2000 feet above sea level creating a large central valley, many interior and coastal canyons, fresh water springs, streams, small coastal wetlands, coastal cliffs, sandy beaches, and rocky intertidal areas. Land ownership on Santa Cruz is split between the Park, which owns and manages the eastern 24% of the island, and The Nature Conservancy (TNC), which owns and manages the remaining 76% of the island. Over the past 150 years, feral sheep and pigs have dramatically affected the land cover on Santa Cruz, removing the native vegetation and contributing to high rates of erosion. Non-native plants, including highly invasive fennel, have capitalized on these disturbances, occupying between 25 to 80 percent of the island's ground cover. Today, Santa Cruz harbors at least 170 introduced plant species, making up 26 percent of the island's total flora (CINP 2002a). Principal land cover categories on Santa Cruz are grassland, and deciduous and evergreen shrubland (Figure 2c).

Anacapa. Anacapa is a chain of three small islets extending four and a half miles from east to west, and totalling 699 acres. East Anacapa is one mile long, a quarter of a mile wide, and rises 250 feet above the water. Middle Anacapa is one and a half miles long, a quarter of a mile wide and 325 feet at its highest point. Western Anacapa, the largest island of this group, is two miles long by six tenths of a mile wide, and rises to a peak of 930 feet. Important land covers on Anacapa are coastal sage scrub, grassland, island chapparal, iceplant, and *Coreopsis* dominated bluffs (Figure 2d).

Santa Barbara. Thirty-eight miles west of Palos Verdes Point, Santa Barbara (639 acres) is the smallest of the Park islands. The island is roughly triangular in outline and emerges from the ocean as a twin-peaked mesa with steep cliffs. Santa Barbara has a few narrow rocky beaches, six canyons, and a badlands area. The steep cliffs and isolation from mainland predators provide safe breeding sites for thousands of sea birds. Principal land covers on Santa Barbara are grassland, iceplant and native shrubland (Figure 2d).

Figure 2. Land cover on San Miguel Island (A), Santa Rosa Island (B), Santa Cruz Island (C), Anacapa and Santa Barbara Islands (D).

Figure 2. (continued).



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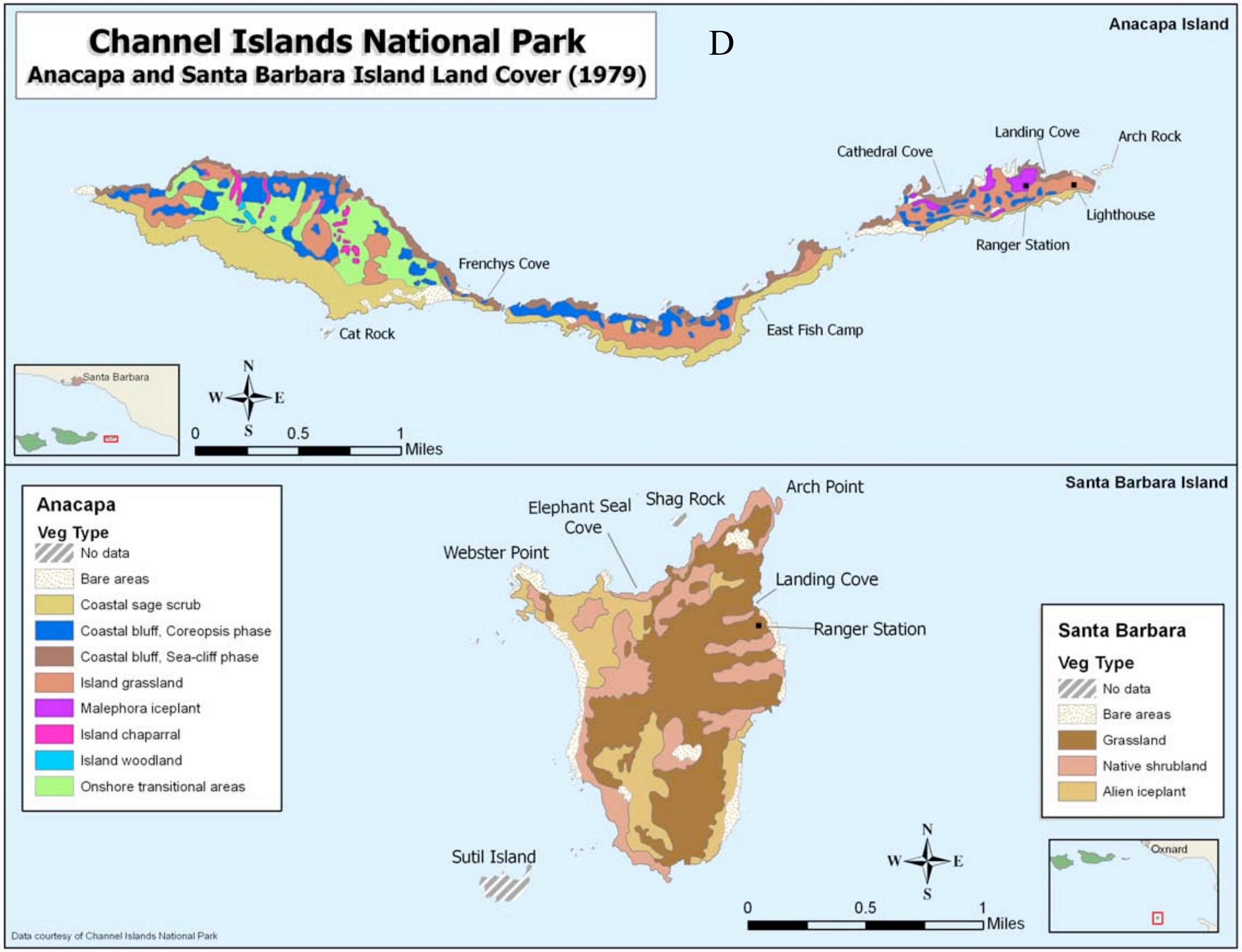


Figure 2. (continued).

A.2. Territorial Designations

Although the marine habitat of the Park is situated entirely within California state waters, the park is hydrologically and ecologically connected to both state and federal waters, and an international shipping lane. Marine jurisidictions that pertain to offshore ownership, sovereignty, mineral, fishery, and national security rights and regulatory control in and near the Park are summarized below.

State Waters

<u>State Tidelands Submerged Lands</u>

Coastal states are given ownership of lands and resources within three nautical miles (nm) of mean high tide line. State control and regulation of the development of resources such as oil and gas, and fisheries, in state waters was confirmed by the Federal Submerged Lands Act of 1953.

Federal Waters

<u>Outer Continental Shelf</u>

The Outer Continental Shelf Lands Act of 1953 confirmed federal jurisdiction over the resources beyond 3 nm from shore

<u>Territorial Seas</u>

Pursuant to a 1988 presidential proclamation, the United States asserts sovereign rights over the lands and waters out to 12 nm from shore. The rights of the States out to 3 nm from shore are not disturbed by this proclamation.

<u>Exclusive Economic Zone (EEZ)</u>

Persuant to a 1983 presidential proclamation, the U.S. asserts jurisdiction over the living and non-living resources from 3-200 nm offshore. The Coastal Zone Management Act (CZMA), which provides for the California Coastal Commission, gives coastal states substantial authority to influence federal actions beyond 3 nm from shore. (An example germaine to the Park is the California Coastal Commission's influence in the handling of offshore oil and gas leases in federal waters of the Santa Barbara Channel).

<u>Contiguous Zone</u>

From 12 to 24 nm offshore, the United States can exercise control over customs, fiscal, immigration, and sanitary matters.

<u>High Seas</u>

Beyond 12 nm from shore, the United States maintains the right to freely navigate its vessels (including war vessels).

A.3. Regulatory Bodies and Management Entities

Listed below are federal, state and local entities which exercise authority over, or have management responsibilities for, the freshwater (streams/wetlands/groundwater) and marine resources in or near the Park. Entities marked by arrows (») have mandates that extend directly into land and water *within Park boundaries*, and thus technically share management of parts of the Park with the National Park Service. Other entities either (1) manage marine species that move in and out of Park boundaries (birds, fish, marine mammals), (2) manage activities outside the Park that influence biological resources (such as fishing, recreation, oil and gas extraction), (3) manage direct discharges of wastewater into the coastal ocean, or (4) manage the quality of mainland runoff.

California State Lands Commission (SLC)

The SLC has jurisdiction over all of California's tidal and submerged lands up to 3 nm from the California shore (and the beds of naturally navigable rivers and lakes, which are not relevant to the the Park). The SLC currently has no program for offshore oil and gas leases in state waters.

California Coastal Commission (CCC)

The CCC addresses public access and recreation, natural resource protection, agricultural operation, coastal development projects, port activities and energy production. Its jurisdiction extends up to 5 miles inland from mean high tide and into the ocean up to the federal waters limit.

»NOAA Channel Islands National Marine Sanctuary (the Sanctuary)

The Sanctuary is one of four National Marine Sanctuaries offshore from California (the others are the Monterey Bay, Gulf of the Farallons, and Cordell Bank sanctuaries). The Sanctuary extends from the mean high tide line to 6 nm offshore of the five islands of the Park. The marine habitat of the Park (the first mile offshore) is fully contained within the Sanctuary. The primary purpose of the National Marine Sanctuary program is resource protection (USC Section 1431b). Prohibitions in the Sanctuary that are relevant to aquatic resources in the Park are:

1. Exploring for, developing, and producing hydrocarbons except pursuant to leases executed prior to March 30, 1981, and except the laying of pipeline (a number of stipulations regarding oil spill equipment apply to laying pipeline)

2. Discharge of Substances. Exceptions are fish, fish parts, bait, water and other biodegradable effluents incidental to vessel use of the sanctuary generated by marine sanitation devices, routine vessel maintenance (e.g., deck wash down), engine exhaust; meals aboard vessels

3. Alteration of, or construction on, the seabed (precludes drilling, dredging - but anchoring and commercial trawling is allowed)

4. Commercial vessels are prohibited within one nautical mile of an island (cargo, tankers, etc.) except to transport persons or supplies to or from an island. Does not apply to fishing (including kelp harvesting), recreational or research vessels.

5. Motorized aircraft are prohibited less than 1,000 feet over the waters within one nautical mile of any island except for enforcement purposes, to engage in kelp bed surveys, to transport persons or supplies to or from an island.

»National Marine Fisheries Service (NMFS)

NMFS is contained within NOAA, and manages the sea's living resources with the EEZ. NMFS has lead management responsibility for anadromous fisheries (salmon), sea turtles (at sea) and all marine mammals, except sea otters, walrus, manatees and polar bears (which are under the authority of the U.S. Fish and Wildlife Service [USFWS]). Seabirds are managed by the USFWS. Pinnipeds at the Park are monitored by the NMFS.

»Pacific Fishery Management Council (PFMC)

The federal government manages the marine resources and fishing activities of the United States through the Magnuson-Stevens Fishery Conservation and Management Act of 1976 and the Sustainable Fisheries Act of 1996 (now called the Magnuson-Stevens Fishery Conservation and Management Act). The purposes of the acts are to provide conservation and management of fishery resources, develop domestic fisheries, and phase out foreign fishing activity within the EEZ. Eight Regional Fishery Management Councils implement the goals of the Act in coordination with the NMFS. The PFMC manages the fisheries resources off Washington, Oregon, and California by developing Fisheries Management Plans for the EEZ. The PFMC is funded through the Department of Commerce. Management plans adopted and implemented to date include one for the:

Pacific Coast Groundfish Fishery

Pacific Coast Salmon Fishery

Coast Pelagic Species Fishery

A management plan for *West Coast Highly Migratory Species* (tunas, sharks, billfish/swordfish, and dorado (also known as dolphinfish and mahi-mahi) was partially approved in 2004. California state fishing regulations (such as the Nearshore Fishery Management Plan as it applies to groundfish species, see below) must be consistent with federal law for species managed by the PFMC.

»U.S. Fish and Wildlife Service (USFWS)

The USFWS is responsible for protecting and conserving fresh water and estaurine fisheries, certain marine mammals (southern sea otter, walrus, manatees, and polar bears), migratory birds, sea birds, sea turtles on shore, threatened and endangered species - and their habitats - for the benefit of the public. Activities of the USFWS include restoration programs; listing, protection, and development of recovery programs under the Federal Endagered Species Act for candidate species; and commenting on federal proposals and federally permitted projects. USFWS provides research and support for international negotiation regarding fisheries, migratory wildlife, and protected species.

»California Fish and Game Commission (Commission)

The Commission is not synonymous with the California Department of Fish and Game. The Commission was created by the State Constitution and is composed of up to five members, appointed by the Governor and confirmed by the Senate. The Commission meets at least eleven times each year to publically discuss various proposed regulations, permits, licenses, management policies and other subjects within its areas of responsibility. It also holds a variety of special meetings to obtain public input on items of a more localized nature, requests for use permits on certain streams, or establishment of new ecological reserves. Probably the best known responsibility of the Commission is its general regulatory powers function, under which it decides seasons, bag limits and methods of take for game animals and sport fish.

»California Department of Fish and Game (CF&G) - Marine Region

The Marine Region is responsible for protecting and managing California's marine resources under the authority of laws and regulations created by the state legislature, the Commission, and the PFMC. CF&G enforces the regulations created by the Commission. Recreational fishing regulations are provided in Fish and Game Code (FGC) Sections 7100-7400 and the California Code of Regulations (CCR), Title 14, Chapter 4. Commercial fishing regulations are provided in FGC Sections 7600-9101 and CCR, Title 14, Chapter 6. Selected code relevant to the Park is summarized in Appendices B and C.

»State Water Resources Control Board (SWRCB), California Environmental Protection Agency (Cal EPA)

The SWRCB oversees California's compliance with the Federal 1972 Clean Water Act and the California Porter-Cologne Water Quality Control Act. Through nine Regional Water Quality Control Boards (RWQCBs), the SWRCB regulates offshore drilling activities, discharges from cruise lines, and ocean dumping, and oversees the State's nonpoint source pollution, stormwater and wastewater discharge programs. Two regional boards are pertinent to the Park:

Region 3: Central Coast RWQCB

includes San Miguel, Santa Rosa, and Santa Cruz Islands, and the coastline and coastal watersheds of Santa Barbara County

Region 4: Los Angeles RWQCB

includes Anacapa and Santa Barbara Islands, and the coastline and coastal watersheds of Ventura and Los Angeles County

»U.S. Navy

The U.S. Navy owns San Miguel , but the National Park Service manages the island. The waters surrounding the Park are sometimes closed for military operations. Bechers Bay, on Santa Rosa, is a naval operating area.

»U.S. Coast Guard

The U.S. Coast Guard owns East Anacapa Island.

»Santa Barbara and Ventura Counties

San Miguel, Santa Rosa, Santa Cruz, and Santa Barbara Islands are in Santa Barbara County. Anacapa Island is in Ventura County.

»The Nature Conservancy (TNC)

TNC owns 76% of Santa Cruz . During the 1980s they eliminated feral sheep from their portion of the island, and are now cooperating with the NPS in efforts to restore native fauna and flora on the island, including the relocation of golden eagles, reintroduction of bald eagles, and eradication of feral pigs.

»University of California Santa Cruz Island Nature Reserve

The Santa Cruz Island Nature Reserve is part of the Natural Reserve System of the University of California. The Reserve is owned and managed by TNC. The Reserve has a field station in the island's central valley which includes a dormitory, kitchen, dining hall, laundry, library/conference room, wet and dry lab; four-wheel-drive vehicles; a 17-foot Boston whaler; and a 5-person inflatable boat.

U.S. Environmental Protection Agency

The U.S. EPA has no direct ocean resource management responsibilities. However, it regulates the use of tributyltin, a component of ship bottom antifoulant paint - which has adverse effects on nontarget marine life.

Minerals Management Service (MMS)

Minerals Management Service (MMS) is the Federal agency responsible for managing the nation's mineral resources offshore of the United States, commonly referred to as the Outer Continental Shelf (OCS), and for collecting and disbursing the revenues from the production of all mineral resources on federal lands, offshore and onshore. The MMS conducts environmental studies on the potential and real effects of offshore mineral development, issues offshore mineral leases to companies, and regulates the operations conducted under MMS permits on the OCS. The Pacific OCS Region of the MMS extends from the California-Mexico border to the Washington-Canada border.

International Maritime Organization

The International Maritime Organization designated the voluntary vessel traffic separation scheme to guide large vessel traffic running through the Santa Barbara Channel.

A.4. Selected Pertinent State Legislation

Marine Life Management Act (MLMA). The MLMA became state law on January 1, 1999, and grants the Commission with additional broad authority to regulate commercial fisheries. The MLMA includes a number of innovative features and goals:

Non-Consumptive Values: The MLMA applies not only to fish and shellfish taken by commercial and recreational fishermen, but to all marine wildlife. Marine life need not be consumed to provide important benefits to people, including aesthetic and recreational enjoyment as well as scientific study and education.

Conserves Entire Systems: It is not simply exploited populations of marine life that are to be conserved, but the species and habitats that make up the ecosystem of which they are a part. Rather than focusing on single fisheries management, the MLMA requires an ecosystem perspective including the whole environment. The habitat of marine wildlife is to be maintained, restored or enhanced, and any damage from fishing practices is to be minimized.

Sustainability: Rather than assuming that exploitation should continue until damage has become clear, the MLMA shifts the burden of proof toward demonstrating that fisheries and other activities are sustainable. Depressed fisheries are to be rebuilt within a specified time. The bycatch of marine living resources in fisheries is to be limited to acceptable types and amounts.

Fishery Management Plans: Rather than ad hoc and piecemeal decisions on individual fisheries, the aim is to base decisions on comprehensive reviews of fisheries and on clear objectives and measures for fostering sustainable fisheries. The vehicle for this objective is a fishery management plan.

Status of the Fisheries Report: Annually, CF&G will prepare a report on the status of California's fisheries and the effectiveness of management programs.

The Legislature called initially for the adoption of only two Fishery Management Plans, for (1) the *white sea bass fishery*, and (2) the *nearshore finfish fishery* (rules for the latter apply to state waters from shore to 1 nm from land). However, the process has led to the development of management plans, or at least electronically posted fishery data, for other taxa important in the Park: abalone, market squid, sea urchins. A draft Market Squid Fishery Management Plan was submitted to the Commission for adoption in early 2006.

Marine Resources Protection Act of 1990. This state law prohibited the use of gill nets and trammel nets to take any species of rockfish south of Point Arguello. In addition, gill nets and trammel nets cannot be used for any species in the Marine Resources Protection Zone, which includes waters within one nautical mile (or 70 fathoms, whichever is less) around San Miguel, Santa Rosa, Santa Cruz, Anacapa, San Nicolas, Santa Barbara, Santa Catalina, and San Clemente Islands (plus ocean waters within 3 nautical miles of the mainland between the Mexican border and Point Arguello).

Marine Life Protection Act (MLPA). The MLPA was passed by the State in 1999 and is codified in FGC Chapter 10.5, Sections 2850 to 2863. The purpose of the MLPA is to improve the array of marine protected areas (MPAs) existing in California waters through the adoption of a Marine Life Protection Program and a comprehensive master plan. The MLPA introduced a three-tiered system of State Marine Protected Areas (State Marine Reserves, State Marine Parks, State Marine Conservation Areas). For more, see http://www.dfg.ca.gov/mrd/mlpa/index.html.

Channel Islands Marine Protected Areas (MPAs). In 2003, a network of 10 State Marine Reserves (SMRs) (in which no fishing is allowed) and 2 State Marine Conservation Areas (SMCAs) (in which limited recreational and/or commercial take is allowed) were established by the Commission in subsets of state waters around all five of the Park islands. The MPAs extend seaward from shore, thus they include portions of the Park. The two SMCAs at the Channel Islands are (1) a recreational-only fishing zone (lobster and pelagic finfish only) off Santa Cruz straddling the site of Painted Cave, and (2) an area with limited commercial (lobster only) and recreational fishing (lobster and pelagic finfish) off Anacapa. Nineteen percent of the state waters within the Sanctuary are included in the MPAs. NOAA's National Marine Sanctuary Program is considering expanding the boundaries of the MPAs into the federal waters of the Sanctuary (see Section III.B).

A.5. Human Utilization

Santa Cruz. Santa Cruz supported sizable human populations over 10,000 years before present. By the time Europeans arrived in the late 1700s, approximately 2,000 Chumash lived on the island, at 11 coastal village sites. By 1807, however, epidemic diseases had decimated the island population. Spanish missionaries relocated the Chumash to mainland missions by 1822. The Chumash population of Santa Cruz settled primarily in and around the Spanish Missions in Santa Barbara and San Buenaventura. Physical remnants of Chumash culture are still preserved on Santa Cruz at more than 3,000 archaeological sites.

Although sea otter hunters, smugglers, and others left traces on Santa Cruz, permanent European settlement did not occur on the islands until the mid-1800s. Beginning in 1830, the island briefly served as a prison colony for 100 convicts, for whom cattle and horses were supplied, which is the first known reference to livestock on Santa Cruz (Junak et al. 1995). In 1839, the Mexican government granted title to the island to Andres Castillero, who became the first private owner of Santa Cruz. In 1853, Dr. James Barron Shaw, acting as agent for Castillero and the island's subsequent owners, the Barron and Forbes Company, began stocking the island with sheep, horses, cattle and hogs. In 1869, ten San Francisco investors purchased the island and formed the Santa Cruz Island Company. In 1870s Justinian Caire acquired the majority of the shares in the company and became sole owner of the island by the end of the 1880s or early 1890s. Caire and his descendants continued and expanded the sheep ranching and agricultural enterprises on the island.

The heart of Shaw's and (later) Caire's operation was located in the island's central valley. The operation was a largely self-sustaining community that supported a diversity of permanent and seasonal employees, which included a blacksmith, carpenters, painters, team drivers, dairymen, cooks, stone cutters and masons, gardeners, dairymen, vintners, grape pickers, sheep shearers, wagon and saddle makers, a cobbler, a butcher, a baker, and a sea captain and sailors. The main ranch and the outranches at Scorpion, Prisoner's and Christy harbors remained the primary ranches through the Caire period. The island's sheep population reached 40,000-50,000 head under Caire, their wool and meat being shipped to market from Scorpion Ranch and Prisoners Harbor. Their numbers on the island were allowed to grow fairly unchecked with periodic round-ups to shear and slaughter some of the stock. By 1875 there were an estimated 60,000 sheep on the island, only half of which could be rounded up for shearing annually (Sauer 1988). During drought years tens of thousands were slaughtered to forestall starvation. Domestic pigs were introduced to Santa Cruz in 1852 (Schuyler 1988). By 1857 pigs had escaped and become feral on Santa Cruz.

After Caire died in 1897, lengthy litigation among his heirs resulted in the island being divided among his heirs into several parcels. The western 90% (54,500 acres) was sold in 1937 to Edwin L. Stanton. Stanton attempted unsuccessfully to revive the island's sheep business, which had declined dramatically after Justinian Caire's death, and then switched to cattle ranching. He, and later his son, began a concerted effort to install fencing and to round up all the sheep on their part of the island. By the 1970's over 263,000 sheep had been captured and sent to market or slaughtered (CINP 2002a). Nevertheless, from the 1920s to the early 1980s, the island supported the largest single population of feral sheep in the world (Van Vuren and Coblentz 1989). Overgrazing led to the expansion of the native coastal prickly pear (*Opuntia littoralis*), which by 1939 had rendered 40% of the rangeland on the island unusable. Eventually biological control was used to control the *Opuntia*, and since 1951, the scale insect, *Dactylopius opuntiae* has destroyed most of the dense *Opuntia* populations on the island (Sauer 1988).

By 1978, TNC acquired a conservation easement on the Stanton holdings. By this time, tens of thousands of roving feral sheep and pigs had reduced much of the island's native vegetation to stubble or bedrock and widespread erosion led to massive landslides. In 1981, TNC began an intensive program of fencing, trapping, and hunting to remove the remaining feral sheep on the Stanton portion of the island. A fence was built to separate TNC's holdings from east Santa Cruz In early 1987, TNC became the sole owner and manager of the western 90% of Santa Cruz. Between 1981-and June 1989, 37,171 sheep had been eradicated from the western 90% of SCI (Schuyler 1993), and 1,500 cattle were removed in a 6 month period in 1988. At this juncture, the remaining herbivores on the island were feral pigs and sheep, although by now the feral sheep were largely confined to the eastern 10% of Santa Cruz.

The east end of the island remained a ranch operation until the island was converted to a private hunting, camping and recreational venture in the early 1980s. The National Park Service acquired full ownership of the east end of the island in 1997. At that time, the NPS began removing sheep within its boundary. The NPS removed 9,270 sheep from the east end between 1997 and 1999. In 2000, TNC conveyed an additional 8,500 acres to the NPS. Today TNC and the NPS own 76% and 24% of Santa Cruz, respectively. As of 2005, thousands of feral pigs occupied the island, rooting up soil, causing substantial erosion, threatening archeological sites, and facilitating the spread of fennel, an invasive weed. Golden eagles, which fed on feral pigs and which were encouraged by the disappearance of bald eagles from the Channel Islands, proceeded to hunt the endemic island foxes to the brink of extinction. An effort to exterminate feral pigs on the entire island, using professional hunters, began in March 2005.

Anacapa. The Indian influence on Anacapa dates back more than 10,000 years ago. The Chumash Indians who occupied Anacapa were of the same villages that inhabited Santa Cruz , although travel between all the Channel Islands was common. It is not known if Chumash Indians lived year-round on Anacapa in permanent settlements. They did occupy all three islets at least seasonally, however. There is evidence of at least twenty-three kitchen midden areas. A lack of a dependable supply of fresh water was a likely deterrent to year-round occupation. There are no Spanish accounts of people living on Anacapa .

Juan Rodriguez Cabrillo was the first European to pass by Anacapa in 1542. Most early explorers failed to specifically mention Anacapa in their charts or logs. The islands were called Las Mesitas, or the Little Tables, by Portola in 1769. Captain George Vancouver renamed them Anacapa from the Canalino Indian name of Enecapah. During the 19th century, seasonal fisherman used Anacapa as a base. In 1848, Anacapa became the property of the United States Government with the Treaty of Guadalupe Hidalgo. Captain George Nidever was one of the first persons after the collapse of Chumash Indian culture to have interests on Anacapa where he raised sheep, even though it was government property.

There have been over a dozen major shipwrecks on Anacapa, the most famous of which was the S.S. General Winfield Scott on December 2, 1853. Shortly after the wreck of the Winfield Scott, Anacapa was surveyed by the U.S. Coast and Geodetic Survey to determine the need for a lighthouse. In 1854, Anacapa was set aside for lighthouse purposes, and was administered by the Lighthouse Bureau.

During the next forty years Anacapa was ranched by several parties - most notable was the Pacific Wool Growing Company. It was not until 1902 that the U.S. Government took an active role as land owner and began to lease the island to a series of sheep operations. One of these, Captain Eaton, had a resort operation on Santa Cruz and used Anacapa as a storage place for bootlegged liquor during prohibition. In 1911 funds became available for the erection of the first lighthouse, which was unmanned. The current lighthouse on Anacapa was turned on for manned operation on March 25, 1932. The site included a 30,000 square foot concrete pad for collecting rain, a water tank, light tower, powerhouse, a fog signal building and several lighthouse keepers' dwellings. The Coast Guardsmen and their families of the light station resided in four large Spanish style white stucco houses with red tile roofs before the light station was automated in December 1968.

In 1937 it was decided that no further leasing be allowed. However, from 1928 to 1956, Raymond "Frenchy" Le Dreau lived as a hermit in one of several cabins built in a cove on West Anacapa which now bears his name. In 1938 President Franklin D. Roosevelt designated Channel Islands National Monument, encompassing both Anacapa and Santa Barbara Islands. In 1939 the Lighthouse Bureau went out of existence, and Anacapa was assigned to National Park Service management. The light station on East Anacapa Island continued to be managed by the U.S. Coast Guard. Frenchy Le Dreau became the unofficial Park Service representative, reporting on acts of vandalism and island activities

In 1980, Anacapa's status changed to that of National Park. The U.S. Coast Guard retained ownership of East Anacapa Island. The buildings other than the lighthouse are now being utilized by the NPS.

Santa Rosa. More than 600 archeological sites have been mapped on Santa Rosa. These include several associated with very early human presence in North America. Chumash Indian villages and camps of early explorers and fur hunters are evident. With Mexico's successful revolt against Spain in 1821, unoccupied Santa Rosa Island became subject to the Mexican flag, and 22 years later, with the Treaty of Guadalupe Hidalgo, the Carrillo brothers became the island's first private owners. In the 1840s and 1850s, Santa Rosa was a cattle ranch. After the cattle industry of old Spanish California collapsed in the 1860s, sheep were brought to Santa Rosa and soon became its economic mainstay. By 1862, the More family owned all of Santa Rosa Island. During the next four decades, the island was used primarily as a sheep ranch. The U.S. Civil war brought with it a great demand for wool used in the manufacture of soldiers' uniforms. In 1874, 300,000 pounds of wool was produced on Santa Rosa.

In 1901, Walter L. Vail and J. V. Vickers bought their first shares in Santa Rosa Island. Most of the sheep were removed and the island was stocked with 1,891 head of cattle from the Empire Cattle Company. It took an additional 30 years for the Vail and Vickers partnership to acquire the remaining shares of Santa Rosa Island. Commercial hunting for introduced Roosevelt elk and kaibab mule deer began in 1979. In March 1980, the United States Congress established Channel Islands National Park. As a result of this legislation, in 1986, the federal government purchased Santa Rosa Island from Vail & Vickers. In executing the sale, Vail & Vickers retained a right to use and occupy 7.6 acres of the island until 2008. Feral pigs were present on the island until 1993. In 1998, the NPS removed the remaining cattle from the island. Vail & Vickers continue to run commercial hunts for trophy elk and mule deer, through a company called called Multiple Use Managers Inc.. The hunts are scheduled to terminate in 2011. Major reductions in the numbers of elk and deer on the island are expected starting in 2008.

San Miguel. A radiocarbon date of 8900 years before present establishes human presence on San Miguel but human occupation on the island may date as back more than 10,000 years ago. Archaeological surveys have mapped 542 sites on the island, evidence that occupation on the island was more than casual or temporary. The first European to land on San Miguel (in 1542) was Juan Rodriguez Cabrillo, the Portuguese explorer credited as the "discoverer" of California. Cabrillo is believed to have wintered and died at Cuyler Harbor in 1543. As on various other Channel Islands, squatters, fisherman and otter hunters lived on the island during historic times. In the 18th and 19th centuries, sea mammal hunters were drawn to the island in search of sea otters. Yankees, Russian sponsored Aleuts, Kanakas and others were among those who came to hunt.

By the mid-1800s, sheep ranchers had replaced the Chumash on San Miguel. The early "owners" of the islands were not legal owners, but owners by possession only. The first sheep rancher on the island was Samuel C. Bruce, who sold his operation to George Nidever, a famous mountainman, sea otter hunter, and later renowned as the man who discovered "The Lone Woman of San Nicholas Island" (about whom the book and movie Island of the Blue Dolphins was based). In 1852 George Nidever built the first European structure on the island, an adobe house, in what is now called Nidever Canyon. Nidever and his sons lived there, and raised sheep and cattle until 1870. During a drought in 1863, Nidever's herd of sheep stripped the island of most of its vegetation, and 5000 sheep and 180 cattle died. Starting in 1869, ownership of San Miguel passed from Nidever to several owners, until in 1890 it was in the sole possession of William G. Waters. Detecting that San Miguel was inadvertently omitted from the the Treaty of Guadalupe, Waters claimed San Miguel as a sovereign territory. In 1896 President Cleveland sent a federal marshal to discuss matters with the "sovereign" of San Miguel. Its ownership was disputed until President Taft signed a bill in 1909 reserving the island for lighthouse use. The U.S. government then took possession of the island, offering Waters leasing rights, which he took. After Waters died, the government leased the island to a succession of ranchers. By the 1930s the island was so overgrazed that barren sands swept from one side of the island to the other. In 1934 President Franklin Roosevelt moved jurisdiction of the island from the Secretary of Commerce to the Secretary of the Navy. In 1938 Anacapa and Santa Barbara Islands became a national monument, but San Miguel was turned down for inclusion.

In 1948, the final tenant ranch family was hastily evicted and the Navy began using San Miguel for target practice. Until the 1960s, planes, ships, and missiles bombarded the island. The island continued to be a central point for naval training well into the 1970's and naval aircraft practiced strafing on a target south of Cardwell Point until 1988. Sheep grazed undisturbed until the 1960s when the Navy ordered the elimination of all the animals. In 1966 the last 148 sheep were hunted and eliminated. In 1980, San Miguel became part of Channel Islands National Park. Although the National Park Service has managed the island since 1963, the Navy still owns San Miguel .

Santa Barbara. Santa Barbara was named by Sebastian Vizcaina, who arrived there in 1602. Because of the lack of fresh water, Native Americans did not reside on the island, but they stopped off on journeys to other islands. Not until the 20th century was Santa Barbara settled to any extent. During the 1920s, farming, grazing, intentional burning by island residents, and the introduction of rabbits severely damaged the native vegetation. During World War II the U.S. Navy used the island as an early warning outpost. Although non-native grasses including oats, barley, and brome, dominate the landscape, the native vegetation, including stands of giant coreopsis up to ten feet tall, is starting to recover.

Current Park Visitation. Concessionaires offer year-round transportation to the islands for day visits and camping trips. Visitation to the islands and waters is low, consisting annually of about 30,000 visitors that go on land, and another 60,000 who go only into park waters. All rock islets within Park boundaries are closed to access above mean high tide. Shore fishing is prohibited on San Miguel. Camping is available on all five islands in NPS-managed campgrounds (Figure 3). No camping is allowed on TNC's portion of Santa Cruz. Several outfitters offer a variety kayak trips to the Channel Islands from May through October. Visitors with their own kayaks can transport them to the islands using the Park's concessionaires.

Santa Cruz has one campground in Scorpion Canyon with 40 sites spread out along the valley floor 1/2 to 1 mile up from the beach landing, and a backcountry campsite at Del Norte on the north side of the island 3.5 miles by trail from Prisoner's Harbor. Anacapa has hiking trails, a visitor center, lighthouse exhibits, a primitive campground, and picnic area. The campground is on East Anacapa, up 154 stairs and 1/2 mile from the dock landing. There are 7 campsites with a campground capacity of 30 people. West Anacapa (except at Frenchy's Cove) is a protected research area and is closed to visitor access. Visitors are allowed on Middle Anacapa only when accompanied by a park ranger. There are two moorings near the landing cove at East Anacapa. These are reserved for use by the National Park Service, the Coast Guard and the park concessionaire. Santa Barbara has 5 miles of hiking trails, a visitor center, and a picnic area. The campground is 1/2 mile uphill from the dock landing. There are 8 campsites with a campground capacity of 30 people. Santa Rosa has hiking trails and a primitive campground and offers ranger-led hikes, vehicle tours, and kayak beach-camping. The campground in Water Canyon is 1.5 mile across the flats from the pier landing, or 1/4 mile from the airstrip. There are 15 campsites with a campground capacity of 50 persons. The campground has windbreaks and running water (most people bring drinking water). Camping on the beaches on Santa Rosa is available with a permit for experienced kayakers and boaters on a seasonal basis. San Miguel has a primitive campground, hiking trails and offers ranger-led hikes, marine-mammal observation, beach exploration, and bird watching. Hiking beyond the beach and campground on San Miguel is on ranger-guided hikes only. The campground is a one mile uphill from the beach landing and has windbreaks. There are 9 campsites with a total campground capacity of 30 people. Fewer than 200 people per year camp on San Miguel.

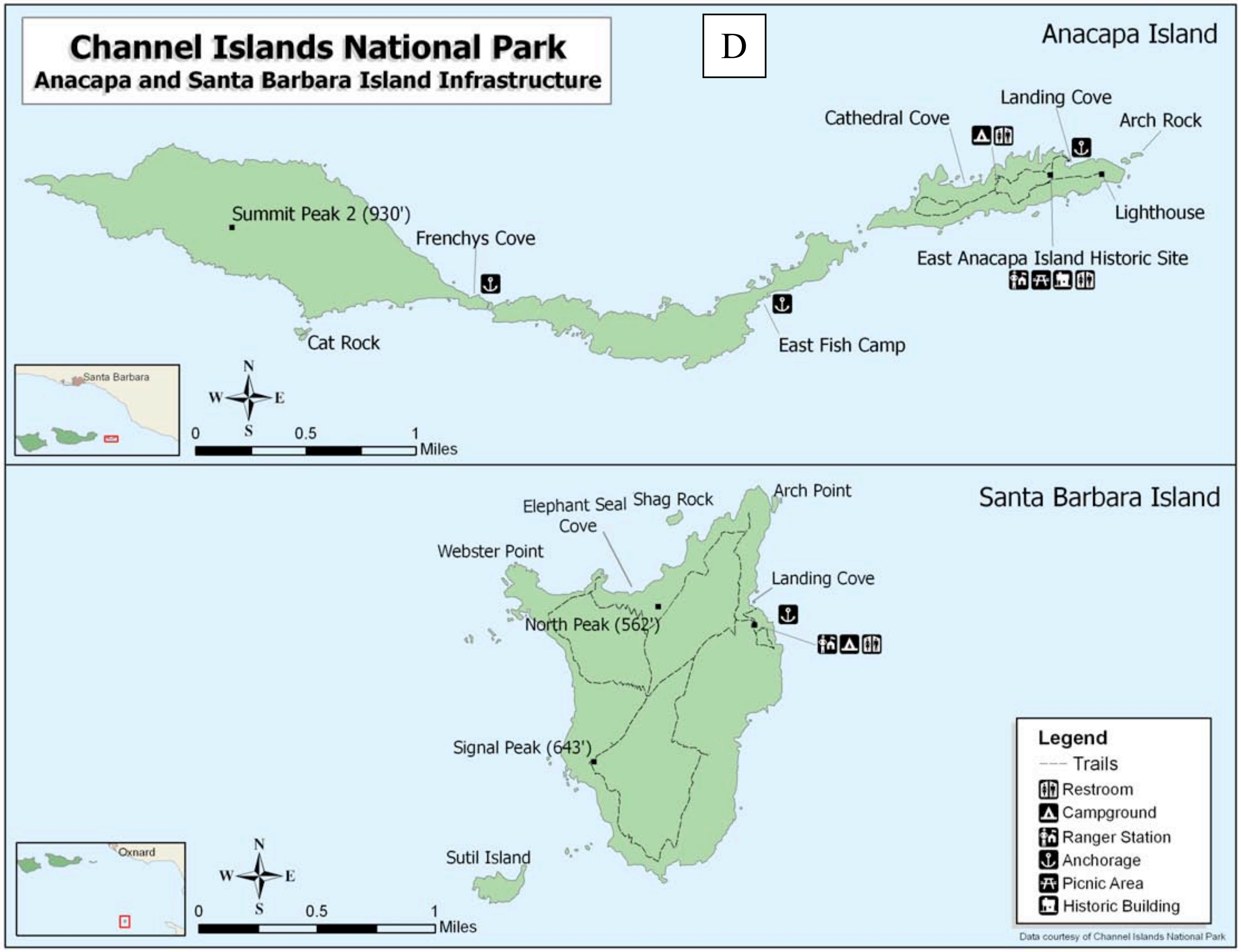
Figure 3. Park infrastructure on San Miguel Island (A), Santa Rosa Island (B), Santa Cruz Island (C), Anacapa and Santa Barbara Islands (D).


Channel Islands National Park
Santa Rosa Island Infrastructure
B
Carrington Point
Corral Point
Northwest Anchorage
Brockway Point
Sandy Point
Pocket Field
Bechers Bay*
Southeast Anchorage
Skunk Point
Black Mountain (1298')
Soledad (1574')
East Point
Grouse (1048')
Lopez (1088')
Cluster Point
China Camp
Ford Point
Johnsons Lee
South Point
Legend
Roads
Restroom
Campground
Ranger Station
Anchorage
Picnic Area
Historic Building
Airstrip
* Location of Pier
Santa Barbara
N
W
E
S
0
2.5
5
Miles
Data courtesy of Channel Islands National Park

Figure 3b.


Channel Islands National Park
Santa Cruz Island Infrastructure
C
West Point
Fraser Point
Cueva Valdez Anchorage
Diablo Anchorage
Frys Harbor
Pelican Bay
Prisoners Harbor*
Potato Harbor
Scorpion Anchorage*
Little Scorpion Anchorage
Christy Beach
Chinese Harbor
Main Ranch
Smugglers Cove
Yellowbanks Anchorage
Johnstons Lee
Corral Point
Coches Prietos Anchorage
Legend
Place Name
Roads
TNC
NPS
Restroom
Campground
Ranger Station
Anchorage
Picnic Area
Historic Building
Airstrip
* Pier located here
Santa Barbara
N
W
E
S
0
2.5
5
Miles
Data courtesy of Channel Islands National Park

Figure 3c.



Channel Islands National Park
Anacapa and Santa Barbara Island Infrastructure
D
Anacapa Island
Landing Cove
Cathedral Cove
Arch Rock
Summit Peak 2 (930')
Frenchys Cove
Lighthouse
East Anacapa Island Historic Site
Cat Rock
East Fish Camp
Santa Barbara
N
W
E
S
0
0.5
1
Miles
Santa Barbara Island
Elephant Seal Cove
Shag Rock
Arch Point
Webster Point
Landing Cove
North Peak (562')
Signal Peak (643')
Sutil Island
Oxnard
Legend
Trails
Restroom
Campground
Ranger Station
Anchorage
Picnic Area
Historic Building
Data courtesy of Channel Islands National Park

Figure 3d.

B. Hydrologic Information

B.1. Oceanographic Setting

a. The Southern California Bight

The Southern California Bight (SCB, or Bight) is a 100,000-square-mile body of water and submerged continental shelf that extends from Point Conception, California, in the north to Cabo Colnett, Baja California, Mexico, in the south (Noblet et al. 2003). It is bounded offshore to the west by the Santa Rosa-Cortes ridge (Figure 4). Within the Bight are submarine valleys and mountains, the peaks of which form the various offshore islands. The ridges and troughs generally run northwest to southeast, with the exception of the Channel, which runs east to west. The Channel is ~100 km long and 40 km wide with a central basin depth of ca. 500 m, and a narrow shelf on both sides ranging in width from 3-10 km. The sills at the eastern and western entrances of the Channel are 220 and 430 m deep, respectively. The passages between the islands are about 40 m deep (Harms and Winant 1998).

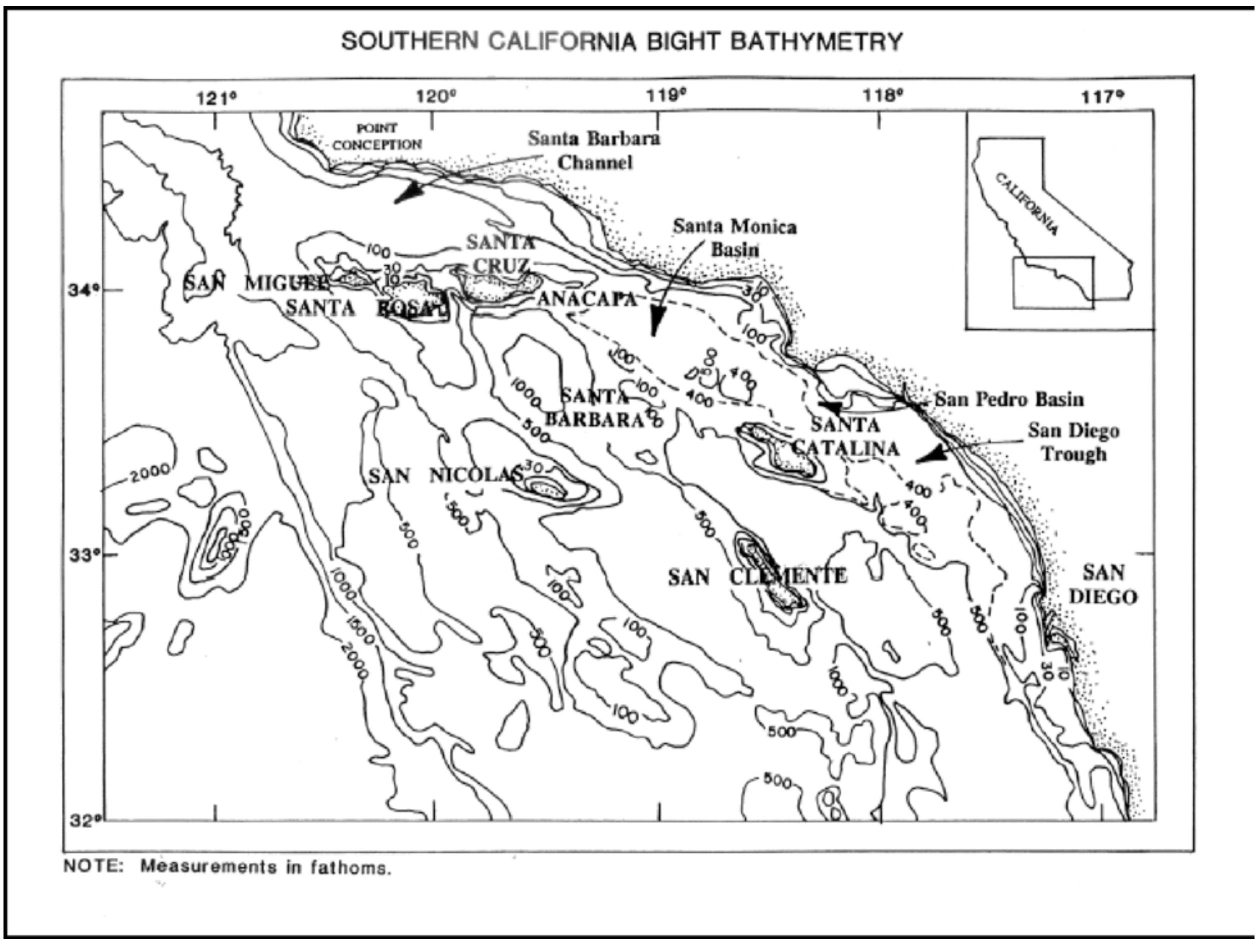


Figure 4. Landmasses and bathymetry of the Southern California Bight (from MMS 2001).

b. Circulation in the Bight

Circulation in the Bight is complex owing to its composite bottom topography. Any water flow entering the 12 basins making up the Bight at depths below 250 m must do so from the southeast along the San Diego Trough and into the Santa Monica–San Pedro basins. The Santa Monica–San Pedro basins act as a conduit for water flow into the rest of the Bight, opening up to the southeast at 737 m, to the northwest into the Santa Barbara Basin at 250 m, and to the west into the Santa Cruz Basin at 650 m. Together, the Santa Monica-San Pedro Basins are 100 km long, 40 km wide, and 900 m deep at the deepest point (Browne 1994).

The sources of ocean water in the Bight are (1) cold, low salinity, highly oxygenated sub-arctic water brought in by the California Current, and ultimately the California Counter-Current; (2) the moderate, saline, central north Pacific water advected into the Bight from the west; and (3) the warm, highly saline, low oxygen content (Equatorial) water entering the Bight from the south, principally by way of the California Undercurrent (at 300 m depth). The California Current carries subarctic water equatorward throughout the year, extends offshore to a distance of about 400 km, and to a depth of 300 m. Maximum speeds of the California Current are found at the surface with the strongest equatorward flow occurring during the spring and summer. When the California Current relaxes, poleward flows are observed nearshore within the Bight (Hickey 1979). The California Current mixes with the warm, saline, north-central Pacific water coming in from the west. South of San Diego, part of the California Current spins eastward into the Bight and then poleward forming the Countercurrent. The Countercurrent is strongest during the fall and winter, with its poleward flow reaching its maximum speeds typically within 50 km offshore of the coast. It joins the poleward California Undercurrent which is deeper and inshore of the Countercurrent.

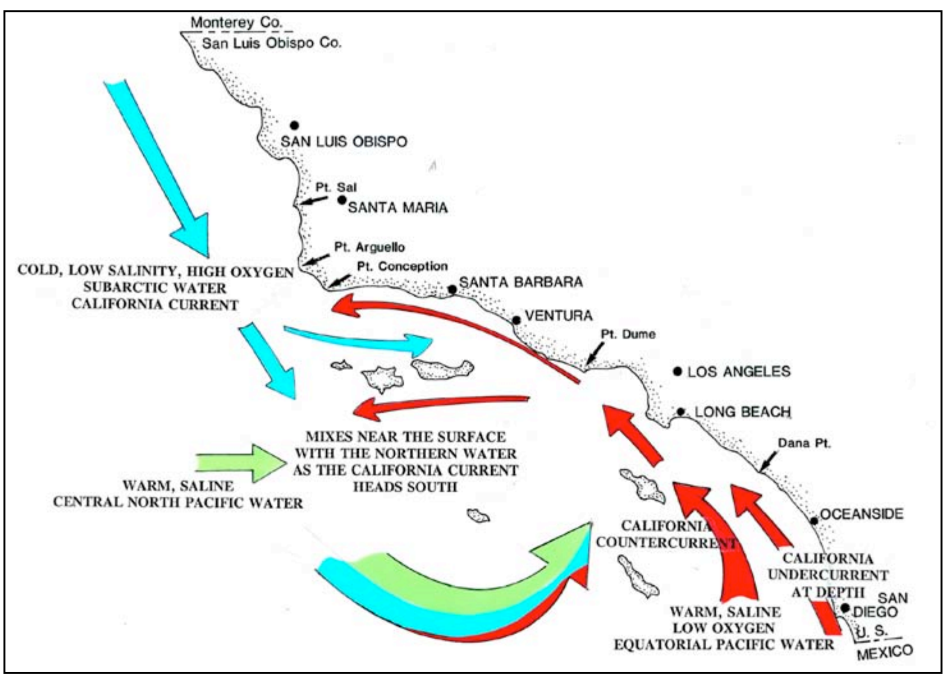


Figure 5. General circulation patterns in the Southern California Bight (Browne 1994).

c. Mean Wind Fields in the Channel

The large-scale wind field is driven by the relative strength of the North Pacific High over the subtropical Pacific Ocean (Reid et al. 1958). During fall and winter, the North Pacific High is relatively weak and the passage of mid-latitude storms dominates the wind climate. These storm systems pass over the Channel in 2-4 days and are large in size compared to the Channel. However, during the spring, strong, persistent equatorward winds occur along the U.S. west coast, continuing through the summer. These winds are called upwelling-favorable winds because their consistent southeast direction moves surface waters offshore. This gives rise to upwelling of cold, nutrient-rich, bottom water at the coast (especially at headlands such as Points Sal, Arguello and Conception), that, in turn, moves this water mass offshore in a continual cycle. At Point Conception, strong wind gradients occur as the equatorward winds detach from the coast (Winant and Dorman 1997). The Santa Ynez mountains at the northern part of the Bight shield Bight waters from this strong wind pattern, causing the winds inside the Bight to be moderate and directed east to southeast throughout the year (Figure 6). The Channel lies in the transition between strong winds to the north and sheltered waters to the south. In the eastern portion of the Channel, wind speeds are much lower, resulting in a large and persistent wind stress curl over the Channel (Dorman and Winant 2000, Oey et al. 2001).

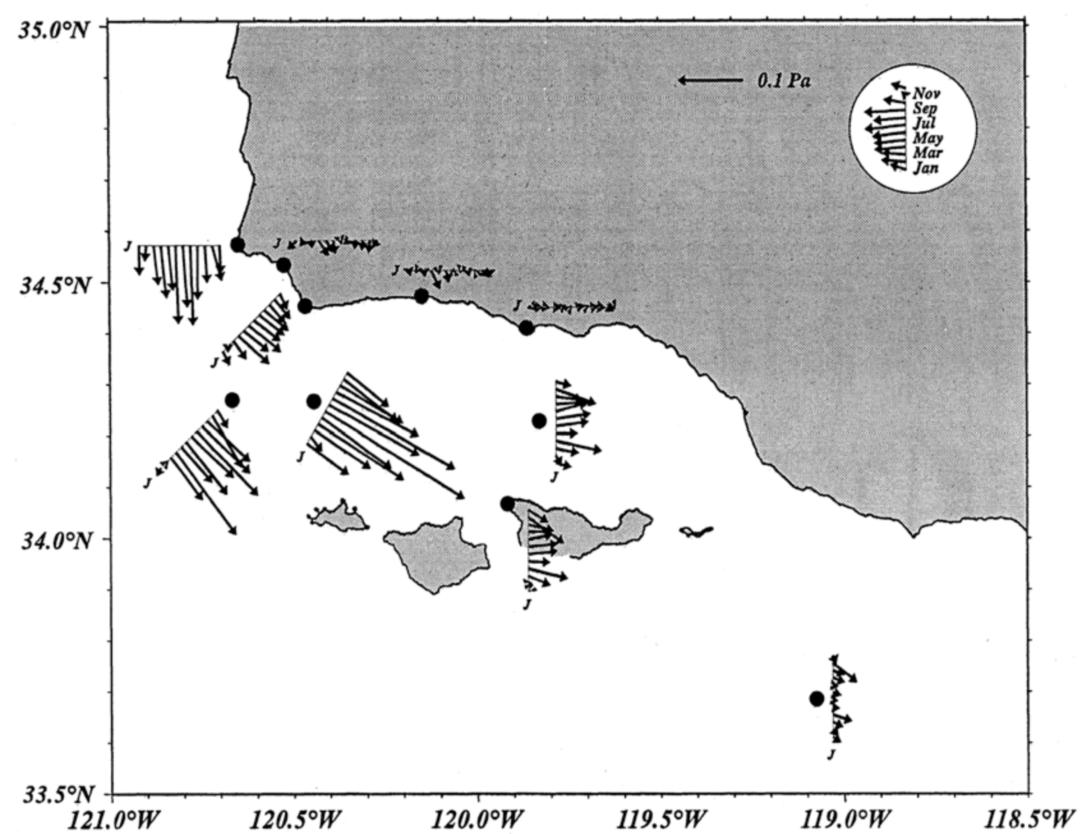


Figure 6. Seasonal cycle of wind stress in the Santa Barbara Channel region. The monthly mean time series are rotated for convenience. The direction of each arrow is the actual direction of the mean wind stress for that month. Arrows are proportional to the wind stress magnitude in pascals. Solid circles show the measurement sites. The beginning of the year is indicated by "J" (January) (Harms and Winant, 1998).

d. Circulation Patterns in the Channel

The mean flow at 5 m depth in the Channel consists of a concentrated jet flowing westward on the northern shelf and a weaker eastward return flow on the southern shelf (Figure 7). These opposing flows result in a mean cyclonic (counterclockwise) circulation concentrated in the western part of the Channel. Mean westward currents on the northern shelf strengthen between the eastern entrance of the Channel and Point Conception. West of Point Conception, mean westward currents drop sharply as the flow out of the Channel encounters equatorward flow from the California Current. The mean flow at 45 m depth is similar to the flow at 5 m with three exceptions: (1) between Port Hueneme and Point Conception, mean westward flow is continuous and uniform, (2) westward flow at 45 m appears to continue north of Points Conception and Arguello, and (3) north of San Miguel, mean 45 m currents are directed eastward rather than southeastward (Harms and Winant 1998).

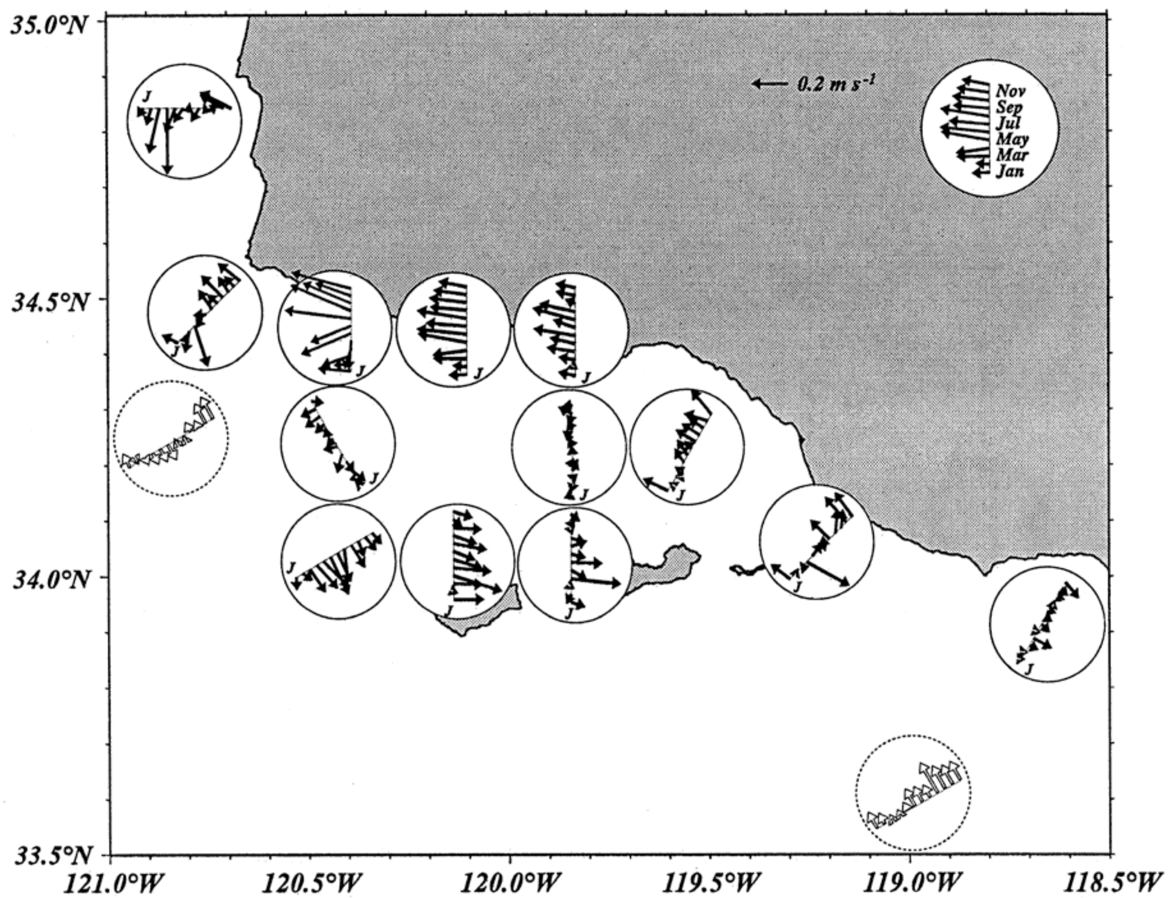


Figure 7. Seasonal cycle of 5-m currents in the Santa Barbara Channel region. The direction of each arrow is the actual direction of the mean current for that particular month. Arrows are proportional to the current magnitude in m/s. The locations of the time series correspond to buoy locations. The beginning of the year is indicated by "J". Open arrows are monthly averaged alongshelf geostrophic velocities at the surface relative to 500 dbar computed from California Cooperative Oceanographic Fisheries Investigations (CalCOFI) observations from 1949-1995 (Harms and Winant 1998).

Circulation in the Channel always tends to be cyclonic. The cyclonic flow is strongest in summer and weakest in winter. About 60% of surface current observations in the Channel can be sorted into six different states or synoptic modes: Upwelling, Relaxation, Cyclonic, Propagating Cyclones, Flood East, and Flood West (Figure 8) (Harms and Winant 1998).

Upwelling. The Upwelling state gets its name from upwelling of cold (approximately 11°C) subsurface waters near Pt. Conception which often occurs during it. The Upwelling state occurs primarily in spring, though it has also been observed in other seasons. It occurs when strong (10 m/s or more) persistent (several days or more) upwelling favorable (equatorward) winds overwhelm any poleward along-shelf pressure gradient. During the Upwelling state, strong equatorward currents occur along the southern boundary of the Channel, and west poleward flow occurs along the northern boundary.

Relaxation. The Relaxation state gets its name from the fact that it generally occurs when winds off Pt. Conception "relax" from their usual equatorward direction. The Relaxation state occurs primarily in fall and early winter. It occurs when poleward along-shelf pressure gradients overwhelm upwelling favorable or weak winds. The most characteristic feature of the resulting flow field is a strong westward flow (50 cm/s or more) along the northern shelf of the Channel, and west equatorward currents at the southwest end of the Channel.

Cyclonic and Propagating Cyclones. The Cyclonic state consists of currents with opposite directions, but similar speeds, on opposite sides of the Channel. Propagating Cyclones involves smaller cyclonic eddies which appear to slowly drift toward the west. During both the Cyclonic and Propagating Cyclones states, a cold 'squirt" (the Santa Rosa cold squirt) is frequently observed on the southeastern side of the cyclonic eddy - as colder water is drawn eastward on the southern shelf of the Channel.

In spring, the Upwelling mode is dominant at 5 m depth. In summer and fall, the 5 m circulation patterns fluctuates from the Upwelling mode, to the Cyclonic mode, to the Relaxation mode, over a period of 2-3 weeks. During these cycles, the Propagating cyclones mode is superposed on the other three, larger scales modes of circulation.

Flood East and Flood West. Flood East and Flood West are alternating states that occur during winter. During the Flood East and Flood West states, currents are in the same direction on both sides of the Channel. In this way, they contrast with the Upwelling and Relaxation states.

Free-floating drifters designed to follow the top meter in the water column were constructed and deployed in support of the Santa Barbara Channel-Santa Maria Basin Circulation Study jointly conducted by the MMS and Scripps Institute of Oceanography. Twenty-nine drifter deployments either from 12 or 24 locations in the Channel and the Santa Maria Basin were conducted from 1993 to 1999 in a manner that would allow a reasonable sampling over the four seasons. The tracks of these drifters can be sorted into categories which support the six Channel circulation modes described above (MMS 2001). Drifter tracks can be viewed at http://ccs.ucsd.edu/research/sbcsmb/drifters/.

Adding a final layer of complexity to circulation patterns in the Channel, high frequency (HF) current-measuring radar observations show that small, sub-mesoscale, anti-cyclonic eddies 4-15 km in diameter, lasting usually about two days, occur over the slope and inner shelf along the northern coast of the Channel (Bassin et al. 2005). No clear seasonal trend is apparent for the formation of these smaller eddies. HF radars on the mainland coast at Refugio State Beach, Coal Oil Point Reserve, Summerland Sanitary District and Reliant Energy's Mandalay Bay Generation Station are used by researchers at the University of California Santa Barbara (UCSB) to monitor surface currents (to 1 m) in the Channel. Real time and daily average surface currents in the coverage area are posted on the project website (Southern Central California CODAR project, www.icess.ucsb.edu/iog/codar_realtime.htm). Extensive HF radar coverage of the California coast, and monitoring of surface currents, is anticipated in the future owing to a recently funded research multi-institution project called the Coastal Ocean Current Monitoring Project (www.cocmp.org).

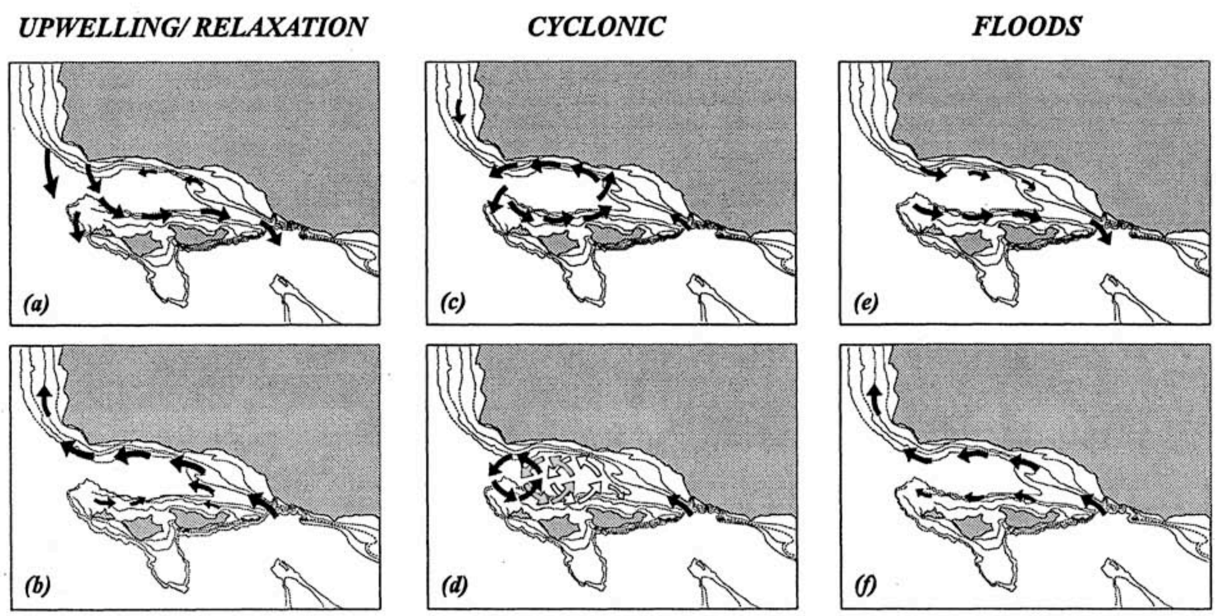


Figure 8. Diagrams of the six synoptic modes of circulation in the Santa Barbara Channel. (a) Upwelling, (b) Relaxation, (c) Cyclonic, (d) Propagating Cyclones, (e) Flood East, and (f) Flood West. (Harms and Winant 1998)

e. SST in the Channel

Figure 9 depicts average monthly SST in the region. In the spring when the upwelling favorable wind forcing is dominant, cold water is upwelled at Pts. Arguello and Conception and spreads eastward into the Channel, with the coldest water appearing along the southern Channel shelf. In the late spring and summer the currents at the eastern entrance to the Channel reverse to the poleward direction and warmer Bight water is introduced along the northern shelf of the Channel continuing to Pt. Conception. Maximum poleward flow within the Bight in summer, combined with seasonal warming, results in the warm SST values from July to October (Otero and Siegel 2004). In mid-fall along shelf temperature gradients in the Channel decrease as warmer Bight water replaces the cold waters offshore Pts. Conception and Arguello and the southern central California coast. Temperature gradients decrease further as Channel SST declines to its winter values.

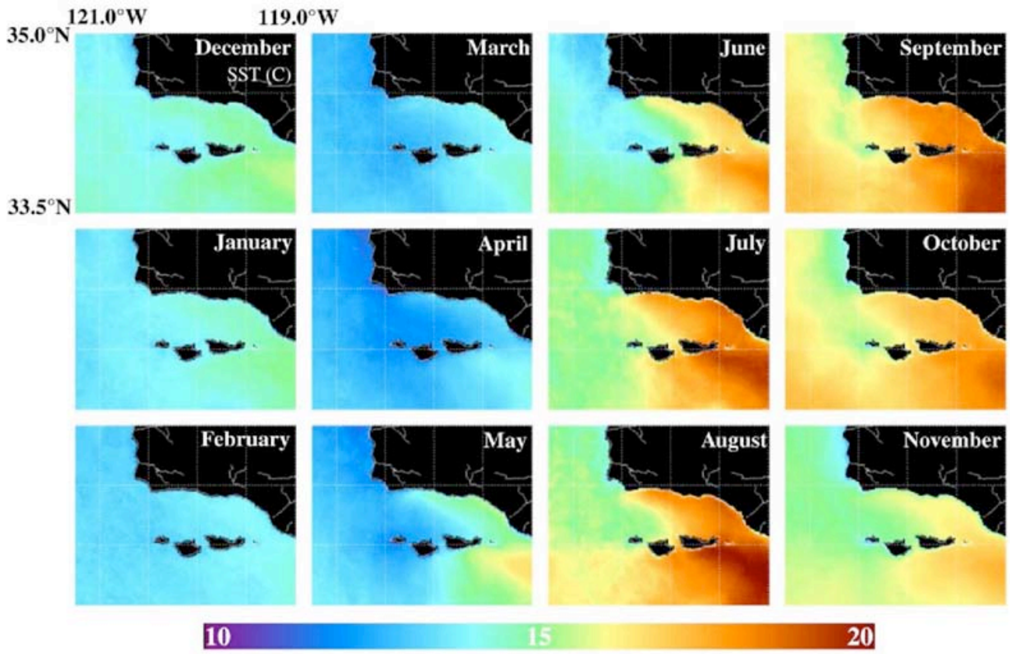


Figure 9. Monthly mean annual cycle for SST computed from AVHRR and SeaWiFS images from October 1997-June 2001 (Otero and Siegel 2004).

f. Regional Consequences of El Niño Southern Oscillation Events

El Niño Southern Oscillation Events (El Niño) events occur irregularly at intervals of 2-7 years, although the average is about once every 3-4 years. They typically last 12-18 months. A "California El Niño " is characterized by warm sea surface temperatures, a deeper surface mixed layer, a depressed thermocline, nutrient-poor water, greater poleward flow, and an anomalously high sea level (Barber and Chavez 1983; Dayton and Tegner 1984; Tegner and Dayton 1987). In the Bight, El Niños can result in little or no production of giant kelp canopies, depending upon the severity of the event. Deepened isotherms associated with El Niño result in severe nutrient limitation and very low kelp productivity. Frond growth rates can be so low during El Niños that terminal blades are formed before the frond reaches the surface (Zimmerman and Robertson 1985). Swell from El Nino-related storms can cause substantial physical damage to giant kelp.

Species more commonly found in tropical waters may migrate to, or be advected into, the Channel during El Niño events (Barry et al. 1995). For example, red crabs (*Pleuroncodes planipes*), pelagic tunicates, and fishes such as albacore, barracuda, dorado, yellowfin tuna, marlin, and triggerfish have occurred far to the north of their usual range during El Niños. In general, highly migratory species like yellowtail and some pelagic species such as barracuda and sardines thrive during warm water events, and the higher water temperatures probably enhance the reproductive success of sardines (Ugoretz 2002). The displacement of species during El Niño events is reflected in depressed commercial catches of temperate-water species such as salmon, northern anchovy, lingcod, sablefish, rockfishes, dungeness crab, market squid, and shrimp (Smith 1985).

g. Regime Shift

Multi-decadal shifts in the physical and biological processes of the Bight can lead to changes in the distribution and abundance of marine species within the Channel. The 32-year period from 1944 to 1975 was characterized by cooler than average temperatures in the Bight, except for the 1957 to 1959 El Niño years (Ugoretz 2002). In contrast, the 23-year period from 1976 to 1998 was warmer than the 78-year mean, with a few minor exceptions. This change, referred to as a regime shift, began when mean annual SST rose an average of nearly 1°C above the mean from the previous 15 years (Hollbrook et al. 1997). The warming coincided with a shift in the basic state of the atmosphere-ocean climate system of the North Pacific in the 1976-1977 winter season (Miller et al. 1994). The shift in SST was accompanied by increases in the intensity and frequency of El Niño episodes, winter storms and upwelling events, and declining nutrient availability in surface waters.

Myriad biological changes in the Channel and the Bight have accompanied the regime shift since 1977. Lowered productivity of the photic zone has coincided with a decrease in macrozooplankton abundance in the upper 200 m of the nearshore pelagic environment. Since the late 1970s, macrozooplankton volume in the California Current has declined by over 70 percent (Roemmich and McGowan 1995, McGowan et al. 1996, McGowan et al. 1998). Smith and Kaufmann (1994) show a corresponding long-term deficit in the supply of food necessary to meet the metabolic demands of the sediment community. CF&G data show decreases over this time period in landings for several categories of groundfish, California sea urchin, swordfish, selected shark species, Pacific mackerel, Pacific herring, California halibut, market squid (Ugoretz 2002). Dugan and Davis (1993) document the general decline in long-term productivity in 19 species of nearshore fishes and invertebrates in California from 1947 to 1986. A study by Love et al. (1998) of long-term trends in the Channel's commercial rockfish fishery shows a substantial decline from 1980 to 1996, with extremely low catches from 1993 to 1996. Holbrook et al. (1997) showed that the density of benthic crustaceans consumed by surfperches at Santa Cruz, and the biomass of understory algae harboring these prey, both fell by ~80% between 1982 and 1995. During the same period, the density of adult and young-of-year surfperch dropped at Santa Cruz (Holbrook et al. 1997). Tegner et al. (1997) show a two-thirds reduction in standing biomass since 1957 in southern California kelp forests. There is also evidence that the abundance of oceanic birds in the region and the Bight have declined steadily since 1988 (Veit et al. 1996, 1997). For example, the sooty shearwater, the most abundant bird in the Channel, has declined by 90 percent.

B.2. Freshwater Features

a. Rainfall and Runoff

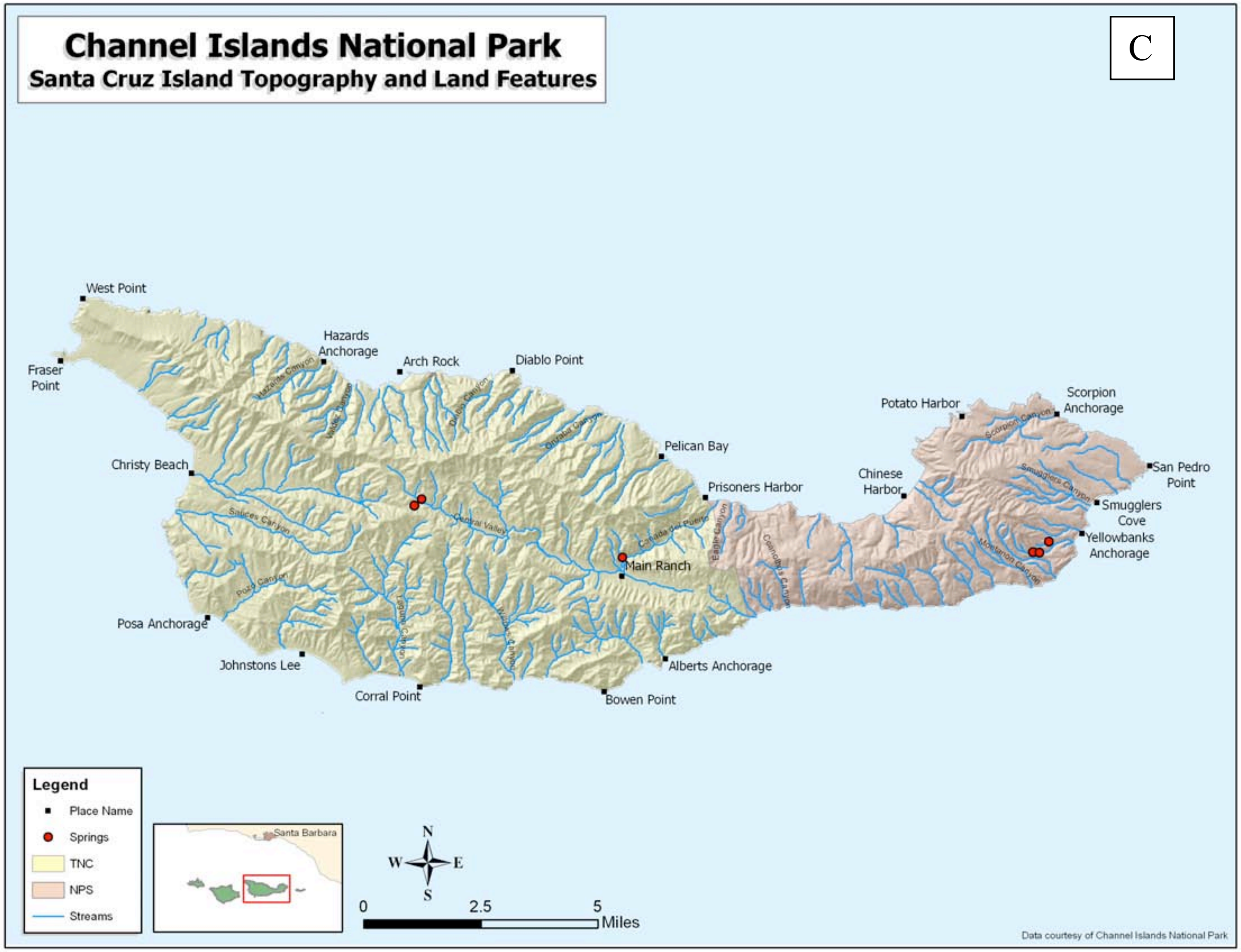
The Park experiences a mediterranean climate with mild, wet winters and moderately warm, generally rainless summers. The majority of terrestrial runoff occurs during winter storms from December to March (Mertes et al. 1998). Approximate average annual precipitation is 8 inches on Santa Barbara, 12 inches on Anacapa, 23 inches on Santa Rosa (values for these three islands were obtained from NOAA's Western Regional Climate Center, www.wrcc.dri.edu/channel_isl, accessed 8/3/2006), and 20 inches on Santa Cruz (Junak et al. 1995).

Owing to generally steep terrain in drainages, intensity of rainfall, and thin soil cover, there is typically a very short time lag (several hours) from rainfall to runoff. A flashy precipitation regime, along with rapidly rising, rugged topography, and fractured sedimentary rocks combine to yield large sediment loads in streams in the region (Mertes et al. 1998). Interannual variability in precipitation and streamflow is high, some of which is associated with El Niño events - although a robust local relationship between El Niño and precipitation has not been found (Haston and Michaelsen 1994).

Figure 10. Topography (based on 30 m digital elevation models [DEMs]), streams, wetlands, and key features of San Miguel Island (A), Santa Rosa Island (B), and Santa Cruz Island (C). Unmapped vernal pools occur on San Miguel and Santa Rosa Islands. Many small coastal lagoons or wetlands are not depicted. DEMs were not available for Anacapa and Santa Barbara Islands. No freshwater features occur on Anacapa and Santa Barbara Islands.


Channel Islands National Park
Santa Rosa Island Topography and Land Features
B
Carrington Point
Corral Point
Northwest Anchorage
Brockway Point
Sandy Point
Bechers Bay
Southeast Anchorage
Skunk Point
Pocket Field
Garanon Canyon
Tecolote Canyon
Arlington Canyon
Soledad Canyon
Dry Canyon
Verde Canyon
Cow Canyon
Lobo Canyon
Windmill Canyon
Cherry Canyon
Black Mountain (1298')
Box Canyon
Water Canyon
Quemada Canyon
Old Ranch House Canyon
Soledad (1574')
Bee Canyon
Whetstone Canyon
Acapulco Canyon
Trancion Canyon
Grouse (1048')
Lopez (1088')
Jolla Vieja Canyon
Wreck Canyon
San Augustin Canyon
East Point
Cluster Point
China Camp
Ford Point
Johnsons Lee
South Point
Legend
Streams
Wetlands
Santa Barbara
N
W
E
S
0
2.5
5
Miles
Data courtesy of Channel Islands National Park

Figure 10b.



Channel Islands National Park
Santa Cruz Island Topography and Land Features
C
West Point
Fraser Point
Hazards Anchorage
Arch Rock
Diablo Point
Pelican Bay
Prisoners Harbor
Christy Beach
Main Ranch
Posa Anchorage
Johnstons Lee
Corral Point
Bowen Point
Alberts Anchorage
Potato Harbor
Scorpion Anchorage
Chinese Harbor
San Pedro Point
Smugglers Cove
Yellowbanks Anchorage
Legend
Place Name
Springs
TNC
NPS
Streams
Santa Barbara
N
W
E
S
0
2.5
5
Miles
Data courtesy of Channel Islands National Park

Figure 10c.

b. Surface Water Features

Freshwater resources in the Park include seasonal and permanent streams, riparian corridors, coastal lagoons or wetlands at the mouths of several canyons, coastal seeps, and vernal pools (Figure 10). Santa Barbara and Anacapa have no streams or other freshwater bodies. The freshwater features of other three islands in the Park are described below. The biological aspects of freshwater habitats are discussed in Section I.C.

Santa Cruz. Streams occur in numerous canyons on the island (Table 1), however none have been the subject of routine sampling or study. The largest watershed is the Central Valley, which runs east/west and drains out to the north shore at the base of the isthmus at Prisoner's Harbor. Santa Cruz watersheds are characterized by steep, highly dissected subdrainages. Most of the steep slopes show many mass slope failures that result in high erosion and sedimentation in the valleys. Most of the major watersheds have a mix of vegetation community types, with coastal sage scrub on south facing slopes, chaparral on north facing slopes on volcanic substrates, and woodland communities in the higher elevations with steeper slopes. Incised gullies are commonplace throughout the drainages (CINP 2002a).

The highly dissected drainages typically have V-shaped valley-bottoms. These drainages are highly efficient at delivering sediment. These valley-bottom types, coupled with low vegetation cover, are capable of causing “flash flood” events (such as the "Scorpion Flood", December, 1997, CINP 2002a). Most drainages have only intermittent above-ground stream flow. However, the larger watersheds have perennial flow in normal precipitation years. Even the largest watershed on the island (Central Valley) has intermittent flow, where stream flow alternates above and below ground throughout its length. Since the removal of grazers, many temporary streams are experiencing longer flow (Kate Faulkner, Chief of Natural Resources, Channel Islands National Park, pers. comm.). Junak et al. (1995) record many freshwater seeps and springs throughout the island. One of the largest springs on the island is located in Aguaje Canyon near Yellowbanks Anchorage (CINP 2002a).

Past livestock grazing, pig rooting, and extensive vegetation changes have caused localized downward trends in soil resources on the island. Gully and sheet erosion is still actively occurring throughout the island, especially within the sedimentary Monterey formations found on the isthmus and east end of the island. The El Niño winter storm events of 1997-98 caused hundreds of small and large landslides throughout the island. This was particularly noticeable in the Scorpion Canyon watershed, one of the most disturbed watersheds on the island (CINP 2002a). Owing to the fact that sheep were removed from the western 90% of Santa Cruz (the TNC-owned portion) before they were removed from eastern 10% (the NPS-owned portion), Pinter and Vestal (2005) were able to compare slope failures on both portions after the 1997-98 storms. Although sheep-grazed land comprised only 10% of the island at that time, 80% of all slope failures occurred in those areas.

Persistent wetlands occur along the lower reaches of the streams in Canada del Puerto (at Prisoner's Harbor), Scorpion Canyon (landward of Scorpion Bay), and Smuggler's Canyon (Noon 2003). The wetlands at the first two sites contain freshwater during the majority of the year. Sand and gravel bars prevent connection with the intertidal, except occasionally during wave overwash during extreme tides. Dredging and grading of stream beds and filling of wetland areas occurred during the ranching era at the Scorpion and Prisoner's wetlands (see

Section I.C.2 for more detail). Small wetlands occur at the mouths of many of the other streams on Santa Cruz. These are sometimes little more than freshwater seeps. At other times, wave overwash produces small (tens of square meters) saline lagoons at these sites. After sufficient runoff, these sites occasionally become fresh and often support cattails or pickleweed (Dan Richards, Marine Biologist, Channel Islands National Park, pers. comm.). Small, but persistent, lagoons occur at the mouths of Willows and Laguna Canyons, and at Christy Beach (Dan Richards, Marine Biologist, Channel Islands National Park, pers. comm.). Several vernal pools occur at the western end of the isthmus near China Harbor (CINP 2002a), and a temporary pond occurs near Frazer Point (Soiseth 1994).

Santa Rosa. As on Santa Cruz, streams, creeks, or washes occur in numerous canyons on the island (Table 1). The major drainages originate from a single central highland, producing long stream lengths and many fourth order stream segments (Mertes et al. 1998). Owing to efforts to characterize the impacts of cattle grazing and deer and elk on water quality and riparian zones, several streams on Santa Rosa have been monitored at intervals since 1993 (CINP 2002b). In addition, the vegetation and physical condition of the riparian corridors of several of these streams were compared before and after cattle were removed from the island (Wagner et al. 2004); more detail is contained in Sections I.C.1 and II.C.3. A small, vernal brackish wetland occurs at Oat Point (referred to as Oat Point Wetland in Park monitoring reports, and sometimes as Oak Point in other sources) that fills either with rain or wave overwash on extreme tides, but does not receive creek input and is hypersaline most of the time (Dan Richards, Marine Biologist, Channel Islands National Park, pers. comm.). Persistent coastal lagoons, or brackish wetlands, occur at the mouths of six canyons: Old Ranch, Old Ranch House, Water, La Jolla Vieja, and Arlington Canyons, and Canada Tecelote. The lagoons in the latter two canyons are brackish most of the time (except during winter runoff), have sparse aquatic vegetation, but are consistently used by ducks (Dan Richards, Marine Biologist, Channel Islands National Park, pers. comm.). Unmapped vernal pools occur in Pocket Field (at least six pools), in the west end of the island (one pool located at 33°50'33"N, 120°13'09"W, according to Soiseth, 1994), and at Skunk Point (at least four pools), between Abalone Rocks and Old Ranch House Lagoon (one pool located at 33°57'22"N, 119°58'31"W according to Soiseth, 1994), and in Water Canyon just west of a stand of Torrey Pines (one pool), in the east end of the island (Furlong 1996; Dan Richards, Marine Biologist, Channel Islands National Park, pers. comm.). During Apr. 1995, when they were first surveyed, these vernal pools ranged in depth from 10-150 cm, and in size from approximately 1500 to >3000 m^2. Pools in Pocket Field were used by cattle at that time, and had mostly mud and introduced grasses at their margins. Pools on the east end of the island were bordered by chapparal or dune vegetation, or emergent aquatic species. Macroinvertebrate species of the vernal pools are discussed in Section I.C.2.

San Miguel. Two named drainages, Nidever and Willow Canyons, occur on the island (Table 1), although Willow Canyon may not have surface water at its mouth most of the year. North Green Mountain Canyon has a seep much of the year. A dry lake bed occurs on the western part of the island, south of Otter Harbor. On occasion it floods to form a fairly large wetland, which remains unstudied (Kate Faulkner, Chief of Natural Resources, Channel Islands National Park, pers. comm.). At least one small vernal pool, containing fairy shrimp, occurs southeast of Green Mountain (located at 34°02'03"N, 120°22'37"W, Soiseth 1994). Some small coastal seeps occur along the Simonton Beach area, providing enough freshwater to support cattails and duckweed (Dan Richards, Marine Biologist, Channel Islands National Park, pers. comm.). As on Santa

Cruz and Santa Rosa, some small, unstudied coastal seeps occur at the mouths of several canyons on the island, which occasionally form small freshwater pools, or become filled with brackish water owing to wave overwash during extreme high tides.

c. Groundwater

No principal aquifers underlie the islands of the Park (Planert and Williams 1995) and groundwater from the mainland does not discharge into the Park. A search of the USGS ground water site inventory yielded no well water, test bore, or other ground water data for the Park. The Park draws from wells on Santa Cruz (at Prisoner's Harbor and Scorpion Bay), on Santa Rosa (in Windmill Canyon), and on San Miguel (in Nidever Canyon). Other than bacterial levels, water quality is not monitored at these sites (Kate Faulkner, Chief of Natural Resources, Channel Islands National Park, pers. comm.).

Table 1. Principal coastal drainages on Santa Cruz, Santa Rosa and San Miguel Islands. Many support seasonal or perennial streams. Dozens of small, unnamed drainages (probably containing dry washes) occur around the periphery of all three islands.

Island	Canyon	Additional Freshwater Feature	Sampling History[a]
Santa Cruz	Scorpion Canyon	wetland occurs on lower reach of stream	
	Little Scorpion Canyon		
	San Pedro Canyon		
	Smuggler's Canyon	wetland occurs on lower reach of stream	
	Canada del Aguaje	springs occur in watershed	
	Cardiac Canyon		
	Montanon Canyon		
	Ceanothus Canyon		
	Three Pork Canyon		
	Canada Pomada		
	Willows Canyon	coastal lagoon at mouth	
	Horqueta Canyon		
	Alamos Canyon		
	Laguna Canyon	coastal lagoon at mouth	
	Canada de Malva Real		
	Johnston Canyon		
	Posa Canyon		
	Alegria Canyon		
	Canada de los Sauces		
	Canada Christy	coastal lagoon at mouth	
	Black Point Canyon		
	Red Rock Canyon		
	Rancho Nuevo Canyon		
	Canada del Agua Santa		

Island	Canyon	Additional Freshwater Feature	Sampling History[a]
	Painted Cave Canyon		
	Hazard Canyon		
	Valdez Canyon		
	Little Valdez Canyon		
	Diablo Canyon		
	Orizaba Canyon		
	Canada del Puerto - drains the large Central Valley	wetland at mouth at Prisoner's Harbor	
	Eagle Canyon		
	Canada del Agua		
	Canada de la Calera		
Santa Rosa	Canada Garanon		
	Canada Tecelotito		
	Canada Tecelote	small coastal lagoon or wetland at mouth	2005
	Arlington Canyon	small coastal lagoon or wetland at mouth	2005
	Canada Soledad		
	Dry Canyon		
	Canada Verde (Trap Canyon connects upstream)		2005
	Cow Canyon		
	Lobo Canyon		1990s, 2002, 2005
	Windmill Canyon (Cherry Canyon connects upstream)		2005
	Water Canyon	small coastal lagoon or wetland at mouth	1990s, 2002, 2005
	Old Ranch Canyon (Box Canyon and Quemada Canyon connect upstream)	coastal lagoon at mouth, which is monitored	1990s, 2002, 2005 ("Quemada Canyon")
	Old Ranch House Canyon	coastal lagoon at mouth, which is monitored	
	San Augustin Canyon		
	Wreck Canyon		2005
	La Jolla Vieja Canyon	small coastal lagoon at the mouth of the canyon	2005 ("La Jolla")
	Trancion Canyon		
	Acapulco Canyon		
	Whetstone Canyon		
	Bee Canyon		
San Miguel	Nidever Canyon		
	Willow Canyon		

C. Biological Resources

C.1. Streams and Riparian Corridors

The native island riparian vegetation can be divided into two components: herbaceous vegetation and woodland vegetation. Herbaceous riparian vegetation occurs in canyon bottoms where soil moisture is available for most of the year. The more common plant species in this community include Mexican rush (*Juncus mexicanus*), common threesquare (*Scirpus pungens*), smooth scouring rush (*Equisetum laevigatum*), sticky Baccharis (*Baccharis douglasii*), saltgrass (*Distichlis spicata*), California bulrush (*Scirpus californicus*), brown-head rush (*Juncus phaeocephalus*), California maidenhair (*Adiantum jordanii*), mule fat (*Baccharis salicifolia*), toad rush (*Juncus bufonius*), common monkey flower (*Mimulus guttatus*), rabbitsfoot grass (*Polypogon monspeliensis*), and cattail (*Typha domingensis*). Water bent grass (*Agrostis viridis*) and Australian brass buttons (*Cotula australis*) are non-native herbaceous species that occur in many of the riparian corridors. Woody vegetation native to the riparian corridors in the Park includes arroyo willow (*Salix lasiolepis*), black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), Mexican elderberry (*Sambucus mexicana*), and coast live oak (*Quercus agrifolia*).

Riparian woodland can be found along some permanent streams on the islands. On Santa Cruz, this habitat is found especially on the north side between Cueva Valdez and Canada del Agua at the western end of the isthmus. Although heavily disturbed, Canada del Agua contains native riparian woodland species such as big-leaf maple (*Acer macrophyllum*), stream orchid (*Epipactus gigantea*), and California bulrush (*Scirpus californicus*) (CINP 2002a). On the south side of Santa Cruz, riparian woodlands are found in Alamos Canyon and in the Coches Prietos drainage. The understory of this community is comprised of species found in the herbaceous riparian community as well as honeysuckle (*Lonicera hispidula* var. *vacillans*), blackberry (*Rubus ursinus*), and giant chain fern (*Woodwardia fimbriata*) in the wetter drainages. Stands of introduced *Eucalyptus* trees along some riparian corridors on Santa Cruz (such as in Scorpion Canyon, the Central Valley, and near Prisoner's Harbor) may have reduced flow in some streams, compared to pre-settlement conditions (Noon 2003).

Riparian corridors in the Park were substantially altered during decades of sheep and cattle grazing, and through the ongoing activities of feral pigs (Santa Cruz), and introduced elk and deer (Santa Rosa). On Santa Rosa, cattle grazing on uplands and extensive use of streams by cattle, elk and deer transformed streams into sediment-choked, braided channels with unvegetated banks (Wagner et al. 2004). The native woody species and perennial herbaceous riparian wetland species - that would ordinarily stabilize the banks, shade the streams, trap the sediment accompanying winter runoff, and dissipate the energy of storm flows - were practically eliminated. Natural riparian vegetation was relegated to portions of canyons too steep for livestock, elk or deer.

Cattle were removed from Santa Rosa in 1998. Following cattle removal in 1998, there has been a substantial recovery of the riparian corridors on Santa Rosa, which was documented in a pre-removal (1995) and post-removal (2004) study of ten reference stream reaches on the island (Wagner et al. 2004). The result of cattle removal has been a transition from the stream conditions described above toward streams with narrower, deeper, meandering channels with well developed floodplains and point bar development (Wagner et al. 2004). Water quality has improved in the streams (see Section II.C). Although the return of native perennial herbaceous species is widespread, the reestablishment of woody species (especially arroyo willow and black cottonwoods) is still hindered by browsing by deer and elk, and a postulated lack of seed sources. Cottonwood and willow seeds are short-lived (~1-2 weeks) and do not enter the seedbank. The paucity of willow and cottonwood stands on the islands after decades of grazing may necessitate the cultivation and transplantation of cuttings in order to facilitate reestablishment of these species (Wagner et al. 2004).

Feral sheep and pigs caused dramatic landscape alteration on Santa Cruz. In many areas of Santa Cruz the native riparian plant species have been locally extirpated and non-native plants and grasses occupy the riparian zone (CINP 2002a). Sheep were removed from TNC's portion of Santa Cruz in the 1980s and from NPS's portion of the island in 1999. Following the removal of feral sheep, there has been a substantial recovery of native upland vegetation on Santa Cruz (CINP 2002a).

Feral pigs are found in all locations and habitat types on Santa Cruz (Schuyler 1988). They favor oak woodland throughout the year, but especially during the fall when the acorn crop is available. Pig utilization of chaparral and grassland increases in winter and spring when grasses and forbs emerge. Coastal areas are the least utilized, year-round. Ridge tops and higher slopes are utilized primarily during the wetter, cooler months. During the dry months pigs are typically found in canyon bottoms or on middle or lower slopes, and are most likely to directly affect riparian corridors at that time. Extensive rooting by feral pigs has facilitated invasion of aggressive non-native weeds (notably fennel), and purportedly accelerated soil erosion and sediment transport into streams (CINP 2002a). A program to eradicate feral pigs did not begin on the island until 2005, and was still in progress as of this writing.

The amphibians in the Park are the black-bellied slender salamander (*Batrachoseps nigriventris*), the Pacific slender salamander (*Batrachoseps pacificus*), the Channel Islands slender salamander (*B. pacificus pacificus*), the Pacific treefrog (*Hyla regilla*), and the red-legged frog (*Rana aurora*). The Channel Islands slender salamander is endemic to the Channel Islands and is a Federal Species of Special Concern. Little appears to be known about the within-stream biota of Park streams. Some stream invertebrate sampling on Santa Cruz comprised part of a biogeographical study in the early 1980s, but the authors did not publish a taxon list for Santa Cruz (Pereira et al. 1982). The invertebrate fauna of Park streams has not been monitored. Water quality information for streams on Santa Rosa is presented in Section II.C.

C.2. Vernal Pools

Vernal pools are scattered on Santa Cruz and, more specifically, at the western end of the isthmus near China Harbor. It is presumed that these vernal pools once supported an assemblage of native flora but because of the intensive grazing history of the islands, most of the plant species that occur within these pools are weedy nonnatives. Non-native species identified by Junak et al. (1995) occurring in the vernal ponds near China Harbor include: Australian saltbush (*Atriplex semibaccata*), bindweed (*Convolvulus arvensis*), short-podded mustard (*Hirschfeldia incana*), common plantain (*Plantago major*), curly dock (*Rumex cripus*), common sow thistle (*Sonchus oleraceus*), and annual exotic grasses (CINP 2002a). At least twelve vernal pools occur on Santa Rosa (see Section I.B.2.b). When they were studied in April 1995, about half of the pools, on the west end of the island in Pocket Field, were being used by cattle and were bordered mostly by introduced grasses and mud (Furlong 1996). Pools that were less affected, or unaffected, by cattle at that time were bordered by chapparal or dune vegetation and emergent aquatic plants. The macroinvertebrate fauna (> 500 nm) of the Santa Rosa vernal pools is summarized in Table 2. Insect taxa were more diverse in the pools which were unused by cattle at that time, although microcrustacean diversity was similar in both categories of pools. Fairy shrimp (*Branchinecta lindahli*), the only obligate vernal pool species encountered, were observed in ponds on Santa Rosa (Furlong 1996, Soiseth 1994) and in a pond near Fraser Point on Santa Cruz (Soiseth 1994). Unidentified anostracans were collected from the vernal pool near Green Mountain on San Miguel (Soiseth 1994). Tadpoles were encountered in the vernal pools by Furlong (1996), but not identified to species.

Table 2. Macroinvertebrate fauna observed in a survey of 12 vernal pools on Santa Rosa Island in April, 1995. Adapted from Furlong (1996).

Class	Order	Genus or species
Crustacea	Anostraca	*Branchinecta lindahli*
	Copepoda	*Diaptomus franciscanus*
	Cladocera	*Daphnia magna*
		Moina
	Ostracoda	*Cypris*
		Cyprinotus
Insecta	Ephemeroptera	*Callibaetis*
	Odonata	*Sympetrum corruptum*
	Hemiptera	*Cenocorixa blaisdelli*
		Cenocorixa
		Corisella inscripta.
		Corisella sp.
		Trichocorixa
		Notonecta kirbyi
	Coleoptera	*Agabinus*
		Deronectes striatellus
		Hydroporus
		Hygrotus lutescens
		Laccophilus
		Liodessus
		Rhantus
		Berosus
		Enochrus hamiltoni pacifica
		Tropistemus
		Emplenote pacifica
		Narpus
	Diptera	*Culex*
		Culiseta
		Procladius
		Cricotopus
		Chironomus
		Orthocladium
		Microtendipes
		Corynoneura
		Tanytarsus
		Dolichopidid larva
		Eristalis

C.3. Coastal Wetlands and Lagoons

Small wetlands or marshes occur at the mouths or lower reaches of streams in several canyons on Santa Cruz including at Prisoner's Harbor, Scorpion Bay, and Smuggler's Cove (Noon 2003) and, according to CINP (2002a), at Canada de los Sauces and Canada de Malva Real. During the majority of the year, sand and gravel bars prevent intertidal exchange at the Prisoner's Harbor and Scorpion Bay wetlands (Noon 2003, Noon et al. 2005). Native plant species that can be found at one or more of the wetlands include California bulrush, cattail, arroyo willow, sticky Baccharis, mule fat (*Baccharis salicifolia*), alkali heath (*Suaeda taxifolia*), California saltbush

(*Atriplex californica*), Coulter's saltbush (*A. coulteri*), Brewer's saltbush (*A. lentiformis*), sandspurry (*Spergularia macrotheca*, and *S. marina*), saltgrass, rabbitsfoot grass, sour clover (*Melilotus indica*), alkali weed (*Cressa truxillensis*), alkali heath (*Frankenia salina*), and sea-blite (*Suaeda taxifolia*). Non-native plant species that occur at one or more of the wetlands include Australian saltbush, brassbuttons (*Cotula coronopifolia*), kikuyu grass (*Pennisetum clandestinum*), sicklegrass (*Parapholis incurva*), sea rocket (*Cakile maritima*), loosestrife (*Lythrum hysopifolium*), curly dock, yerba manse (*Anemopsis california*), weedy cudweed (*Gnaphalium luteo-album*), English plantain (*Plantago lanceolata*), goosefoot (*Chenopodium murale*), Boccone's sandspurry (*Spergularia bocconii*), and foxtail barley (*Hordeum murinum*) (CINP 2002a, Noon 2003). *Eucalyptus*, olive (*Olea europaea*) and tree tobacco (*Nicotiana glauca*) are non-native species that either dominate (in the case of *Eucalyptus*) or are rapidly colonizing the riparian floodplain terraces along several lower stream reaches (Noon 2003).

The ranching era resulted in substantial alterations of the wetlands on Santa Cruz. Some of them were extensively used by feral sheep. Since the removal of the sheep, vegetative cover, duration of flooding, and the depth of standing water has increased dramatically, especially in the estuaries on the south side of the island (Junak et al. 1995). Over the last 100 years, dredging has occurred in the lower reach of Scorpion Creek confining flow to a 35-foot wide, 800-foot long channel (Noon 2003). Much of the original floodplain and estuary has filled with sediment, or was graded by previous settlers. Currently, vehicles are driven across the floodplain to a storage area for a concessionaire's kayaks. In Smuggler's Creek, Park staff stabilized 75 feet of the north side of the channel in order to protect an archeological site. Dredging and filling of the wetland at Prisoner's Harbor also took place during the last 100 years, resulting in a 1,500 foot long, 40-foot wide channel bordered by berms. At this site, historic photographs indicate that gravel and sand fill were used to create a complex of corrals (which remain). Fill apparently came from both the dredged stream and nearby hillsides (Noon 2005). There is debate about whether this activity destroyed a small estuary at the site, or decreased the size of the palustrine wetland that occurs there now (Young 2004). The feasibility of restoring pre-settlement wetland geomorphology at these sites on Santa Cruz was recently investigated by Park personnel, and described in a series of reports (Noon 2003, 2005; Young 2004). In anticipation of a restoration project at Prisoner's Harbor, a series of 18 shallow ground water monitoring wells were installed in July 2005 in the lower floodplain of Canada del Puerto Creek, and soil and fill characteristics were described (Noon 2005).

Small wetland areas occur at the mouths of other streams on Santa Cruz and Santa Rosa Islands. As indicated in Section I.B., the status of these sites can alternate from freshwater seeps; to impounded winter runoff with palustrine vegetation; to small, brackish or saline lagoons produced by wave overwash. Small, but persistent, lagoons occur at three sites on Santa Cruz (at the mouths of Willows and Laguna Canyons, and at Christy Beach), and at six sites on Santa Rosa (at the mouths of Old Ranch, Old Ranch House, Water, El Jolla Vieja, and Arlington Canyons and Canada Tecelote). Lagoons on Santa Rosa are usually separated from the ocean by a sandy berm, and water levels are above sea level (Dugan and Hubbard 1990). Tidal exchange is infrequent, and salinity ranges from 0-150 ppt. Halophytic vegetation common at these lagoons includes saltgrass, jaumea (*Jaumea carnosa*), alkali heath, and pickleweed (*Salicornia virginica*). Wigeongrass (*Ruppia maritima*) can occupy up to 60% of some lagoon sites on Santa Rosa in the spring (Dugan and Hubbard 1990). Silver burr ragweed (*Ambrosia chamissonis*) can occur on the sand spit at Old Ranch House Canyon Lagoon (Cole and Liu 1994).

Water boatman (*Trichocorixa reticulata*) is the most common and ubiquitous macrofauna species inhabiting lagoons on Santa Rosa (Dugan and Hubbard 1990). Brine flies (*Ephydra packardii*) are abundant in the lagoons seasonally. Other fly larvae, such as ceratopogononid, chironomid, and chloropid larvae, *Coelopa vanuzei*, *Brachysia* sp. *Nemotelus* sp., *Tabanus*, and *Limonia marmora* are less frequently encountered (Dugan and Hubbard 1990, Richards 2004). Tiger beetles (*Cicindela hemorrhagica*, *C. hirticolis*, *C. roseiventris*) are common. Less frequent beetles include *Dyschirius marinus*, *Hydaticus* sp., *Oreodytes* sp., *Thinusa maritima*. The tube building polychaete (*Polydora cornuta*) can be abundant on the berm separating Old Ranch House Canyon lagoon from the beach. Topsmelt (*Atherinops affinis*) invades Old Ranch House Canyon lagoon during wash overwash in the spring, and can survive long enough to reproduce. The arrow goby (*Clevelandia ios*) also occurs in this lagoon.

The highest numbers of shorebird and waterfowl species are observed in the lagoons in September during migration. Least sandpipers, great blue herons, western sandpipers, killdeer, long-billed dowitchers, greater yellowlegs, and song sparrows were most frequently observed at lagoons (Table 3). American widgeon and northern pintail may overwinter at the lagoons. Ducks utilize the lagoons in winter months, and mallard ducks have been nesting in several of the lagoons in recent years. Snowy plovers breed in the lagoon areas and surrounding beaches on Santa Rosa during April-June (Dugan and Hubbard 1990). California brown pelicans sometimes feed in lagoons on Santa Rosa, and osprey and peregrine falcons are attracted to the areas (Dugan and Hubbard 1990).

Long-term monitoring of beaches and lagoons on Santa Rosa began in 1994 (Dugan et al. 1990). The lagoon habitats at the eastern end of Santa Rosa (Old Ranch Canyon Lagoon, Old Ranch House Canyon Lagoon, and Oat Point wetland) are surveyed annually for depth, transparency, salinity, and temperature (see Section II.C.6).

Table 3. Bird inventory for Old Ranch, Old Ranch House lagoons and Oat Point Wetland during 1988/89 survey by Dugan and Hubbard (1990)

Table . List of bird species observed at the three coastal lagoons during the study.

Species	Number of days sighted
Pied-billed Grebe	1
Brown Pelican	3
Brandt's Cormorant	3
Great Blue Heron	20
Black-crowned Night Heron (KD)	1?
Brant(DF)	1?
Mallard	2
Green-winged Teal	3
American Widgeon	11
Northern Pintail	6
Blue-winged Teal	3
Cinnamon Teal	2
Ruddy Duck	6
Surf Scoter	3
American Coot	14
Snowy Plover	12
Semipalmated Plover	10
Killdeer	25
Black-bellied Plover	5
Marbled Godwit	1
Whimbrel	1
Willet	4
Greater Yellowlegs	20
Wilson's Phalarope	3
Red-necked Phalarope	10
Red Phalarope	1
Long-billed Dowitcher	17
Common Snipe	1
Ruddy Turnstone	2
Dunlin	2
Western Sandpiper	18
Least Sandpiper	29
Baird's Sandpiper	5
Pectoral Sandpiper	4
Mew Gull	2
California Gull	1
Western Gull	10
Peregrine Falcon	2
Osprey	2
Red-tailed Hawk	2
American Kestrel	1
Mourning Dove	1
Black Phoebe	5
Say's Phoebe	2
Barn Swallow	13
Common Raven	8
Water Pipet	1
Chipping Sparrow	1
Song Sparrow	28+
Brewer's Blackbird	1

C.4. Sandy Beaches

Sandy beaches are a major component of the intertidal region of the northern Channel Islands. Sandy beaches dominate portions of Santa Cruz, Santa Rosa and San Miguel's shorelines. On Santa Rosa, sandy beaches make up approximately 30 km of shoreline, encompassing a wide variety of exposures and beach types. Approximately 20% of the shoreline of the California Channel Islands are sandy beach, in comparison to 80% of the shoreline of the southern California mainland coast (Richards 2004).

Macrophyte debris, primarily algal wrack, serves as a major source of energy for the beach communities. High depositional beaches, such as Sandy Point and Soledad West on Santa Rosa, face northwest into the prevailing winds and swell. Consequently, they receive large quantities of marine debris, carcasses, and macrophyte wrack, primarily *Macrocystis pyrifera* (Richards 1994, Dugan *et al.* 1993, Lerma and Richards 2002, Richards and Rich 2004). As a result of this allochthonous input, these tend to be the most productive beaches; however, they are also the most vulnerable to an oil spill (Richards 2004). There is a direct relationship between amphipod abundance and macrophyte wrack cover (Lerma and Richards 2000, Dugan et al. 2000, Richards 2004). Macrophyte wrack cover has increased at the beaches of Santa Rosa Islands from 1994-2004 (Richards 2004).

Key invertebrate fauna on sand beaches are sand crabs (*Emerita analoga* and *Blepharipoda occidentalis*), bloodworms (*Euzonus mucronata)*, isopods (Excirolana chiltoni), beachhoppers (*Megalorchestia* spp.), purple olive snails (*Olivella biplicata*) and Pismo clams (*Tivella stultorum*). Sandy beaches provide foraging and resting habitat for a number of shorebirds including black-bellied plover, willet, whimbrel, long-billed curlew, gulls, and sanderlings. Invertebrates in wrack on the upper beaches attract black and ruddy turnstones, dowitchers, and other shorebird species. Other birds observed at the sand beaches are black oystercatchers, common ravens, killdeer, snowy plovers, song sparrows, western gulls, and western sandpipers. Gulls and ravens are most common when there are carcasses on the beach. Song sparrows and black phoebes are often seen catching flies (Richards 2004). Snowy plovers nest on some beaches on San Miguel and Santa Rosa; visitor use of these areas is restricted during the nesting season. Pinnipeds haul out on sandy beaches, and breeding occurs at sites on San Miguel and Santa Rosa.

Five beaches (Abalone Rocks, Becher's Pier, China Camp, Sandy Point, and Soledad West) on Santa Rosa are surveyed annually by Park staff (Figure 11). Methods include bird censuses, physical measurements, clam gun (cores) transects of upper beach and washzone habitats, and point contact transects to determine macrophyte wrack cover. Annual reports describing data from the intertidal monitoring program from 1994-2004 are available at: http://www.nature.nps.gov/im/units/chis/HTMLpages/AnnlReports/MarineReports.htm.

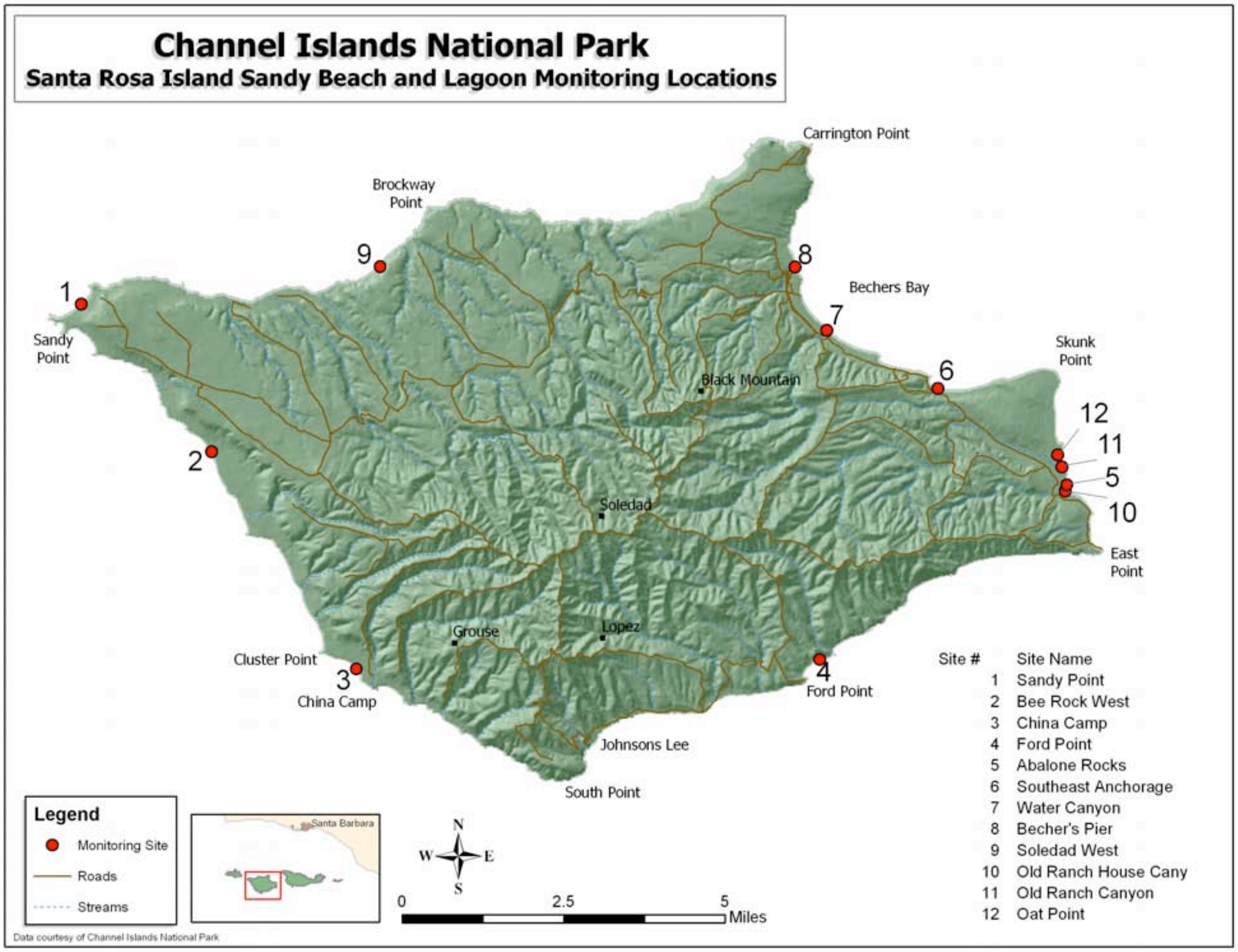


Figure 11. Sandy beach monitoring sites on Santa Rosa Island.

C.5. Intertidal Habitat[9]

The intertidal zone 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 m) 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. Lower gradients can result in intertidal regions tens of meters wide. Bottom substrate in the intertidal of the Park may consist of fine muds, sand, gravel, cobble, boulders, and bedrock. Rocky shoreline exceeds sandy shoreline in the Park. On a per island basis, the percent of shoreline consisting of bedrock ranges from 74% (Santa Barbara) to 62% (Santa Rosa). The contribution of boulder beaches to island coastline ranges from 22% (Santa Barbara Islands) to 0.2% (San Miguel). San Miguel and Santa Rosa Islands have the most sandy beaches (36% and 33%, respectively) (Ugoretz 2002). Sandy intertidal habitat occurs primarily

[9] Some of the material under Intertidal Habitat, Nearshore Subtitdal Habitat, and Deeper Water and Shelves, is modified from Ugoretz (2002).

on the southern shores, except for at San Miguel and Santa Rosa, which have sandy beaches on north and south shores.

Figure 12. Rocky intertidal monitoring sites at Channel Islands National Park.

In sandy and muddy intertidal zones, infauna - such as worms, crustaceans, snails, and clams - are more important than sessile or mobile epifuana. Rocky intertidal at the Park supports surfgrass and macroscopic crusts and turfs of green, brown and red algae. Sessile invertebrates include mussels, barnacles, limpets, and abalone (although the latter are less abundant now). Mobile invertebrates include snails, crabs, and sea stars. Acorn barnacles (*Chthamalus* spp.) generally dominate the upper rocky intertidal zone, and are commonly accompanied by other barnacles, such as *Balanus glandula* and *Tetraclita rubescens*. The next lower zone is dominated by a turf-like red alga (*Endocladia muricata*). The lowest zone is typified by the California mussel (*Mytilus californianus*). Only six fish are common inhabitants of the intertidal: wooly sculpin (*Clinocotus analis*), reef finspot (*Paraclinius integrippinus*), rockpool blenny (*Hypsoblennius gilberti*), spotted kelpfish (*Gibbonsi elegans*) and California clingfish (*Gobiesox rhessodon*) (Cross and Allen 1993).

Long term monitoring of rocky intertidal habitat began at the Park in 1982. Currently, the program consists of annual sampling at twenty-one permanent sampling sites (Figure 12) (Richards and Lerma 2005). Cover of dominant and target organisms are determined in fixed (50 x 75 cm) plots either in the field or from photographs. Black abalone (*Haliotis cracheroidii*) are counted and measured in fixed 1-11 m^2 plots, or in a search of a defined area of the reefs. Giant owl limpets *(Lottia gigantea)*, are measured within fixed circular plots of one-meter radius. Ochre sea stars *(Pisaster ochraceus*) are counted in a general search of the reef. Surfgrass cover, cover (*Phyllospadix* spp.) is measured in fixed point-intercept transects. Currently, motile invertebrates (small snails, chitons, limpets, etc.) are counted in the photoplots. Annual reports describing data from the intertidal monitoring program from 1982-2000 are available at: http://www.nature.nps.gov/im/units/chis/HTMLpages/AnnlReports/MarineReports.htm..

Appendix A lists common or significant marine plants and macroscopic algae found at the Park, including taxa monitored by the Park. Among these algal species, 6 species of green algae, 19 species of brown algae (including giant kelp, *Macrocystis porifera*, and feather boa kelp, *Egregia menziesii*), and 60 species of red algae are monitored at rocky intertidal sites by the Park (Richards and Lerma 2005). Appendix B lists over 130 species of marine invertebrates of particular interest or concern that occur in a variety of habitats at the Park. Among these, 4 species of anemones, 11 species of hydroids, 3 species of sponges, 4 species of polychaetes, 1 species of flat worms, 1 genus of ribbon worms, 5 species of barnacles, 8 species of crabs, 33 species of molluscs, 6 species of sea slugs, 3 species of chitons, 5 species of bivalves, and 7 species of sea star are currently monitored by the Park in the rocky intertidal (Richards and Lerma 2005). The most common shorebird that frequents the intertidal is the black oystercatcher (*Haematopus bachman).* Other shorebirds that frequent the rocky intertidal of the Park include black turnstones (*Arenaria melanosephala*), willets (*Cataptrophorus semipalmatus)*, wandering tattler (*Heteroscelus incanus)*, ruddy turnstones (*Arenaria interpres),* and western sandpipers (*Calidris mauri*), and (rarely) surf scoters (*Melanitta perspicullata*). Some sites that have headlands or reefs that extend out to sea are used as roosting areas by western gulls (*Larus occidentalis*), various cormorants (*Phalacrocorax* spp.) and California brown pelicans, (*Pelicanus occidentalis californicus*). Elephant seals (*Mirounga angustirostris*), California sea lions (*Zalophus californianus*) and harbor seals (*Phoca vitulina*) haul out on many exposed rocky benches.

<u>Intertidal species of special concern</u>. Black abalone and sea stars are both slow-growing, long-lived taxa with variable recruitment success. Black abalone populations in southern California suffered catastrophic declines since the mid-1980s that have resulted in nearly complete disappearance of the species along mainland shores south of Point Conception (Miller and Lawrenz-Miller 1993), as well as at many of the Channel Islands (Lafferty and Kuris 1993; Richards and Davis 1993). Commercial landings of black abalone peaked in 1973 and declined thereafter (Leet et al. 1992). Black abalone is now a candidate Federally Endangered Species. Mortality was associated with "withering syndrome", 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). Overfishing also played a role in population declines. Sport and commercial black abalone fisheries have been closed since 1993. Sea star diseases, usually observed in warmer waters, have been anecdotally reported in southern California a number of times since 1978 (Dungan et al. 1982), especially during the 1982-1984 El Niño (Eckert et al. 2000). A number of sea star species, including *Pisaster ochraceus* (ochre sea stars), *P. giganteus*, and *Asterina miniata*, were struck by a wasting disease in CHIS in 1997 (Eckert et al. 2000). An urchin-

specific bacterial disease entered the Channel Islands region after 1992 and has acted since then as a density-dependent mortality source (Lafferty 2004, Behrens and Lafferty 2004).

C.6. Nearshore Subtidal Habitat

Nearshore subtidal habitats range from the lower limit of the intertidal zone down to a depth of 30 m. In the Park, nearshore subtidal substrates include mud, sand, gravel, cobble, and bedrock. Light is sufficient within this zone to support kelp, eelgrass, surfgrass, and a variety of other algae. 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 intertidal habitats, shallow-water shores are subject to dynamic physical processes, including wave exposures, along-shore currents, upwelling, temperature/salinity/nutrient differentials, and suspended sediment loads.

a. Soft Bottoms

Nearshore soft bottom habitats in the Park consist mostly of sand. Epifauna adapted to shifting sand include sea pens, sea pansies, sand crabs, moon snails, sand dollars, sand stars, bottom-dwelling sharks and rays, and flatfishes. Infauna include worms, crustaceans, snails, and clams. Many sandy habitats at Park islands have relatively steep slopes. The sand is often coarse, shelly debris because there is little sediment runoff from land and strong water currents sweep organic material away. Stable sand habitats with fine grain sediments generally are limited to sheltered coves at canyon mouths, such as those found around Santa Cruz. 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. 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*). Invertebrates from the soft bottom subtidal habitat that are harvested in commercial or sport fisheries are geoduck (*Panopea abrupta*), warty sea cucumber (*Parastichopus parvimensis*), and the yellow rock crab (*Cancer anthonyi*).

b. Eelgrass beds

Eelgrass (*Zostera* spp.) has been found at 10 locations around the Northern Channel Islands at depths of 3 to 15 meters (Engle et al. 1998). 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 ha) occur at Smugglers Cove, Canada del Agua, and Prisoners Harbor on Santa Cruz and at Bechers Bay on Santa Rosa. Moderately sized beds (approximately 0.3 to 0.7 ha) are found at Scorpion and Forney Coves on Santa Cruz and at Johnsons Lee on Santa Rosa. A few small patches of eelgrass exist at Cathedral Cove and Cat Rock on Anacapa and at Yellowbanks Anchorage on Santa Cruz. Feeding "fronts" of white urchins, which prefer soft substrates, are believed to have eliminated eelgrass beds on the north side of Anacapa (Engle 1994). The single patch at Cathedral Cove is the only known remnant of widespread beds once scattered there (Ugoretz 2002).

A total of 278 species (and higher taxa) have been identified from eelgrass beds in the Park (number excludes most infauna, species requiring laboratory identification, or minute species, J. Engle and others, unpublished data). The diversity of conspicuous plant, invertebrate, and fish epibiota has been found to be 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 a brown alga (*Punctaria occidentalis*), a flatworm, (Phylloplana viridis), the sea hare (*Phyllaplysia taylori*), and a limpet (*Tectura depicta*), are epiphytes unique to *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*), 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 habitat for juvenile fishes, especially giant kelp fish, surf perches, senoritas, olive rockfish, and kelp bass (J. Engle, 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 (Ugoretz 2002).

c. Subtidal Rocky Reefs

High-relief subtidal volcanic reefs with walls, ledges, caves and pinnacles are widespread in the Park. Low-relief sedimentary reefs exist as well, particularly on Santa Rosa. The distribution of subtidal reefs at the Park is less well known than the distribution of the rocky intertidal reefs. However, nearshore reefs are often found offshore from the rocky intertidal habitat. Kelp beds generally are good indicators of subtidal reefs (except for beds of the *Macrocystis angustifolia* form that occur on sand). Numerous green, brown, and red algae occur, as well as surfgrass. Algal forms included are crusts, turfs, large blades, stalked plants (palm kelp), or kelp forest (giant kelp). Boring clams and sea urchins create holes and depressions in reefs comprised of softer sedimentary rock. Other common reef fauna are worms, crustaceans, molluscs, brittle stars, and fishes. Deeper current-swept reefs with less light have well developed attached suspension-feeding invertebrate cover, including sponges, sea anemones, sea fans, plume worms, bryozoans, and tunicates.

Invertebrates from subtidal reefs that are now, or were historically, harvested in commercial or sport fisheries are California hydrocoral (*Stylaster californicus*), brown rock crab (*Cancer antennarius*), red rock crab (*Cancer productus*), green, pink, red and white abalone (*Haliotus fulgens*, *H. corrugata*, *H. rufescens*, and *H. sorensen*, respectively), rock scallops (*Crassedoma giganteum*), red urchins (*Strongylocentrotus franciscans*), purple urchins (*Strongylocentrotus purpuratus*), spiny lobster (*Panulirus interruptus*). White abalone was declared an endangered species under the Federal Endangered Species Act in 2000. Owing to its persistent purple color, California hydrocoral used to be harvested for sale in shell shops, however the fishery is currently closed. In the Park, it is known from only a few deep reefs at Santa Barbara, Santa Cruz and San Miguel (J. Engle, unpublished data). Commercial divers harvest red urchins using hookah gear and rakes down to 33 m. Harvestable sizes of red urchins declined in the Park between 1985-1995 (decreasing from 15% to 7% of the total population at survey sites, Leet et al. 2001). Coincident with the decline of red urchins, purple urchins have increased markedly in number at many sites in the Park creating vast areas denuded of macroalgae, or "urchin barrens" (see *kelp forest* below) (Harold and Reed 1985, Ambrose et al. 1993, Engle 1994, Richards et al. 1997, Carroll et al. 2000, Lafferty and Kushner 2000). However, a poorly understood type of wasting disease was first noticed in subtidal populations of purple sea urchins in 1992 (Richards and Kushner 1994). A trophic cascade (commercial harvest of lobster -» release of predation pressure on urchins by lobster -» increases in urchin size and density -» density dependent mortality from disease) is postulated as the cause of epidemics affecting purple sea urchins in the Park (Lafferty 2004) and why rocky reefs inside fishing refugia are more likely to support kelp forest than reefs in fished areas (Behrens and Lafferty 2004). Only a small commercial harvest of purple urchin comes from the Channel Islands (Ugoretz 2002). The Channel Islands are a primary harvest location for the regional commercial rock crab trap fishery.

Nearshore reef fish. About 30 percent of the species and 40 percent of fish families in the Bight occupy hard substrate 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).

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 m. Surfgrass beds are highly productive ecosystems, providing structurally complex microhabitats for a rich variety of epiphytes, epibenthos, and infaunal species. For example, 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). Also, *Phyllospadix spp.* beds provide nursery habitat for various fishes and invertebrates, including the California spiny lobster (*Panulirus interruptus*). Spiny lobster juveniles shelter in the thicket of leaves and forage on a variety of tiny snails and clams.

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). Transplant projects undertaken to speed recovery of *Phyllospadix spp.* beds destroyed by shoreline construction in other regions have been largely unsuccessful.

d. Kelp Forest

Giant kelp (*Macrocystis pyrifera*) forms extensive underwater beds on subtidal reefs (except the *M. angustifolia* form on the south coast occurs on sand) between depths of 3 to 30 m throughout the Park. The complex vertical structure of highly productive kelp ecosystems provide 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. Although kelp has been harvested in the past in the Park, currently it is not (see Section III.B).

Kelp forests in the Park occur along two biogeographic and physical gradients (Davis 2005). Kelp forest assemblages of algae, invertebrates, and fishes in the cold, nutrient-rich waters of the western islands in the Oregonian zone (stretching north to Alaska) are distinct from those in the warm waters around the southeastern islands in the Californian zone (extending southward to the middle of Baja California in Mexico). A third assemblage occupies a transition zone between these two extremes (Figure 13). Physically, kelp forests north of the islands are exposed to winter storm waves from the Gulf of Alaska, while those on the southern shores are protected from winter storms. The islands' south coast kelp forests are exposed to large summer swells generated from winter storms in the Southern Hemisphere and nourished by seasonal upwelling from adjacent oceanic basins. These different physical settings created six discrete kelp forest zones (three biogeographic zones by two exposure zones).

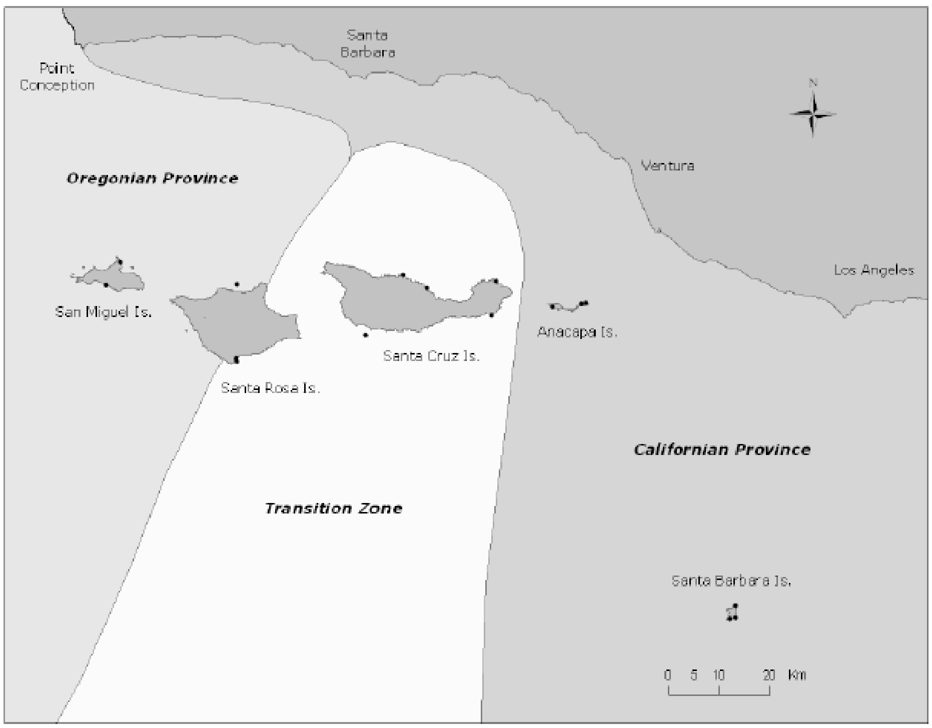


Figure 13. Biogeographic provinces in the Southern California Bight (Davis 2005).

Vertical structure. Kelp forest typically has several layers of understory algae that increase habitat heterogeneity (Dayton et al. 1984). Boa kelp, palm kelps, and bladder weeds can rise one or more meters off the bottom like bushes. Below these are smaller prostrate or low-growing algae less than one meter in height. Next lower can be a turf layer, and finally a crust layer often dominated by pink coralline algae (Ugoretz 2002). 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 invertebrates. Sea lions, seals, and occasionally whales use kelp beds as foraging areas.

Kelp forest monitoring. Nearly 1,000 species of marine fish, invertebrates, and algae occur in extensive kelp forests of *Macrocystis pyrifera* surrounding the islands (Davis et al. 1997). Since 1982, the Park has conducted long-term ecological monitoring of 63 kelp forest taxa on all five islands using permanent transects at 16 sites (Figure 14). Divers using SCUBA or surface-supply-air conduct surveys using random and fixed quadrats, band transects, random point contacts, photogrammetric plots, fish transects, roving diver fish counts, artificial recruitment modules (ARMs) and video transects. In 2005, 16 new monitoring sites were added to the long-term kelp monitoring program. These sites were added as part of a three year (2005-2007) study to collect baseline information inside and adjacent to four of the new marine protected areas. Annual reports produced by the kelp forest monitoring program from 1982-1999 are available on line at: http://www.nature.nps.gov/im/units/chis/HTMLpages/AnnlReports/MarineReports.htm.

Kelp mortality. Significant fluctuations in kelp abundance occur in the Park, related to both physical and biological factors. El Niños lead to significant losses of giant kelp for two main reasons; (1) higher temperatures and lower nutrient concentrations produced by intrusions of water masses from the South decrease kelp growth rates (Tegner and Dayton 1987), and (2) swell during powerful winter storms physically detaches and tears kelp plants. The impact of the El Niño in California depends on the strength of the event. Mild El Niños, that slowed kelp growth, were felt along the coast of California during 1977-1978 and 1992-1993. Especially strong events impacted kelp resources and stopped commercial kelp harvesting off California in 1941, 1957-1959, and 1982-1984. Storms associated with the 1982-1984 El Niño devastated kelp beds throughout California.

Overgrazing by urchins contributes to fluctuations in kelp extent at the Park. Red and purple urchins ordinarily subsist on drifting kelp fragments that settle into rock crevices. When drift plants are scarce, urchins emerge from crevices and become efficient grazers of kelp holdfasts, causing detached plants to drift away. Population explosions of urchins can denude entire kelp beds, creating "urchin barrens" (Ebeling et al. 1985, Murray and Bray 1993). Urchin barrens 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). Essentially absent for almost the last century in the Park, sea otters were historically important keystone predators of urchins in the Bight and at the Channel Islands. Their absence has likely contributed to the formation of urchin barrens. In addition there is now evidence that lobster harvest in the Park is linked to urchin barren development (Behrens & Lafferty 2004). Urchin barrens became increasingly common during the 1980s and 1990s at the Channel Islands. For example, as recently as 1999, 11 of the Park's 16 kelp monitoring sites were dominated by sea urchins, or were urchin barrens (Kushner et al. 2001).

<u>Kelp forest fish</u>. In the northern Bight, 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. 1980a, 1980b). 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 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. Other fish common in the water column of kelp forest are kelp bass (*Paralabrax clathratus*), giant kelpfish (*Heterostichus rostratus*), and kelp rockfish (*Sebastes atrovirens*). Fish that ambush their prey or graze, such as pile surfperch, (*Damalicthys vacca*) black surfperch, garibaldi, California sheephead (*Semicossphylus pulcher*) gopher rockfish (*Sebastes carnatus*) 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 beds are black surfperch (28 percent); at Santa Cruz, kelp bass (14 percent). Kelp beds are important

spawning areas for obligate species such as tubesnouts and, possibly, giant kelp fish, and are important nursery areas for juvenile fishes of many species (Carr 1989).

Figure 14. Original (red) and new (yellow) kelp forest monitoring sites at Channel Islands National Park. The new sites were added to the monitoring program in 2005 to better evaluate the effects of the Marine Protected Areas on kelp forest biota.

C.7. Deeper Water Shelves and Slopes

The deeper offshore habitats in the Sanctuary consist of offshore shelves, ridges, and banks (50 to 500 m deep), basin slopes (150 to 600 m deep), and basin floors (deeper than 600 m). Owing to bathymetry within Park boundaries, deep slopes are of less importance in the Park than offshore shelves. Except for a small area south of Anacapa, all of the marine habitat in the Park is <300 m (50 fathoms) in depth, and most of the waters within Park boundaries are <100 m (17 fathoms) deep. Well over 90 percent of deep-water benthic habitats around the Channel Islands consists of fine sands in shallower portions, grading into silt and clay-dominated sediments in deeper portions (SAIC 1986). Coarse sediments occur near Point Conception, and north of San Miguel (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 (Ugoretz 2002). Direct observations revealed that many previously reported hard-bottom areas are not exposed rock; instead, the reefs are 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 .

Soft bottom fauna. Most deep muddy-bottom invertebrates are detritus feeders. The stability of most deep-water soft-bottom habitats permits greater diversity of infauna and epifauna (life on or just above the substrate) compared to shallow particulate substrates disturbed by waves and surge. Typical infaunal 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. Epifauna include shrimp (*Pandalus spp.*), octopus (*Octopus spp.*), California sea cucumbers (*Parastichopus spp.*), seastars (Class Asteroidea), heart urchins (*Lovenia spp.*), and flatfishes (Families Bothidae and Pleuronectidae). Invertebrates from the deep water soft bottom that are harvested in commercial fisheries are California sea cucumbers, ridgeback prawns (*Sicyonia ingentis*) and spot prawns (*Pandulus platyceros*).

Hard bottom fauna. Deep water rocky-substrate invertebrates are predominantly suspension-feeders. Common invertebrates include sponges, anemones, cup corals, sea fans, bryozoans, feather stars, brittle stars, sea stars, and lamp shells. Demersal fishes can be common, 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 m) 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*.

C.8. Fish Fauna

About 481 species of fish inhabit the Bight (Cross and Allen 1993). This 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 Bight, (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.

Table 4 provides an overview of the fish species reported for the Park by the Inventory and Monitoring Program of the National Park Service (NPSpecies). Appendix C provides more detail for fish species that are targeted by commercial or sport fishermen, including regulatory actions, fishing regulations, and sources of on-line profiles of biology, fishing effort and stocks for individual species.

Table 4. Fish Fauna of Channel Islands National Park. All species listed appear on the NPSpecies list for the Park. Species marked by asterisks were on the list, but indicated as unconfirmed. Species indicated as taken by sport or commercial fishermen are explicitly referred to in the California Code of Regulations, Fish & Game Code, and the California Ocean Sport Fishing or Commercial Fishing Digests. Other finfish may be minor elements of the recreational or commercial catch. For details on fishing regulations see Section III.B and Appendix C.

Common Name	Scientific Name	Taken for Sport?	Taken Commercially?	Where Found
NEARSHORE SPECIES				
NEARSHORE ROCKFISH - (State designated category of species)				
Black and yellow rockfish	Sebastes chrysomelas	Yes	Yes	Intertidal-36m
China rockfish	Sebastes nebulosus	Yes	Yes	9-90m
Gopher rockfish	Sebastes carnatus	Yes	Yes	9-36m, reefs
Grass rockfish	Sebastes rastrelliger	Yes	Yes	Intertidal-6m
Kelp rockfish	Sebastes atrovirens	Yes	Yes	5-15m, water column in kelp
Black rockfish	Sebastes melanops	Yes	Yes	Intertidal-91m, kelp canopy
Blue rockfish	Sebastes mystinus	Yes	Yes	Intertidal-91m, kelp canopy
Brown rockfish	Sebastes auriculatus	Yes	Yes	3-55m, subtidal reefs
Calico rockfish	Sebastes dalli	Yes	Yes	20-280m
Copper rockfish	Sebastes caurinus	Yes	Yes	3-182m
Olive rockfish	Sebastes serranoides	Yes	Yes	1-121m
Quillback rockfish	Sebastes maliger	Yes	Yes	23-273m
Treefish	Sebastes serriceps	Yes	Yes	3-45m
Whitebelly rockfish	Sebastes vexilaris	Yes	Yes	
NEARSHORE GROUNDFISH				
California Halibut	Paralichthys californicus	Yes	Yes	usually < 100m, most abundant <30m
Starry Flounder	Platichthys stellatus	Yes	Yes	(down to 300m), but usually more shallow, esp. in bays
Sanddab, Pacific	Citharichthys sordidus	Yes	Yes	sand, mud 30-1800 ft
Sanddab, Speckled	Citharichthys stigmaeus	Yes	Yes	sand, mud surface to 1200 ft
Sanddab, Longfin	Citharichthys xanthostigma	Yes	Yes	sand, mud 7-660 ft
Sanddab, Gulf	Citharichthys fragilis	Yes	Yes	sand, mud 59-1140 ft
NEARSHORE CROAKERS				
*California Corbina	Menticirrhus undulatus	Yes	PROHIBITED	sandy beaches to 15m
*Spotfin Croaker	Roncador stearnsii	Yes	PROHIBITED	sand and mud 1-17m
Queenfish	Seriphus politus	Yes		
White Seabass	Atractoscion nobilis	Yes	Yes	rocky bottoms and kelp beds
White Croaker	Genyonemus lineatus	Yes	Yes	sand and mud, usually 3-30m
Yellowfin Croaker	Umbrina roncador	Yes	PROHIBITED	mostly <10m
Black Croaker	Cheilotrema saturnum			
SURFPERCHES (family Embiotocidae)				
Barred surfperch	Amphistichus argenteus			beaches
Black perch	Embiotoca jacksoni	Yes	Yes	rock and kelp
Calico surfperch	Amphistichus koelzi			beaches
Dwarf perch	Micrometrus minimus			rock and kelp
*Reef perch	Micrometrus aurora			
*Dwarf perch	Micrometrus minimus			
Zebra perch	Hermosilla azurea			
Island seaperch	Cymatogaster aggregata gracilis			
Kelp perch	Brachyistius frenatus			water column in kelp
Pile perch	Rhachochilus vacca			various shallow
Pink seaperch	Zalembius rosaceus			deep water
Shiner perch	Cymatogaster aggregata			various shallow
Sharpnose seaperch	Phanerodon atripes			rock and kelp
Striped seaperch	Embiotoca lateralis			rock and kelp

Common Name	Scientific Name	Taken for Sport?	Taken Commercially?	Where Found
Silver surfperch	Hyperprosopon ellipticum			beaches
Spotfin	Hyperprosopon anale			beaches
White seaperch	Phanerodon furcatus			various shallow
Walleye surfperch	Hyperprosopon argenteum			various shallow
Rainbow seaperch	Hypsurus carvi			rock and kelp
*Redtail surfperch	Amphistichus rhodoterus			beaches
Reef perch	Micrometus aurora			rock and kelp
Rubberlip	Rhacochilus toxotes			various shallow
OTHER REGULATED NEARSHORE FISH				
Cabezon	Scorpaenichthys marmoratus	Yes	Yes	Intertidal-76m
California Scorpionfish	Scorpaena guttata	Yes	Yes	3-182m
California Sheephead	Semicossyphus pulcher	Yes	Yes	3-55m
Greenling, Kelp	Hexagrammos decagrammus	Yes	Yes	Intertidal-50m, common 3-20m
*Greenling, Rock	Hexagrammos lagocephalus	Yes	Yes	Intertidal-shallow
Greenling, Painted	Oxylebius pictus	Yes	Yes	
*Greenling, Whitespotted	Hexagrammos stelleri	Yes	Yes	
Monkeyface Prickleback	Cebidichthys violaceus	Yes	Yes	Intertidal-24m
Southern spearnose poacher	Agonopsis sterletus		PROHIBITED	demersal, 42-91m, soft bottom
Lingcod	Ophiodon elongatus	Yes	Yes	mostly 10-110m
Giant Seabass	Stereolepis gigas	PROHIBITED	PROHIBITED	prefer nearshore rocky reefs 12-43m
Kelp Bass	Paralabrax clathratus	Yes	PROHIBITED	shallow to 50m, water column in kelp
Barred Sand Bass	Paralabrax nebulifer	Yes	PROHIBITED	usually < 30m
Spotted Sand Bass	Paralabrax maculato-fasciatus	Yes	PROHIBITED	shallow sandy-mud bays with surfgrass or eelgrass
Garibaldi	Hypsypops rubicundus	PROHIBITED	PROHIBITED	subtidal reefs
Wolf eel, northern wolfish	Anarrhichthys ocellatus		PROHIBITED	
California lizardfish	Synodus lucioceps	Yes		shallow sand, 1-50m
Opaleye	Girella nigricans	incidental	incidental	kelp beds, found to 30m
Spotted ratfish	Hydrolagus colliei		Yes	
UNHARVESTED NEARSHORE FISH				
Longspine combfish	Zaniolepis latipinnis			37-200m
Shortspine combfish	Zaniolepis trenata			
High cockscomb	Anoplarchus purpurescens			
Black prickleback	Xiphister atropurpureus			
Crisscross prickleback	Plagiogrammus hopkinsi			
Twoline prickleback	Esselenia laurae			
Threeline prickleback	Esselenia carli			
Masked prickleback	Ernogrammus walkeri			
Mosshead warbonnet	Chirolophis nugator			
Zebra perch	Hermosilla azurea			
Senorita	Oxyjulius californica			kelp canopy
Wooly sculpin	Clinocotius analis			rocky intertidal
Spotfin sculpin	Icelinus tenuis			
Lavender sculpin	Leiocottus hirundo			
Coralline sculpin	Artedius corallinus			
Scalyhead sculpin	Artedius harringtoni			
Smoothhead sculpin	Artedius lateralis			
Bonehead sculpin	Artedius notospilotus			
Roughback sculpin	Chitonotus pugetensis			
Calico sculpin	Clinocottus embryum			
Mosshead sculpin	Clinocottus globiceps			
Bald sculpin	Clinocottus recalvus			
Bull sculpin	Enophrys taurina			
Brown Irish Lord	Hemilepidotus spinosus			
Pit head sculpin	Icelinus cavifrons			
Threadfin sculpin	Icelinus quadriseriatus			
Yellowfin sculpin				
Rosy sculpin	Oligocottus rubellio			

Common Name	Scientific Name	Taken for Sport?	Taken Commercially?	Where Found
Fluffy sculpin	Oligocottus snyderi			
Snubnose sculpin	Orthonopias triacis			
Darter sculpin	Radulinus boleoides			
Smoothgum sculpin	Radulinus vinculus			
Roughcheek sculpin	Ruscarius creaseri			
Sailfin sculpin	Nautichthys oculofasciatus			
sculpin sp.	Artedius creaseri			
Reef finspot	Paraclinus integripinnis			rocky intertidal
*Rockpool blenny	Hypsoblennius gilberti			rocky intertidal
*Bay blenny	Hypsoblennius gentilus			
*Mussel blenny	Hypsoblennius jenkinsi			
High cockscomb	Anoplarchus purpurescens			
rockweed gunnel	Apodichthys fucorum			
Kelp gunnel	Ulvicola sanctaerosae			
Guadaloupe cardinalfish	Apogon guadalupensis			
Porcupinefish	Diodon hystrix			
Slimy snailfish	Liparis mucosus			
Spiny boxfish	Ostracion diaphanum			
Red brotula	Brosmophycis marginata			
Finescale triggerfish	Balistes polylepis			
Rock wrasse	Halichoeres semicinctus			
Blacksmith	Chromis punctipinnis			kelp canopy
Pacific butterfish	Peprilus simillimus			
Kelp gunnel	Ulvicola sanctaerosae			
Island kelpfish	Alloclinus holderi			
Crevice kelpfish	Gibbonsia montereyensis			
Giant kelpfish	Heterostichus rostratus			water column in kelp
Spotted kelpfish	Gibbonsia elegans			intertidal
Striped kelpfish	Gibbonsia metzi			
kelpfish sp.	Gibbonsia erythra			
Orangethroat pikeblenny	Chaenopsis alepidota			
Smooth ronquil	Rathbunella hypoplecta			
*Northern ronquil	Ronquilus jordani			
*Rough ronquil	Rathbunella alleni			
*Stripedfin ronquil	Rathbunella hypoplecta			
Sarcastic fringehead	Neoclinus blanchardi			
Yellowfin fringehead	Neoclinus stephensae			
Onespot fringehead	Neoclinus uninotatus			
California clingfish	Gobiesox rhessodon			intertidal
Northern clingfish	Gobiesox maeandricus			intertidal
Lined clingfish	Gobiesox eugrammus			
Kelp clingfish	Rimicola muscarum			
Slender clingfish	Rimicola eigenmanni			
California moray	Gymnothorax mordax			
Pacific saury	Coloabis saira			
Sargo	Anisotremus davidsoni	Yes		
Spotted cusk eel (1)	Chilara taylori			
Spotted cusk eel (2)	Otophidium taylori			
Tube snout	Aulorhynchus flavidus			
Ocean whitefish	Caulolatilus princeps			rocky reefs and sand
Scythe butterflyfish	Chaetodon falcifer			rocky reefs
*Mosshead warbonnet	Chirolophis nugator			
Snubnose pipefish	Cosmocampus arctus			
Barred pipefish	Syngnathus auliscus			
Great pipefish	Syngnathus californiensis			
Bay pipefish (1)	Syngnathus leptorhynchus			
Bay pipefish (2)	Syngnathus griseolineatus			
pipefish sp.	Syngnathus arctus			
Chocolate pipefish	Syngnathus euchrous			
Barcheek pipefish	Syngnathus exilis			
Deepwater blenny	Cryptotrema corallinum			

Common Name	Scientific Name	Taken for Sport?	Taken Commercially?	Where Found
Bay blenny	Hypsoblennius gentilis			
Salema	Xenistius californiensis	Yes		
Half Moon	Medialuna californiensis	incidental	incidental	shallow subtidal and kelp beds, found to 30m
SKATES and RAYS				
Shovelnose guitarfish	Rhinobatos productus	Yes		sand and mud to 17m
Banded guitarfish	Zapteryx exasperata			
Piked dogfish	Squalus acanthias	Yes	Yes	
Bat ray	Myliobatis californica	Yes		mud, sand, rocks and kelp; down to 50m
California Skate	Raja inornata	Yes	Yes	common <20m, (but may occur to 733m)
Thornback	Platyrhinoidis triseriata			shallow to 50m in sand
Pacific electric ray	Torpedo californica			3-467m, sand, rocky areas, kelp beds
Round stingray	Urolophus halleri			mostly < 17m, loose sand and mud
*California butterfly ray	Gymnura marmorata			shallow bays, sandy beaches
SILVERSIDES				
Jacksmelt	Atherinopsis californicus	Yes	Yes	bays and up to few miles offshore, spawn in eelgrass
Topsmelt	Atherinops affinis	Yes	Yes	bays and nearshore
Grunion	Leuresthes tenuis	Yes		nearshore down to 20m
GOBIES				
Bluebanded goby	Lythrypnus dalli			hard substrates
Zebra goby	Lythrypnus zebra			hard substrates
Arrow goby	Clevelandia ios			
Cheekspot goby	Ilypnus gilberti			
Bay goby	Lepidogobius lepidus		minor aquarium trade	
Halfblind goby	Lethops connectens			
Shadow goby	Quietula y-cauda			
Blind goby	Typhlogobius californiensis			
Tidewater goby	Eucyclogobius newberryi			
Blackeye goby	Coryphopterus nicholsi			hard substrates
NEARSHORE SHARKS				
Pacific Angel Shark	Squatina californica	Yes	Yes	range from 1-200m, remain buried in sand during day
Leopard Shark	Triakis semifasciata	Yes	Yes	most common in intertidal to 5 m, in CNIP in kelp beds, sandy bottoms near rocky reefs and surf zone on sandy beaches
*Soupfin Shark	Galeorhinus galeus	Yes	Yes	females <15m, males >22m, close inshore up to 500m
Swell shark	Cephaloscyllium ventriosum			
Horn shark	Heterodontus francisci			2-150m, demersal
Bronze whaler, copper shark	Carcharhinus brachyurus			reef associated 0-100m
Brown smoothhound	Mustelus henlei			
Gray Smoothhound	Mustelus californicus	Yes		
DEEPER FISH				
DEEPER GROUND FISH				
Longspine thornyhead	Sebastolobus altivelis	Yes	Yes	deep water, 600-1000m
Shortspine thornyhead	Sebastolobus alascanus			
Dover sole	Microstomus pacificus			60-1600m on mud bottoms
Sablefish	Anoplopoma fimbria			400-1400m
Pacific hake (whiting)	Merluccius productus			
Petrale sole	Eopsetta jordani			found 20-500 m
SHELF ROCKFISH (State designated category of species)				
Greenspotted rockfish	Sebastes chlorostictus	Yes	Yes	49-201 m

Common Name	Scientific Name	Taken for Sport?	Taken Commercially?	Where Found
Starry rockfish	Sebastes constellatus	Yes	Yes	24-274m, rocky reefs
Squarespot rockfish	Sebastes hopkinsi	Yes	Yes	18-183 m, reefs
Bocaccio ("red snapper")	Sebastes paucispinis	Yes	Yes	adults caught on rocky reefs 83-250m, kelp beds are nurseries
Cowcod	Sebastes levis	PROHIBITED	Yes	deep offshore on rocky habitat
Chilipepper	Sebastes goodei	Yes	Yes	deep offshore
Canary rockfish	Sebastes pinniger	PROHIBITED	Yes	common only to 166m
Shortbelly rockfish	Sebastes jordani	Yes	Yes	mostly at 133-233m over smooth bottom
Rockfish, Halfbanded	Sebastes semicinctus	Yes	Yes	
Rockfish, Rosy	Sebastes rosaceus	Yes	Yes	
Rockfish, Stripetail	Sebastes saxicola	Yes	Yes	
Rockfish, Vermillion	Sebastes miniatus	Yes	Yes	shallow subtidal to 466m
*Yelloweye Rockfish	Sebastes ruberrimus	PROHIBITED	Yes	
Yellowtail Rockfish	Sebastes flavidus	Yes	Yes	deep reefs near shelf break, down to 600m
Greenblotched rockfish	Sebastes rosenblatti	Yes	Yes	61-396m, demersal
Widow rockfish	Sebastes entomelas	Yes	Yes	pelagic, 0-549m
Pink rockfish	Sebastes eos	Yes	Yes	demersal, 76-366m
Rosethorn rockfish	Sebastes helvomaculatus	Yes	Yes	demersal, 25-549m, soft bottom
Speckled rockfish	Sebastes ovalis	Yes	Yes	30-366m, rocky reefs
Flag rockfish	Sebastes rubrivinctus	Yes	Yes	0-302m, rocky bottom
SLOPE ROCKFISH (State designated category of species)				
Blackgill Rockfish	Sebastes melanostomus	Yes	Yes	deep water offshore
Splitnose rockfish	Sebastes diploproa	Yes	Yes	bathydemersal, 0-800m
Redbanded rockfish	Sebastes babcocki	Yes	Yes	49-625 m, soft bottom
Bank Rockfish	Sebastes rufus	Yes	Yes	deep water offshore
DEEPER FLATFISH, generally				
Pacific Halibut	Hippoglossus stenolepsis	Yes	Yes	shallow to 1000m
Rex sole	Errex zachirus, Glyptocephalus zachurus	Yes	Yes	
English sole	Pleuronectes vetulus	Yes	Yes	40-300m
*Rock Sole	Pleuronectes bilineatus	Yes	Yes	shallow to 1000m
*Butter Sole	Pleuronectes isolepsis	Yes	Yes	
Fantail Sole	Xystreurys liolepis			
Sand Sole	Psettichthys malanostictus	Yes	Yes	
Slender Sole	Lyopsetta exilis			
Lefteyed flounders	Bothidae			
Bigmouth Sole	Hippoglossina stomata			
California tonguefish	Symphurus atricauda			
Curlfin turbot	Pleuronichthys decurrens	Yes	Yes	
Hornyhead turbot	Pleuronichthys verticalis			
Spotted turbot	Pleuronichthys ritteri			
Diamond turbot	Hypsopsetta guttulata			
C-O sole	Pleuronichthys coenosus			
*Arrowtooth flounder	Atheresthees stomias	Yes	Yes	
SKATES and RAYS				
Big skate	Raja binoculata	Yes	Yes	3m-867m
Longnose Skate	Raja rhina	Yes	Yes	27m-750m
*Sandpaper Skate	Bathyraja interrupta			moderate depth
Starry skate	Raja stellulata			moderate depth
OTHER DEEPER FISH: Benthopelagic/Bathypelagic/Bathydemersal				
Smooth stargazer	Kathetostoma averruncus			
Blacktip poacher	Xeneretmus latifrons		PROHIBITED	bathydemersal 18-400m, soft bottom
Pygmy poacher	Odontopyxis trispinosa		PROHIBITED	demersal, 9-373 m
Bluespotted poacher	Xeneretmus triacanthus		PROHIBITED	bathydemersal, 73-373 m
Fitch's scabbardfish	Lepidopus fitchi			100-500 m, usually sandy bottom
Bigfin eelspout	Lycodes cortezianus			73-620 m
ragfish	Icosteus aenigmaticus			0-1420 m

Common Name	Scientific Name	Taken for Sport?	Taken Commercially?	Where Found
Silvery hatchetfish, Sladen's hatchetfish	Argyropelecus sladeni			bathypelagic 0-2926 m
half-naked hatchetfish	Argyropelecus hemigymnus			bathypelagic 100-700 m
Bigeye lightfish	Danaphos oculatus			bathypelagic 183-914m
Showy bristlemouth	Cyclothone signata			bathypelagic 0-800m
Specklefin midshipman	Porichthys myriaster			
Plainfish midshipman	Porichthys notatus			
black-belly dragonfish	Stomias atriventer			bathypelagic, 100-1500m
Pacific blackdragon	Idiacanthus antrostomus			bathypelagic
Shiny loosejaw	Aristostomias scintillans			bathypelagic, 29-1010m
North-Pacific argentine	Argentina sialis			11-274m
Filetail catshark	Parmaturus xaniurus			91-1251m, demersal
Yellowtail jack	Seriola dorsalis	Yes		3-835m bentho-pelagic, and off kelp beds and rocky areas
*Great amberjack, yellowtail	Seriola lalandi	Yes	Yes	3-825m, bentho-pelagic, and off kelp beds and rocky areas
California smoothtongue	Bathylagus stilbius			bathypelagic, to 690m
Snubnose blacksmelt	Bathylagus wesethi			bathypelagic
California headlightfish	Diaphus theta			
Broadfin lampfish	Lampanyctus ritteri			
Pearly lanternfish	Myctophum nitidulum			
Flashlightfish	Protomyctophum crockeri			
Northern lampfish	Stenobrachius leucopsarus			0-3400m
Mexican lampfish	Triphotarus mexicanus			
Pacific hagfish	Eptatretus stoutii			demersal, 16-633 m
Spiny dogfish	Squalus acanthias	Yes	Yes	
EPIPELAGIC AND COASTAL PELAGIC SPECIES				
Pacific Bonito	Sarda chiliensis	Yes	Yes	deep coastal waters and open ocean
California Barracuda, Pacific Barracuda	Sphyraena argentea	Yes	Yes	
Pacific Sardine	Sardinops sagax	Yes	Yes	
Northern Anchovy, Californian anchoveta	Engraulis mordax	Yes	Yes	
Pacific mackerel	Scomber japonicus	Yes	Yes	
Jack Mackerel	Trachurus symmetricus	Yes	Yes	
Green jack	Caranx caballus			3-100m
*Mobula	Manta japonica			
*Pacific manta	Manta birostris			
*Pelagic stingray	Pteroplatytrygon violacea			
*King Salmon (Chinook)	Onchorhynchus tshawytscha	Yes	Yes	
*Steelhead trout	Onchorhynchus mykiss	PROHIBITED	PROHIBITED	
Ocean sunfish	Mola mola		PROHIBITED	
Great white shark	Carcharodon carcharias	PROHIBITED	PROHIBITED	
California flying fish	Cypselurus californicus			
Medusafish, brown rudderfish	Icichthys lockingtoni			pelagic to 91m, young hide in jellies
Basking shark	Cetorrhinus maximus		PROHIBITED	
Whiptail ribbonfish	Desmoderma lorum			
King-of-the-salmon	Trachipterus altivelis			
HIGHLY MIGRATORY PELAGIC FISHES				
*Albacore	Thunnus alalunga	Yes	Yes	
Broadbill swordfish	Xiiphias gladius	Yes	Yes	
*Pacific Northern Bluefin Tuna	Thunnus orientalis	Yes	Yes	
*Skipjack Tuna	Katsuwonus pelamis	Yes	Yes	
*Yellowfin Tuna	Thunnus albacares	Yes	Yes	
Striped Marlin	Tetrapturus audax	Yes	PROHIBITED	
Shortfin Mako Shark	Isurus oxyrinchus	Yes	Yes	

Common Name	Scientific Name	Taken for Sport?	Taken Commercially?	Where Found
Common Thresher Shark	Alopius vulpinus	Yes	Yes	
Bigeye Thresher	Alopias superciliocus	Yes		
Blue Shark	Prionace glauca	Yes	as bycatch	
*Opah	Lampris guttatus			
*Louvar	Luvarus imperialis			
*Dolphinfish (Mahi-Mahi, Dorado)	Coryphaena hippurus	Yes	Yes	

C.9. Seabirds and Shorebirds

Over 195 species of birds use open water, shore, or island habitats in the Bight south of Point Conception (Ugoretz 2002). The Park 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 shorebirds (Lehman 1994). The Channel Islands provide breeding and nesting sites for many species and large numbers of seabirds, including many threatened and endangered species. The diversity of habitats provided both on- and offshore also contributes to the high species diversity in the region. Sandy beaches provide foraging and resting habitat for a number of shorebirds including black-bellied plover, willet, whimbrel, long-billed curlew, gulls, and sanderlings. The upland portions of the beach provide kelp deposits (wrack) that attract invertebrates where black and ruddy turnstones, dowitchers, and other shorebird species forage.

Seabirds and shorebirds reported from the Park are listed in Appendix D. Eleven seabird species commonly breed in the park, and the islands are crucial breeding grounds for two species in particular: the California brown pelican and Xantus's murrelet (*Synthliboramphus hypoleuca)*. California brown pelicans are a federally listed endangered species. West Anacapa, Middle Anacapa (in 2006), East Anacapa (since 2005), Prince Island (an islet off of San Miguel, in 2006), and Santa Barbara Island are the only locations on the west coast of the United States where California brown pelicans breed[10]. Xantus's murrelets are considered a California species of special concern and are a globally rare seabird species (one of the ten rarest seabird species in the North Pacific, Ugoretz 2002). The world's population of Xantus's murrelet only breeds from the Channel Islands south to Central Baja California, Mexico. Eighty percent of the United States breeding population and 33.5 percent of the world's breeding population of Xantus's murrelet nests at the Channel Islands, primarily at Santa Barbara (Ugoretz 2002). Although it is not discussed further in this report, light pollution from squid boats is of concern in the Park, as the bright lights used to attract squid are believed to disturb the social interactions, foraging, and possibly the nest-tending behaviors of Xantus's murrelets, and other nocturnally active seabirds.

Seabird Monitoring. In 1985, the Park established a Seabird Monitoring Program. Monitoring protocols (locations, species) have varied from 1985 to the present. Since 1997, monitoring efforts have been concentrated at Santa Barbara. Breeding colonies, or nests, are monitored for the following species: double-crested (*Phalacrocorax auritus*), Brandt's (*Phalacrocorax penicillatus*), and pelagic (*Phalacrocorax pelagicus*) cormorants; pigeon guillemot (*Cepphus columba*); Leach's (*Oceanodroma leucorhoa),* ashy *(Oceanodroma homochroa),* and black

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[10] California brown pelicans began nesting at Prince Island (a small islet off San Miguel Island) in 2006, for the first time in over 70 years.

(Oceanodroma melania) storm-petrels; western gulls (*Larus occidentalis*), Xantus's Murrelet, and California brown pelican. Annual reports from the seabird monitoring program for 1990-1999 are available at:
http://www.nature.nps.gov/im/units/chis/HTMLpages/AnnlReports/MarineReports.htm.

Bald Eagles. Bald eagles are currently listed as threatened under the Endangered Species Act, but have been proposed for de-listing. They formerly bred on all of the Channel Islands, but were extirpated in the mid-20th century due to persecution and the effects of DDT and other related compounds (Kiff 1980). Santa Cruz regularly supported at least five pairs of bald eagles, which nested in niches and potholes on the sea cliffs. Known nesting areas included Pelican Bay, San Pedro Point, Blue Banks, Valley Anchorage, Chinese Harbor, Potato Harbor, and Middle Grounds. Anacapa had as many as three nesting pairs in some years. Kiff (1980) estimates that the Northern Channel Islands supported at least 10 nests, and probably more, at any one time. In 2002, a multi-agency effort to reintroduce bald eagles to the Northern Channel Islands began, using money obtained in the Montrose Chemical Company contaminant case settlement (see Section II.B.1). In that year 12 juvenile bald eagles were released on Santa Cruz, and similar releases occurred in the next four summers. As of January 2005, over 25 of the young. transplanted, bald eagles remained on the northern islands. (Some have left the area, the whereabouts of a few others are unknown, and a small number have died). Because bald eagles don't breed until 4-5 years of age, the first breeding attempts by the transplanted birds should occur in 2006 (CINP 2002a). On April 12, 2006, a bald eagle chick was successfully hatched by a pair of eagles that had been raised in captivity on Catalina Island, but which flew to Santa Cruz and made a nest there. This chick was the first bald eagle to hatch in the wild on the Channel Islands in over 30 years. One other chick, from a second nest, was successfully hatched in 2006.

C.10. Marine Mammals

Cetaceans. At least 33 species of cetaceans have been reported in the Sanctuary (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 (Table 5). 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 Sanctuary. 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, or rorquals.

Of the odontocetes, seven species are commonly seen, either during certain seasons or year-round. They are 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 (approximately 16°C). All cetaceans are protected under the Marine Management Protection Act. Additional protection status is conferred to some species under federal or state authority (Table 5).

Table 5. Cetacea occurring in the Channel Islands National Marine Sanctuary. Adapted from Ugoretz (2002).

Common Species Name (Scientific Name)	**Pop. or Stock Size**	**Protected Status [a]**	**Relative Abundance**	**Seasonality**	**Normal Habitat**
Odontocetes - Oceanic Dolphins and toothed whales					
Baird's Beaked whale (Berardius bairdii)			Rare		
Long-beaked common dolphin *(Delphinus capensis)*	Stock size: 89,800		Common	Year round	Coastal - up to 300 nautical miles offshore
Short-beaked common dolphin (*Delphinus delphis)*	Stock size: 372,000		Common	Year round	Coastal - up to 50 nautical miles offshore
Bottlenose dolphin *(Tursiops truncatus)* Offshore stock	Stock size: 2,555		Common	Year round	Shelf, slope and offshore
Bottlenose dolphin *(Tursiops truncatus)* Coastal stock	Stock size: 140		Common	Year round	Surf zone up to 1km offshore
Pacific white-sided dolphin (Lageno-*rhynchus obliquidens*)	Population: 12,1693		Sporadically abundant	Usually summer and fall	Shelf to farther offshore
Rough-toothed dolphin *(Steno bredanensis)*	Not available for area		Known only from a few strandings		Pelagic
Striped dolphin (*Stenella coeruleoalba)*	Not available for area				Pelagic
Long-snouted spinner dolphin *(Stenella longirostris*)	Not available for area		Possible during El NiZo events		Pelagic
Spotted dolphin *(Stenella attenuata)*	Not available for area		Known only from strandings		Pelagic
Northern right whale dolphin (*Lissodelphis borealis)*	Stock size: 21,332		Sporadically abundant	Winter and spring	Continental shelf and slope
Risso's dolphin *(Grampus griseus)*	Stock size: 32,376		Common	Year round	Shelf, slope and
Short-finned pilot whale *(Globicephala macrorhynchus)*	Stock size: 970		Uncommon	Most often summer and fall	Shelf, slope and offshore
Orca or Killer whale *(Orcinus orca)*	Stock size: 336		Uncommon	Year round	Shelf, slope and offshore
False killer whale *(Pseudorca cressidens)*	Not available for region		Rare		Shelf to offshore and pelagic
Cetaceans: Mysticetes - Right Whales					
Northern right whale *(Eubalaena glacialis)*	Not available for region	FE, DEP, SS	Extremely rare		Coastal
Cetaceans: Odontocetes - True Porpoises					
Dall's Porpoise *(Phocoenoids dalli)*	Stock size: 47,661		Uncommon	Winter and spring	Shelf to well off-shore
Harbor Porpoise *(Phocoena phocoena)*	Stock size: 5,732	SS	Uncommon		Shallow coastal
Cetaceans: Odontocetes - Sperm Whales					
Sperm Whale *(Physeter macrcephalus)* Family Physeteridae	Stock size: 1,191	FE, DEP, SS	Rare	April to mid June and August to mid November	Deep sea
Pygmy sperm whale *(Kogia breviceps)* Family Kogiidae	Stock size: 3,145		Uncommon		Deep sea, pelagic
Dwarf sperm whale *(Kogia simus)* Family Kogiidae	Stock size: 891		Known from three strandings		Deep sea, pelagic
Cetaceans: Mysticetes - Gray Whales					
California gray whale *(Eschrichtius robustus)*	Population: 26,600	Delisted from the Federal Endangered Species List in 1994	Common	December through May; occasionally rest of year	Coastal
Cetaceans: Mysticetes – Rorquals					
Blue whale *(Balaenoptera musculus)*	Stock size:1,785 to 2,200	FE, DEP, SS	Common in Season	June to September; occasionally through November	Shelf and slope

Common Species Name (Scientific Name)	Pop. or Stock Size	Protected Status [a]	Relative Abundance	Seasonality	Normal Habitat
Fin Whale *(Balaenoptera physalus)*	Stock size: 933	FE, DEP, SS	Uncommon	Summer, fall; possible year-round	Shelf and slope
Sei whale *(Balaenoptera borealis)*	Not available for region	FE, DEP, SS	Very Rare		
Bryde's whale *(Balaenoptera edeni)*	Stock size: 24		Rare		Shelf and slope
Minke whale *(Balaenoptera acutorostrata)*	Stock size: 631	SS	Uncommon	Year-round; Most abundant in summer and fall	Coastal to slope
Humpback whale *(Megaptera novaeangliae)*	Stock size: 843	FE, DEP, SS	Common in Season	May to September	Shelf and slope

[a] All pinnipeds and cetaceans are protected under the Marine Mammal Protection Act of 1972 (MMPA).
FE - Federally listed as endangered under FESA
FT- Federally listed as Threatened under FESA
DEP- Listed as a depleted stock under MMPA
SS- Listed as a strategic stock under MMPA
ST- State-listed as Threatened under the California Endangered Species Act
PRO- Fully protected mammal under CA Fish and Game Code 4700

Pinnipeds

Six species of pinnipeds haul out on park beaches and use park waters (Table 6). The four most abundant are the California sea lion, northern elephant seal, harbor seal and northern fur seal. Northern (Steller) sea lions and Guadalupe fur seals are observed very infrequently. Ribbon seals have been rarely observed in the Sanctuary. The westernmost beach on San Miguel, Point Bennett, is the only place in the world where up to six different species of pinnipeds can be found. In the winter, as many as 50,000 individuals seals, sea lions, and northern elephant seals can be seen at one time on Point Bennett, where they breed and where the pups are born. The beaches on the south side of San Miguel, and Cardwell Point on the east end of San Miguel, are important habitat for both northern elephant seals and California sea lions.

[The following summaries are largely drawn from Ugoretz, 2002]

California sea lion (*Zalophus californianus* California sea lions have two main rookeries at the Channel Islands, one at San Miguel, the other at San Nicolas Island (the latter outside of the Park). As many as 95% of the 16,000-17,000 pups born in the Channel Islands can be from these two rookeries (McGinnis 2000). Other rookeries exist at Santa Barbara and San Clemente islands (the latter outside of Park). Several haul-out sites exist on Santa Cruz and Anacapa Islands.

Northern (Steller) sea lion (*Eumetopias jubata*). The National Marine Fisheries Service manages the northern sea lion as two stocks. The eastern, or "*San Miguel*", stock (which includes those in California waters) is federally listed as threatened. The Steller sea lion once had two rookeries on San Miguel. After the El Niño event of 1982/1983, these rookeries were abandoned. Only one sighting of a Steller sea lion has been reported at the Channel Islands since that time.

Northern fur seal (*Callorhinus ursinus*) The northern, or Alaskan, fur seal has two rookeries of approximately 4,500 animals at San Miguel. These were reestablished in the late 1950s. The two rookeries have grown over the years to an estimated 4,300 animals (Barlow et al. 1997). At

San Miguel, 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 7 to 8 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 federally listed as threatened. 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 6,443 animals (Barlow et al. 1997), virtually all of which are found in Mexican waters at Guadalupe Island. A pup was born on San Miguel in 1997.

Northern elephant seal (*Mirounga angustirostris*). The California population is considered a separate stock (Barlow et al. 1997). Northern elephant seals have two large rookeries on San Miguel (Point Bennett) and San Nicolas Islands. On San Miguel, the south side beaches, and Cardwell Point on the east end, are also important areas (Dan Richards, Marine Biologist, Channel Islands National Park, pers. comm.). Smaller rookeries are found on Santa Barbara (especially at Webster Point and the Southeast Sea Lion Rookery) and Santa Rosa (at Sandy Point and Cluster Point in the southwest). They have also been reported at Santa Cruz and Anacapa Islands but have not established rookeries there. Barlow et al. (1995) indicate that the Channel Islands rookeries account for 85% of the births in California. The California stock was estimated at 84,000 animals in 1996 (Forney et al. 2000).

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*). 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. One estimate of the California stock is 30,293 animals (Forney et al. 2000). Harbor seals breed on all the islands, however, they do not form the large colonies that the other species do (Dan Richards, Marine Biologist, CINP, pers. comm.). Harbor seals pup from February through May. Some pups have been reported in December and January at several rookeries. The highest numbers are 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.

Table 6. Pinnipeds occurring in the Channel Islands National Marine Sanctuary. Adapted from Ugoretz (2002).

Common Name (Scientific Name)	Pop. or Stock Size	Protected Status[a]	Relative Abundance	Seasonality	Normal Habitat
California sea lion *(Zalophus californianus c.)*	Stock Size: 167,000 to 188,000		Common	Year round	Coastal
Steller sea lion *(Eumetopias jubata)*	No stock size available	FT, DEP, SS	Now extremely rare		Coastal
Northern fur seal *(Callorhinus ursinus)*	Stock size: 12,704		Uncommon	May to November	Pelagic
Guadalupe fur seal *(Arctocephalus townsendi)*	Population: 6443	FT, ST, SS, PRO	Extremely rare		Pelagic
Northern elephant seal (Mirounga *angustirostris)*	Stock size: 84,000	PRO	Common in season	December to August	Pelagic, Highly migratory
Pacific harbor seal *(Phoca vitulina richardsi)*	Stock size: 30,293		Common	Year round	Coastal
Ribbon seal *(Histriophocal fasciata)*	Not applicable		Extremely rare		

[a] All pinnipeds and cetaceans are protected under the Marine Mammal Protection Act of 1972 (MMPA).
FE - Federally listed as endangered under FESA
FT- Federally listed as Threatened under FESA
DEP- Listed as a depleted stock under MMPA
SS- Listed as a strategic stock under MMPA
ST- State-listed as Threatened under the California Endangered Species Act
PRO- Fully protected mammal under CA Fish & Game Code 4700

Southern Sea Otter

Once common around the islands, the southern sea otter (*Enhydra lutris nereis*) was hunted to local extinction by the end of the 1800's. Now, a few are spotted in the Park. The southern sea otter is considered protected, depleted and strategic under the MMPA, is a fully protected species under the California Endangered Species Act, and is a federally listed Endangered Species. Population size is ca. 2100 (USFWS 2003). From 1987-2001, USFWS caught and relocated all sea otters that appeared south of a line drawn from Pt. Conception to San Miguel. Relocation areas were near the city of Santa Cruz and Moss Landing to the north, and San Nicolas Island to the south. This activity was part of a political compromise designed to placate commercial fishermen of crab, urchins and lobsters in the Santa Barbara area, who were competing with the otters for crab, urchins and lobsters. As of 2003, the translocated colony at San Nicolas Island contained about 27 sea otters (USFWS 2003). On October 5, 2005, the USFWS announced its intent to end the relocation program and to allow sea otters to recolonize the Southern California coast at a natural rate. As a result, although sea otters have been essentially absent from the Park for almost a century, it is reasonable to expect that they will begin to recolonize the Channel Islands at some point in the future.

II. ASSESSMENT OF WATER QUALITY

A. WATERBORNE POLLUTANTS ARISING FROM THE MAINLAND

A.1. Pertinent Mainland Coastline

The Northern Channel Islands (San Miguel, Santa Rosa, Santa Cruz and Anacapa) are separated from the mainland by the Channel. Of these four islands, Anacapa is closest to the mainland; ~24 km separate East Anacapa and Port Hueneme, near the city of Oxnard. The north shores of San Miguel, Santa Rosa and Santa Cruz are ~50-65 km from the mainland coast. Runoff from the mainland directly enters the Channel from numerous small coastal streams that drain the southern slopes of the Santa Ynez mountains and from the mouths of the Ventura and Santa Clara Rivers. Santa Barbara is situated ~64 km from the nearest mainland point, Palos Verdes Point, in Los Angeles County. All five of the islands are subject to Bight-scale processes and current regimes. Coastal water quality from the west entrance of the Channel, at Point Conception, to the east entrance of the Channel, at Port Hueneme, is most directly relevant to the four northern Channel Islands. Owing to its southerly location outside of the Channel, Santa Barbara is more likely to be affected by coastal water quality from Point Mugu to (at a minimum) the mouth of the Los Angeles River.

A.2. Water quality jurisdictions

Water quality in California is regulated by the California Water Resources Control Board. The state is divided into the following nine Regional Water Quality Control Boards (Regional Boards):

Region 1: North Coast WQCB
Region 2: San Fransisco Bay WQCB
Region 3: Central Coast WQCB
Region 4: Los Angeles WQCB
Region 5: Central Valley WQCB
Region 6: Lahontan WQCB
Region 7: Colorado River Basin WQCB
Region 8: Santa Ana WQCB
Region 9: San Diego WQCB

The stretch of coastline most likely to deliver pollutants to Channel Islands National Park (north to south, from Point Conception to Los Angeles Harbor) is contained in Regions 3 and 4.

<u>Region 3.</u> Surface waters from Region 3 are assigned to 16 smaller areas referred to as *Hydrologic Unit*s (HUs). Two of these HUs are pertinent to this report: *South Coast HU 15* (which includes mostly first order streams draining the coastal mountains from Point Arguello to Carpinteria) and *HU 16* (which includes San Miguel, Santa Rosa and Santa Cruz) (Figure 15).

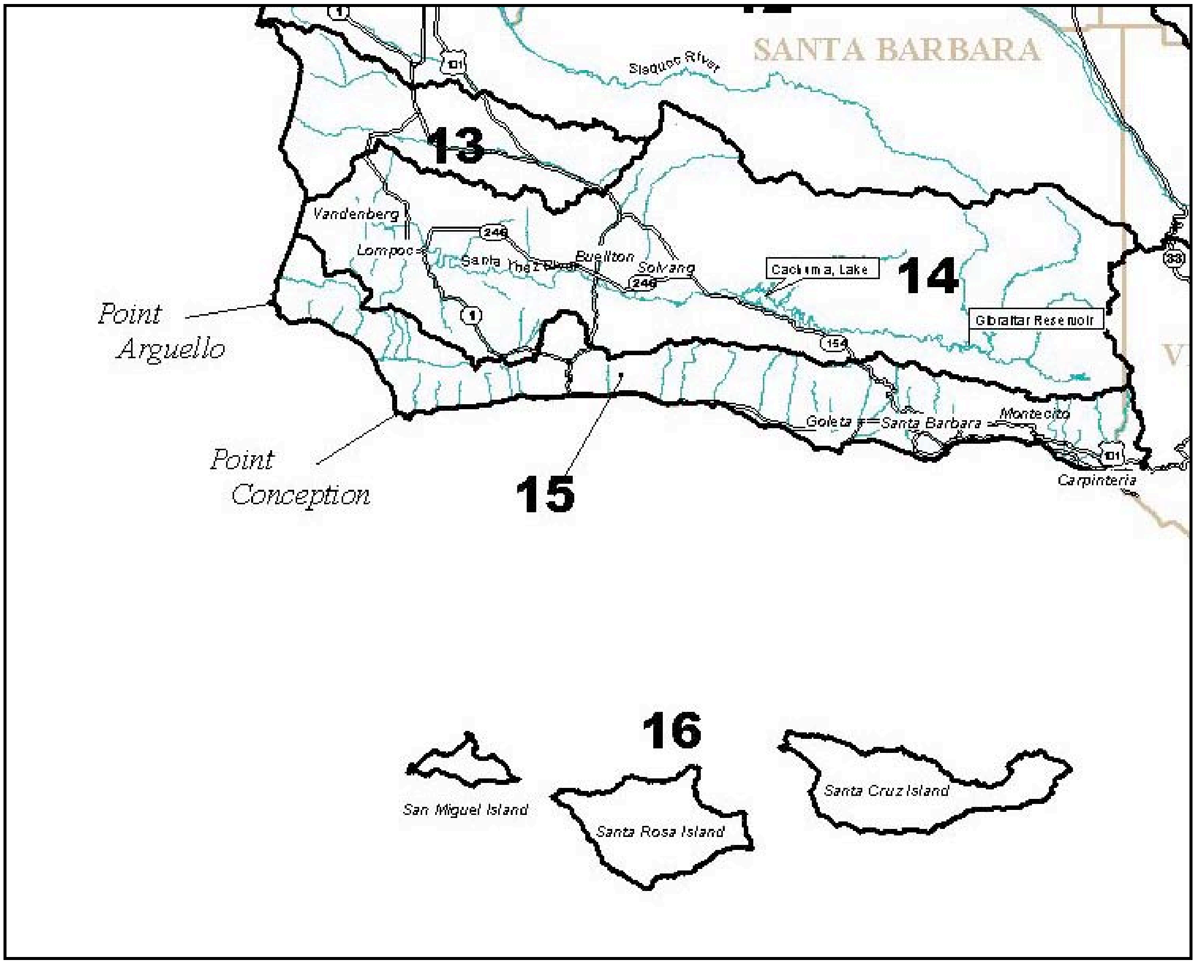


Figure 15. Southernmost Hydrologic Units in Region 3. Hydrologic Unit 15 (*"Central Coast"*) contains coastal streams that empty into the Santa Barbara Channel. Hydrologic Unit 16 contains surface waters on San Miguel, Santa Rosa and Santa Cruz Island (downloaded, and modified 8/2005 from www.waterboards.ca.gov/centralcoast/images/reg3map_001.jpg).

Region 4. Surface waters from Region 4 are assigned to one of ten *Watershed Management Areas* (WMAs) (Figure 16). State lists of 303(d) water quality limited segments and NPDES permits are developed for individual WMAs. Two of the islands in the Park (Anacapa and Santa Barbara) fall under the jurisdiction of Region 4, and constitute the "Channel Islands WMA". Storm flow from three other WMAs of Region 4 are especially pertinent as potential direct sources of pollution in the Channel:

(1) Misc. Ventura Coastal WMA (which is a collection of first order coastal streams, three harbors and one lake),
(2) Ventura River WMA, and
(3) Santa Clara River WMA.

Four other WMAs of Region 4 are pertinent as sources of pollutants to the coastal ocean in the vicinity of Santa Barbara Island:

(1) Calleguas Creek WMA,
(2) Santa Monica Bay WMA,
(3) Dominguez Channel WMA, and
(4) Los Angeles River WMA.

Owing to some development on Catalina, San Clemente and San Nicolas Islands, the Channel Islands WMA is also included in discussions below.

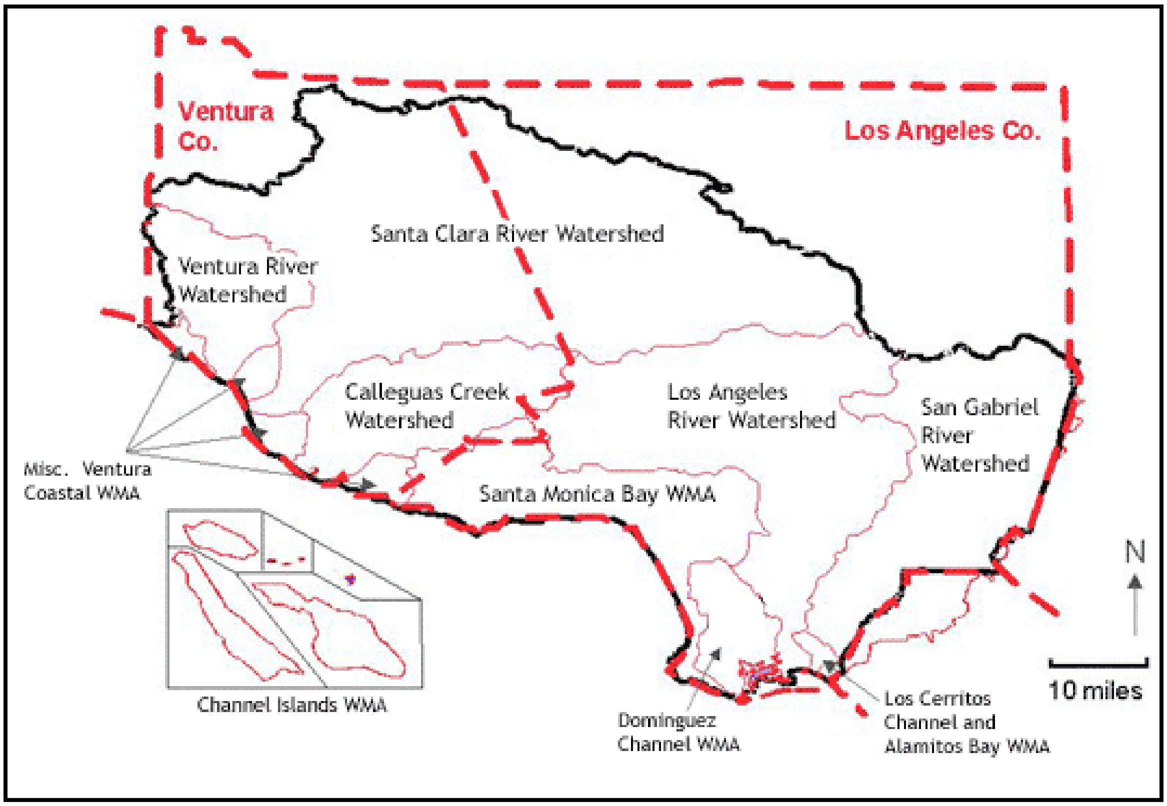


Figure 16. Division of Region 4 into Watershed Managements Areas (WMAs). Map was obtained from the Region 4 website: (http://www.waterboards.ca.gov/losangeles/html/programs/regional_programs.html#Watershed)

A.3. Point sources on Mainland

a. State permitted discharges to waterways (NPDES permitees)

As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Industrial, municipal, and other facilities must obtain permits if their discharges go directly into surface waters. In California, the NPDES permit program is administered by the State. The permits contain limits on what can be discharged, monitoring and reporting requirements, and other provisions. Pollutants include dredged soil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste. Point source means any discernible, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel, conduit, discrete fissure, or container. It also includes vessels or other floating craft from which pollutants are or may be discharged. By law, the term "point source" also includes concentrated animal feeding operations, which are places where animals are confined and fed. By law, agricultural stormwater discharges and return flows from irrigated agriculture are not "point sources".

NPDES waste water permits are either *individual* or *general*. An individual permit is specifically tailored to an individual facility. These are developed based on the type of activity, nature of discharge, and receiving water quality. Individual permits are further categorized into *Major* or *Minor* dischargers. *Major* dischargers are either (1) Publically Owned Waste Water Treatment Works (POTWs) with a yearly average flow of over 0.5 million gallons per day (MGD), (2) industrial sources with a yearly average flow of over 0.1 MGD, or (3) those with lesser flows but with acute or potential adverse environmental impacts. *Minor* dischargers are all other dischargers that are not categorized as Major. A *general permit* is an NPDES permit that covers several facilities that have the same type of discharges and are located in a specific geographic area (such as oil platforms, see Section II.B.2). A general permit applies the same or similar conditions to all dischargers covered under the general permit. Table 7 lists all permittees that discharge treated sewage directly into the ocean in the pertinent coastal areas.

b. POTW discharges: Historic and current threats

The major souces of pollutants in the Bight in the early 1970s were POTWs. In a notorious example, prior to 1971, the White's Point Outfall on the Palos Verdes Shelf (see JWPCP in Table 7) was the conduit for massive DDT and PCB release into the coastal ocean. Between 1947 and 1971, Montrose Chemical Corp. of California's Torrance manufacturing plant, seven miles inland, dumped about 1,800 tons of DDT and an undisclosed amount of PCBs into the Los Angeles County sewer lines, which terminate at the White's Point Outfall (see Section II.B.1). Owing to improved treatment, source control, and pretreatment, cumulative pollutant loads from POTWs have declined several fold - even orders of magnitude for some dischargers. For example, between 1971 and 1996, the percentage of combined wastewater flow by Bight POTWs subjected to secondary treatment rose from 10% to 49% (Schiff et al. 2000). This has resulted in recovery for some marine biota over the last 30 years. Fish diseases (such as fin rot and epidermal tumors) were common in the 1970s, but now are at background levels. Kelp beds near large sewage outfalls that were only a fraction of their historical extent in 1970 have experienced exceptional recruitment. Reductions in kelp extent to 1970 levels are currently only observed during El Niño events, such as during 1987-1988 (Schiff et al. 2000). Largely as a result of reductions in emissions from POTWs in the Bight, suspended solids and BOD decreased by 50%, heavy metals decreased by 90%, and chlorinated hydrocarbons decreased by 99%, in discharges to the ocean between 1971 and 1996. Consequently, urban runoff (stormwater) in the Bight now contributes significantly more suspended solids, nitrate, phosphate, chromium, copper, lead, nickel and zinc than discharges from small and large POTWs combined (Table 8). The main source of lead is oil platform discharges, and the main source of mercury is power plant discharges. PCBs are no longer detected in POTW discharges in the Bight (Schiff et al. 2000).

Summary. Appendix E lists all major, minor, and general NPDES wastewater discharge permits issued in coastal watersheds (as of 9/2005) from Point Conception to the mouth of the Los Angeles River. Owing to the enormity of the list, the specific contaminants associated with each permit, and reported violations from specific facilities, are not provided in the appendix. A north to south trend of increasing urbanization and industrialization - and increasing numbers of potential point-sources of pollution - is evident, however, following even a casual inspection of the list.

Table 7. POTW outfalls from treatment plants that discharge directly to the ocean from Point Conception to the mouth of the Los Angeles River.[a]

POTW (NPDES#)	**Treatment processes**	**distance from shore (feet)**	**depth (feet)**	**Comments**
Region 3, Unit 15				
Goleta CA0048160	Primary and secondary blended w. disinfection	5800	90	An upgrade to full secondary treatment is planned under a settlement for 2014. Treats sewage from Goleta, UC Santa Barbara, some of Santa Barbara County, Santa Barbara Municipal Airport
Santa Barbara CA0048143	Secondary with disinfection	8720	79	Up to 4.3 MGD can be recycled
Montecito CA0047899	Secondary with disinfection	1550	22	
Summerland CA0048054	Secondary with disinfection	740	19	Tertiary, except when filters are being changed
Carpinteria CA0047364	Secondary with disinfection	1000	25	
Region 4				
Oxnard CA0054097	Secondary	5280	48	
Hyperion (Los Angeles City) CA0109991	Secondary	10,000	200	2 additional outfalls used in emergencies. Some wastewater reclaimed and reused. Treats dry weather storm water runoff. Los Angeles, Beverly Hills, San Fernando, W. Hollywood, Santa Monica, Inglewood, Universal City, Alhambra, Pasadena, S. Pasadena, Culver City, and El Segundo
JWPCP LA County CA0053813 "White's Point Outfall"	Blended primary and secondary with disinfection	10,000	200	Called the White's Point Outfall. **Significant source of DDT** to Palos Verdes Shelf during 1950s-70s when Montrose Chemical Company operated - one of the nation's largest producers of DDT. Legacy effects from DDT contamination in this area are predicted to persist for another century[b].
Terminal Island (LA City) CA0053856	Tertiary with disinfection		outer LA Harbor	This plants treats wastewater from domestic sources and heavy industry. Reuse is being practiced. Terminal Island in the Los Angeles-Long Beach Harbor, communities of Wilmington, San Pedro and a portion of Harbor City.
Avalon CA0054372	Secondary	400	130	City of Avalon on Catalina Island
NALF, San Clemente Island WWTP	Secondary			Treats waste from a US Navy Auxiliary Landing Field

[a]Information on distances and depths, and some comments, obtained from "Heal the Ocean - "Ocean Wastewater Discharge Inventory for the State of California", report by Heal the Ocean to the California Ocean Protection Council, March 2005

[b]Distribution and Fate of Contaminated Sea-floor Sediment on the Shelf Offshore Los Angeles, introduction to USGS research at White's Point, and links to publications http://walrus.wr.usgs.gov/pv/. White's Point is discussed in Section II.B.1.

A.4. Non-Point Source Water Pollution from Mainland

a. State Storm Water Program

The 1987 Water Quality Act requires the EPA to issue NPDES permits for the several categories of stormwater discharges. This is an effort to regulate non-point source pollution generated by runoff from land and impervious areas such as paved streets, parking lots, and building rooftops during precipitation. Through the Regional Boards, the SWRCB issues NPDES permits to government and private entities for storm water discharges. This process is distinct from the issuance of NPDES permits for *waste water* discharges. Three different types of storm water permits are issued: municipal, construction and industrial. Once permits are issued, the permittees are obligated to certain monitoring and reporting procedures and to carrying out best management practices to limit contamination of storm flow with sediment and other contaminants.

Construction Permits. Owing to Stormwater Phase II Final Rule of 1999, operators of small construction sites (1-5 acres of disturbed area) became required to obtain a NPDES permit and develop a Storm Water Management Program (SWMP). Dischargers whose projects disturb one or more acres of soil, or whose projects disturb less than one acre but are part of a larger common plan of development that in total disturbs one or more acres, are required to obtain coverage under the General Permit for Discharges of Storm Water Associated with Construction Activity (Construction General Permit, 99-08-DWQ). Construction activity subject to this permit includes clearing, grading and disturbances to the ground such as stockpiling, or excavation, but does not include regular maintenance activities performed to restore the original line, grade, or capacity of the facility.

Industrial Permits. The federal storm water regulations, Code of Federal Regulations Section 122.26(b)(14), require the following facilities to obtain industrial stormwater permits:

1. Facilities subject to storm water effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards (40 CFR Subchapter N);
2. Manufacturing facilities;
3. Mining/oil and gas facilities;
4. Hazardous waste treatment, storage, or disposal facilities;
5. Landfills, land application sites, and open dumps that receive industrial waste;
6. Recycling facilities such as metal scrap yards, battery reclaimers, salvage yards, automobile yards;
7. Steam electric generating facilities;
8. Transportation facilities that conduct any type of vehicle maintenance such as fueling, cleaning, repairing, etc.;
9. Sewage treatment plants;
10. "Light industries" where industrial materials, equipment, or activities are exposed to storm water.

Table 8. Total mass emissions of selected pollutants from several sources to coastal ocean in the Southern California Bight. Table adapted from Schiff et. al. (2000).

		Percent of Total Load					
Constituent	**Total Load**	**Urban Runoff**	**Large POTWs**	**Small POTWs**	**Industrial Facilities**	**Power Plants**	**Oil Platform**
Year of estimate		1994-1995	1997	1995	1995	1995	1990
Flow		21.36	11.19	1.44	0.17	65.81	0.04
Suspended solids (mt)	674 200	88.76	10.90	0.29	0.05	0.01	«0.01
BOD (mt)	140 541	-	98.19	1.68	0.13	«0.01	«0.01
Oil and grease (mt)	19 922	-	96.37	2.32	0.45	0.14	0.72
Nitrate-N (mt)	9224	95.41	2.87	1.65	-	0.07	-
Nitrite-N (mt)	151	-	84.11	15.89	-	-	-
Ammonia-N (mt)	45 898	1.96	90.06	7.84	0.12	0.01	-
Organic N (mt)	5880	-	99.00	1.00	-	-	-
Phosphate (mt)	4702	61.68	38.32	-	-	-	-
Total P (mt)	1841	-	100.0	-	-	-	-
Cyanide (kg)	8026	-	80.99	18.71	«0.01	«0.01	0.30
Arsenic (kg)	5723	-	87.37	6.67	4.11	1.00	0.86
Cadmium (kg)	2085	-	47.01	21.68	0.21	30.94	0.16
Chromium (kg)	38 396	76.05	18.23	3.65	0.25	1.05	0.78
Copper (kg)	149 464	58.61	35.46	4.53	0.03	1.31	0.06
Lead (kg)	51 349	76.53	4.67	4.64	0.03	2.29	11.83
Mercury (kg)	262	-	8.39	4.19	0.03	85.38	2.02
Nickel (kg)	91 572	63.67	32.53	2.96	0.15	0.01	0.69
Selenum (kg)	9212	-	84.67	8.48	6.85	«0.01	«0.01
Silver (kg)	6031	«0.01	89.54	10.38	0.01	_0.01	0.07
Zinc (kg)	443 437	71.35	19.39	3.57	0.24	4.17	1.27
Phenols (kg)	166 643	-	97.57	0.02	0.84	«0.01	1.57
Chlorinated	2900	-	96.55	3.45	«0.01	«0.01	-
Nonchlorinated	94 966	-	99.83	0.17	«0.01	«0.01	-
Total DDT (kg)	3	-	91.18	8.82	«0.01	«0.01	-
Total PCB (kg)	«0.1	-	-	-	-	-	-

Municipal Permits. The Municipal Storm Water Permitting Program regulates storm water discharges from municipal separate storm sewer systems (MS4s). MS4 permits were issued in two phases. Under *Phase I*, which started in 1990, the Regional Boards have adopted NPDES storm water permits for medium (serving between 100,000 and 250,000 people) and large (serving 250,000 people) municipalities. Most of these permits are issued to a group of co-permittees encompassing an entire metropolitan area. These permits are reissued as they expire.

Under *Phase II*, which started in 1999, MS4s serving less than 100,000 people must obtain a NPDES permit, called a General Permit for the Discharge of Storm Water from Small MS4s (WQ Order No. 2003-0005-DWQ). Included as MS4s are smaller municipalities, including non-traditional small MS4s (governmental facilities such as military bases, public campuses, and prison and hospital complexes). The permit must describe how the regulated entity will identify and implement a range of Best Management Practices into an effective SWMP that reduces the discharge of pollutants to the maximum extent practicable (MEP). MEP is the performance standard specified in Section 402(p) of the Clean Water Act. SWMPs include public education and outreach; illicit discharge detection and elimination; construction and post-construction; and good housekeeping for municipal operations. In general, medium and large municipalities are required to conduct chemical monitoring, though small municipalities are not.

Region 3. As of 9/2005, no Phase I municipal stormwater permits had been issued in HU 15 (as of 9/2005, Salinas was the only Phase I municipal permittee in Region 3). The following Phase II municipal permits have been applied for, or approved, in HU 15:

- Isla Vista (applied)
- Carpinteria (approved)
- Santa Barbara, City (applied)
- Summerland (applied)
- Goleta (applied)
- Santa Barbara County (applied)
  The permit includes the urbanized unincorporated areas of the county on the South Coast, in the Santa Ynez Valley, and in the Orcutt area of the Santa Maria Valley. In May 2004 the County of Santa Barbara released its Draft Storm Water Management and Discharge Control Ordinance as required by the Phase II storm water regulations.

Region 4. As of 9/2005, the following Phase I municipal stormwater permits had been issued in Region 4:

- City of Long Beach (NPDES #CAS004003)
- County of Los Angeles and the Incorporated Cities Therein except the City of Long Beach (NPDES #CAS004001)
- Ventura County (NPDES #CAS004002)
  This permittee is a partnership of the County of Ventura, Ventura County Flood Control District, and the Cities of Camarillo, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, San Buenaventura (Ventura), Santa Paula, Simi Valley, and Thousand Oaks.

b. Contaminants present in mainland water bodies draining to ocean.

303(d) Listed Water Bodies. California's SWRCB and the nine Regional Boards are responsible for monitoring, assessment, and reporting under Clean Water Act Sections 303(d) and 305(b) for the State of California. The State Board and Regional Boards cooperate in developing Section 305(b) and Section 303(d) listing reports. *For the purposes of this report, the 303(d) lists provide an indication of the overall levels of pollution in the coastal watersheds in the vicinity of the Park, and the diversity of contaminants present in waterbodies drain into the ocean along the pertinent stretch of coastline*. Appendix F provides a complete list of all pertinent 303(d) listed waters, and reported impairments, from Regions 3 and 4. Types of impairments reported from Region 3 (HUs 15-16) and Region 4 are summarized in Tables 10 and 11, respectively.

Table 9. Categorization of NPDES permits from Point Conception to the mouth of the Los Angeles River (as of 9/2005). Owing to their temporary nature, the number of active Construction Stormwater Permits in any jurisdiction changes frequently.

Hydrologic Unit	**Waste Water Permits**	**Storm Water Permits**
Region 3 Hydrologic Units		
Unit 15	Major: 6 includes. 5 POTWs Minor: 1	Municipal: 1 (Carpinteria) Industrial: 37 Construction: 62
Unit 16	none	none
Region 4 WMAs		
Southern Channel Islands	Major: 1 (Catalina Island) Minor: 4	Industrial: 5 Construction: 1
Misc. Ventura	Major: 4 1 POTW and 2 generating stations Minor: 9 General: 11	Industrial: 82 Construction: 92
Ventura River	Major: 1 POTW discharging to middle reach, upgraded to tertiary treatment General: 6	Industrial: 37 Construction: 13
Santa Clara River	Major: 4 POTWs (one discharging to estuary, one to middle reaches, two into upper watershed) Minor: 11 General: 15	Industrial: 114 Construction: 317
Calleguas Creek	Major: 5 (all POTWs) Minor: 6 General: 13	Municipal: 1 Industrial: 73 Construction: 276
Santa Monica Bay	Major: 7 includes 3 POTWs (two direct ocean discharges), one refinery, 3 generating stations Minor: 21 General: 158	Industrial: 87 Construction: 220
Dominguez Channel and Los Angeles/Long Beach Harbors	Major: 9 includes 1 POTW, 2 generating stations, 5 refineries Minor: 48 General: 0	Industrial: 399 Construction: 134
LA River	Major: 144 includes 4 POTWs Minor: 23 General: 114	Municipal: 2 Industrial: 1336 Construction: 436

sources of data:
Region 3:
SWRCB Stormwater Site, Construction Permit Database (http://swrcbnt3.swrcb.ca.gov/stormwater/search/ConSearch.asp),
Industrial Permit Database (http://swrcbnt3.swrcb.ca.gov/stormwater/search/IndSearch.asp)
Municipal Permit Database (http://www.swrcb.ca.gov/stormwtr/municipal.html)
Region 4: watershed management site: http://www.waterboards.ca.gov/losangeles/html/programs/regional_programs.html#Watershed

According to current 303(d) lists, coastal watersheds in Region 3 are much less polluted than in Region 4. The majority of the pollutants in Region 3 are pathogens (unspecified), fecal coliform, or total coliform in stream segments, stream mouths, or beaches. Toxicants (priority organics and metals) were only reported from two water bodies (Carpinteria Marsh and Goleta Slough). Most of the contamination in Region 4 originates south of the Santa Clara River watershed. No toxicants were reported from the Ventura River watershed, although there were bacterial and nutrient exceedances in some reaches. The Santa Clara River watershed was also affected by nutrient and bacterial contamination, but only one toxicant was reported from the watershed (toxiphene, in the river's estuary). Although most of the NPDES waste water permittees in the Misc. Ventura WMA discharge into coastal streams, no exceedances were reported in lotic systems in this hydrologic unit. Instead, contamination with metals and other toxicants was reported for Channel Island Harbor, Port Hueneme, and McGrath Lake, which are situated in the Oxnard Plain south of both Ventura and the mouth of the Santa Clara River. According to the CA 303(d) lists, no impaired waters occur on any of the Channel Islands (Unit 16 in Region 3, plus Channel Islands WMA in Region 4), including all of the islands within the Park, plus Catalina, San Clemente and San Nicolas Islands.

Table 10. Types of impairments in 303(d) listed waters (coastal streams, beaches and sloughs) in Region 3, Hydrologic Unit 15 (vicinity of city of Santa Barbara to the Ventura County line). No impairments were reported for Unit 16 (San Miguel, Santa Rosa and Santa Cruz Islands). See Appendix F for the complete list of 303(d) listed segments from this part of the coast.

Fecal Coliform
Low DO
Metals
Nutrients
Pathogens
Priority Organics
Total Coliform
Unknown toxicity

Owing to high numbers of point sources and permitted discharges, and the wide range of contaminants in surface waters from the Calleguas Creek WMA southward, it is very likely that mainland runoff entering the coastal ocean from Point Mugu to the mouth of the Los Angeles River is much more polluted than runoff north of Point Mugu. Mainland runoff *directly* entering the Channel (which occurs from Port Hueneme to Point Conception) should carry a smaller load of pollutants than mainland runoff south of the Channel. Santa Barbara Island is most directly offshore from the Palos Verdes Point, at the southern end of Santa Monica Bay. To the extent that pollutants can be transported 36 miles from the shore to Santa Barbara Island, contaminants from many of the hydrologic units of Region 4 represent potential threats to water quality in the Park (but see Section II.A.6). During synoptic flow regimes that transport water from the Bight offshore of Los Angeles County poleward into the Channel (*Relaxation* and *Flood West* regimes, see Section I.B.1) pollutants from Region 4 are potentially transported into the Channel. For these reasons, summary discussions of the overall condition of surface waters in each of the pertinent WMAs of Region 4 are provided in Appendix G. These discussions provide some guidance in setting priorities for addressing the risks to the Park represented by dry weather or wet weather flow from the principal drainages in Region 4.

Table 11. Types of impairments in 303(d) listed waters (streams, rivers, beaches, channels, sloughs, harbors, bays, lakes) in Region 4 from the Ventura County/Santa Barbara County line to the mouth of the Los Angeles River. See Appendix F for the complete list of 303(d) listed segments from this part of the coast.

aldrin (tissue)	enteric viruses	PCBs (tissue & sediment)
algae	eutrophic	PCBs (tissue)
aluminum, total	eutrophic trash	pesticides
ammonia	exotic vegetation	pH
beach closures	fecal coliform	reduced tidal flushing
benthic comm. effects	fish barriers	scum/foam-unnatural
boron	fish consumption advisory	sediment toxicity
cadmium	habitat alteration	sedimentation/siltation
cadmium (sediment)	hexachlorocyclohexane (HCH) (tissue)	Selenium
cadmium, dissolved	hydromodification	Selenium, total
ChemA* (tissue)	Lead	shellfish harvesting advisory
chlordane (sediment)	Lead (in sediment)	silver (sediment)
chlordane (tissue - fish consumption advisory)	Lead (sediment)	specific conductance
chlordane (tissue & sediment)	Lead (tissue)	sulfate
chlordane (tissue)	Lead, dissolved	swimming restrictions
chloride	Low DO	Tetrachloroethylene/PCE
chlorpyrifos (tissue)	low DO/organic enrichment	total dissolved solids
chromium (sediment)	Mercury	toxaphene
coliform	Mercury (sediment)	toxaphene (tissue & sediment)
coliform, fecal	Mercury (tissue)	toxaphene (tissue)
copper	nickel	toxaphene (tissue)
copper (sediment)	Nickel (sediment)	toxicity
copper (tissue & sediment)	nitrate (NO3)	trash
copper, dissolved	nitrate + nitrite	Trichloroethylene/TCE
dacthal (sediment)	nitrogen	Zinc
DDT	nutrients (algae)	Zinc (sediment)
DDT (fish consumption advisory)	odors	Zinc (tissue & sediment)
DDT (sediment)	oil	zinc, dissolved
DDT (tissue & sediment)	organophosphorus pesticides	
DDT (tissue)	PAHs	
debris	PAHs (sediment)	
Dichloroethylene/1,1-DCE	PAHs (tissue & sediment)	
dieldrin (sediment)	pathogens	
dieldrin (tissue)	PCBs	
endosulfan (tissue & sediment)	PCBs (fish consumption advisory)	
endosulfan (tissue)	PCBs (sediment)	

A.5. Contamination and Toxicity in Storm Plumes

Episodic storms, typically occurring late fall through early spring, contribute up to 95% of the annual runoff volume and pollutant load in the Bight (Schiff et al. 2000). Current estimates of mass emissions for the southern California region indicate stormwater discharges of many constituents rival, and often exceed, those from combined point sources (e.g. nitrate, phosphate, chromium, copper, lead, nickel and zinc (Table 8). More than 60% of the southern California shoreline exceeds water contact standards for bacteria following wet weather events. However, Ahn et al. (2005) discovered that severe bacterial contamination in the surf zone from stormwater discharged from the Santa Ana River (south of Los Angeles) was limited to a fairly small stretch of the beach (<5 km on either side of the river). They postulated that the spatial confinement of the contamination resulted from physical transport processes (e.g., dilution by rip cell-mediated exchange of water between the surf zone and offshore) or nonconservative processes (e.g., the removal of fecal indicator bacteria from the surf zone by die-off or sedimentation) (Ahn et al. 2005).

Direct measurements of chemical contaminants in offshore storm plumes are scarce. However, storm drain discharges in Southern California have been shown to be toxic to marine and freshwater organisms and this toxicity persists to some degree as discharge plumes spread through coastal receiving waters (Jirik et al. 1998). Toxicity tests, measuring the ability of sea urchin sperm to fertilize eggs, were conducted on stormwater collected from Ballona Creek and surface water of storm plumes in the Santa Monica Bay (Bay et al. 2003). Toxicity was present whenever plume water contained at least 10% creek water. Toxicity was detected at a maximum of 4 km offshore after a 2-year storm in Feb. 1996. Dissolved zinc, and occasionally dissolved copper, were found to be at toxic levels in undiluted stormwater from Ballona Creek, and postulated to be the constituents responsible for much of the toxicity in tests conducted on plume water. Overall, dissolved constituents were responsible for more toxicity than particle-bound constituents in creek water. However, particle-bound toxicity was relatively more important in plume water at sea than it was in creek water upstream of the mouth. Zinc was similarly implicated in toxicity tests of Chollas Creek stormwater in the San Diego Bay (Schiff et al. 2003).

A.6. Likelihood that Mainland Storm Plumes enter the Park

a. Mainland storm plumes that enter the Channel

Otero & Siegel (2004) evaluated four years (Oct. 1997-Jun. 2001) of Advanced Very High Resolution Radiometer (AVHRR) and Sea-viewing Wide-Field-of-View sensor (SeaWiFS) data for the Channel. Normalized water-leaving radiance at 555 nm, or *LwN(555)*, was used as a proxy for suspended sediment to delineate plumes at sea produced by mainland runoff. The annual cycle for mean monthly LwN(555), computed by Otero & Siegel (2004) for the whole period, is presented in Figure 17. It shows that most sediment enters the coast between Ventura and Oxnard (owing to the mouths of the Ventura and Santa Clara Rivers), and that, on average, February is the month during which sediment plumes penetrate furthest offshore into the Channel toward Anacapa and Santa Cruz.

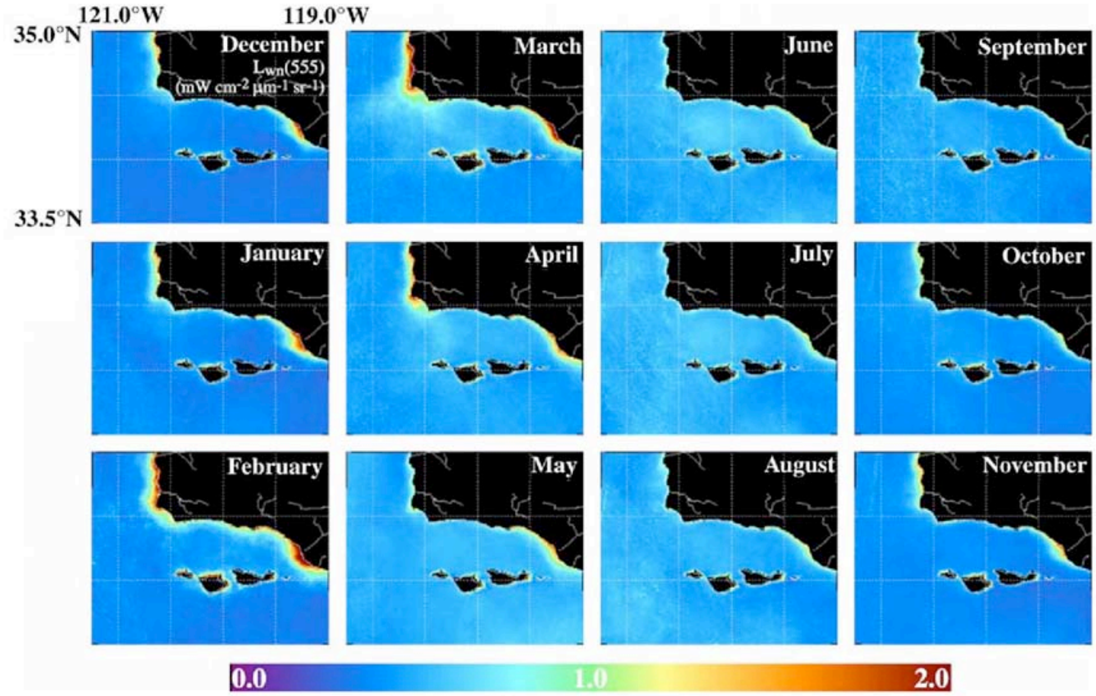


Figure 17. LwN(555) monthly mean annual cycle computed from all available images. Images above are composites of all data from each month. The monthly mean annual cycle is computed from October 1997 to June 2001 (Otero & Siegel 2004).

Salinity in the well-mixed freshened surface layer (*hypopycnal plume*) produced by the Santa Clara River ranges from 30.0-33.0 psu, and is <10 m deep (Warrick et al. 2005). Over 90% of the sediment entering the ocean is lost from the water column within ~1 km of the mouth of the Santa Clara River during discharge events. In contrast, the hypopycnal surface plume is advected (initially by discharge inertia in a well defined jet, and subsequently by wind and currents) at least an order of magnitude further away from the river mouth (Warrick et al. 2004a). Annually recurring storms (~2-year events) produce jets extending ~10 km offshore. However, remotely sensable fine suspended sediments ordinarily extend further away from the river mouth than the salinity anomalies (Dave Siegel, Professor, Department of Geography, UCSB, pers. comm.). Large sediment plumes, covering >20% of the Channel, occur about once per year (Warrick et al. 2004a). Less frequent, larger storms (~10-year events) can produce plumes extending ~30 km into the Channel (Warrick et al. 2004b) (Figure 18). Growth of phytoplankton, especially at the leading edge of sediment plumes, can interfere with retrievals of suspended sediment signals, such that remotely sensed data may exaggerate the area of sediment plumes to some degree (Libe Washburn, Professor, Department of Geography, UCSB, pers. comm.).

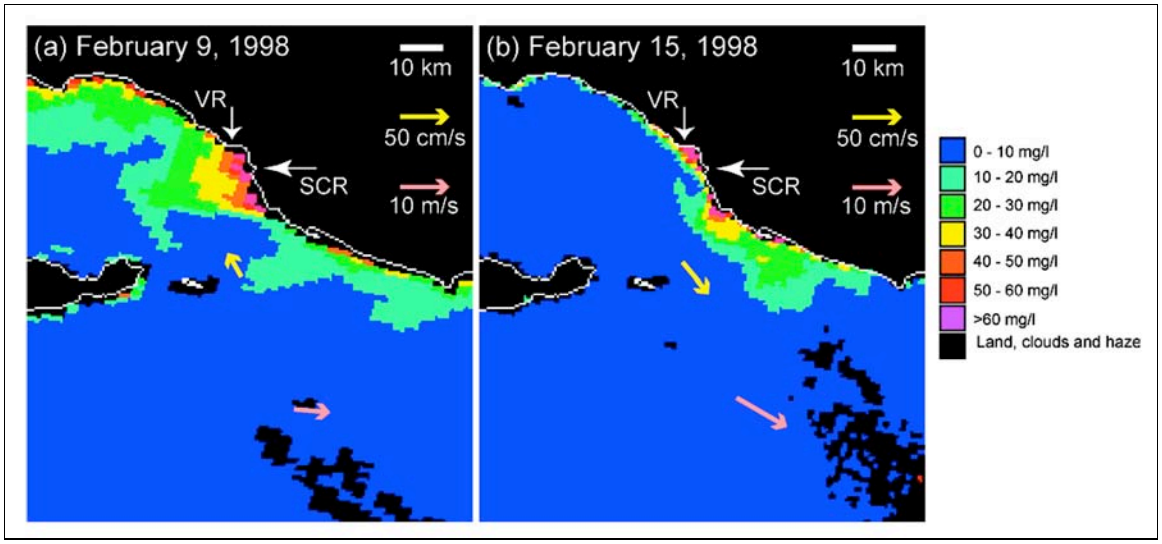


Figure 18. Suspended sediment concentrations retrieved from SeaWiFS images during two large storms (~10-year storms) in Feb. 1998. Pink arrows are mean wind vectors and yellow arrows are mean surface currents measured at NOAA and UC San Diego operated buoys, respectively (Warrick et al. 2004b).

Despite the occurrence of extensive surface sediment plumes in 1997 (Mertes et al. 1998), transects of salinity from Goleta Point (near Santa Barbara) to Santa Rosa Island (UCSB Plumes & Blooms project) did not reveal freshened water extending into the Channel at that time (see Figure 39 on page 125, salinity data are examined in detail in Section II.C.8.b). In Feb. 1983, after 25 cm of rain in the previous month, a large plume generated by the combined outflow of the Ventura and Santa Clara Rivers was 10 km long and 25 km wide (Mertes et al. 1998; image not shown here, but plume was smaller than the one in Figure 18(a) above). A similar amount of rain (28 cm) fell during Feb. 2004 in the Santa Ynez Mountains behind the city of Santa Barbara (San Marcos Pass station data-Santa Barbara Flood Control District), and yet by the end of Feb. 2004, cross shelf surface salinity anomalies were not detected in the Channel (at least not along the Plumes & Blooms transect for that month, see Figure 38a). The capability of fine suspended sediments to be advected beyond the zone of reduced surface salinity in storm plumes raises the possiblity that fine-particle-bound contaminants have a longer reach than dissolved contaminants after discharge events. Indeed, it may be that 25 to 50-year rain events (such as occurred in the winter of 2004/2005) are necessary to observe significant dilution of ocean water across the whole channel (see Section II.C.8)

Nezlin et al. (2005) evaluated six years (1997-2003) of SeaWiFS images of river plumes generated by storms of different sizes in the Ventura area, and created contour plots of the frequency of occurrence of pixels that exceeded the threshold signal for suspended sediment (Figure 19). These results show that storms >2.5 cm are required before plumes spread along the local coast as far north as Santa Barbara Point.

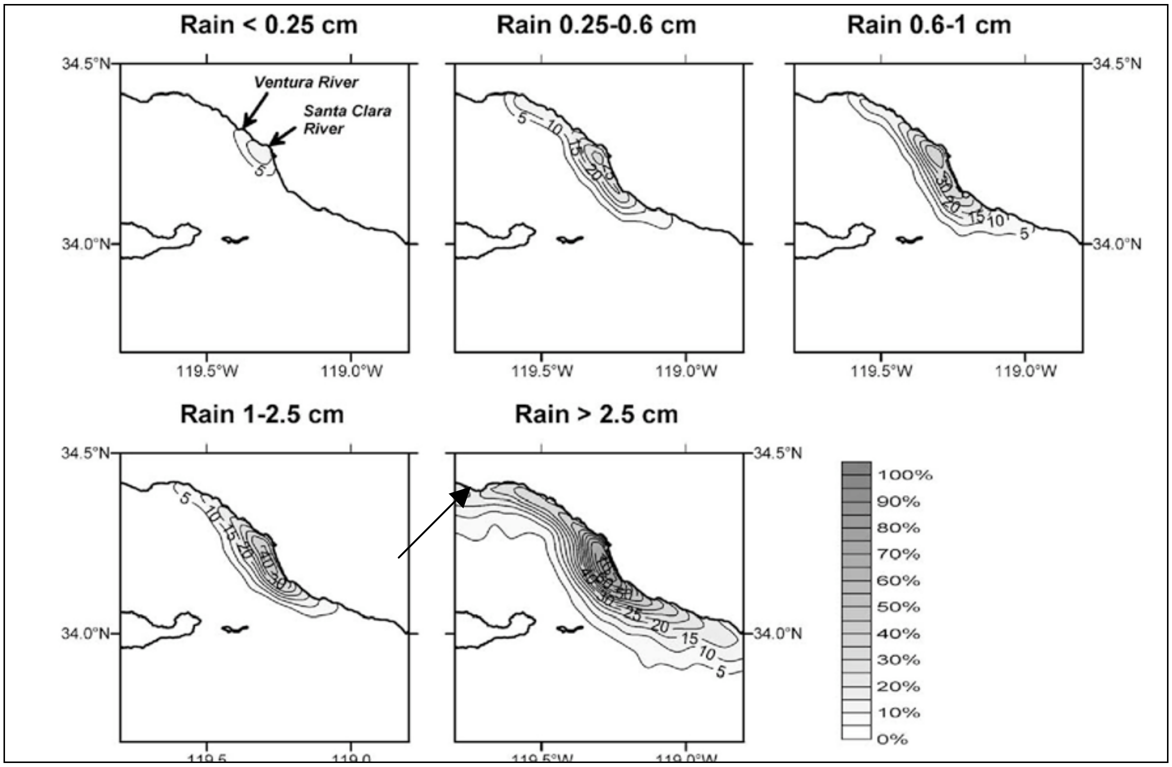


Figure 19. The areas occupied by freshwater plume after rainstorms of different magnitude in the Ventura region. The isolines indicate the percentage of satellite images with nLw555>1.3 mW cm^{-2} μm^{-1} sr^{-1}; the resulting grids were smoothed by 5-km cosine-filter (Nezlin et al. 2005). The arrow points to Santa Barbara Point, which is near the start point of the cross channel transects conducted by the Plumes & Blooms project of UCSB (see Section II.C.8).

The Santa Clara and Ventura River watersheds are the largest watersheds that drain into the Channel, amounting to 71% and 9.8%, respectively, of the total watershed area discharging into the Channel (Warrick et al. 2005). Their combined output produces the largest plumes in the Channel (Mertes et al. 1998). Conditions in these two watersheds will have the maximum influence on which kinds of contaminants from the mainland could eventually be advected into Park waters surrounding the Northern Channel Islands during discharge events.

b. Mainland storm plumes that enter the ocean south of the Channel.

Santa Monica Bay. Storm plumes were studied during three wet seasons (95/96 to 97/98) in Santa Monica Bay (Washburn et al. 2003, Bay et al. 2003). There, runoff plumes from single rainfall events of < 2 cm have cross-shelf length scales of 4–7 km, along-shore scales of at least 10 km, vertical scales of about 10 m, and persist for at least three days after a storm (Bay et al. 1998, Washburn et al. 2003). As was done for the Ventura area, Nezlin et al. (2005) created contour plots of the frequency of plume occurrence for different sized storms in the Santa Monica Bay (Figure 20). Even after storms in the largest size category (>2.5 cm), sediment plumes rarely extend in the cross-shelf direction outside of the bay.

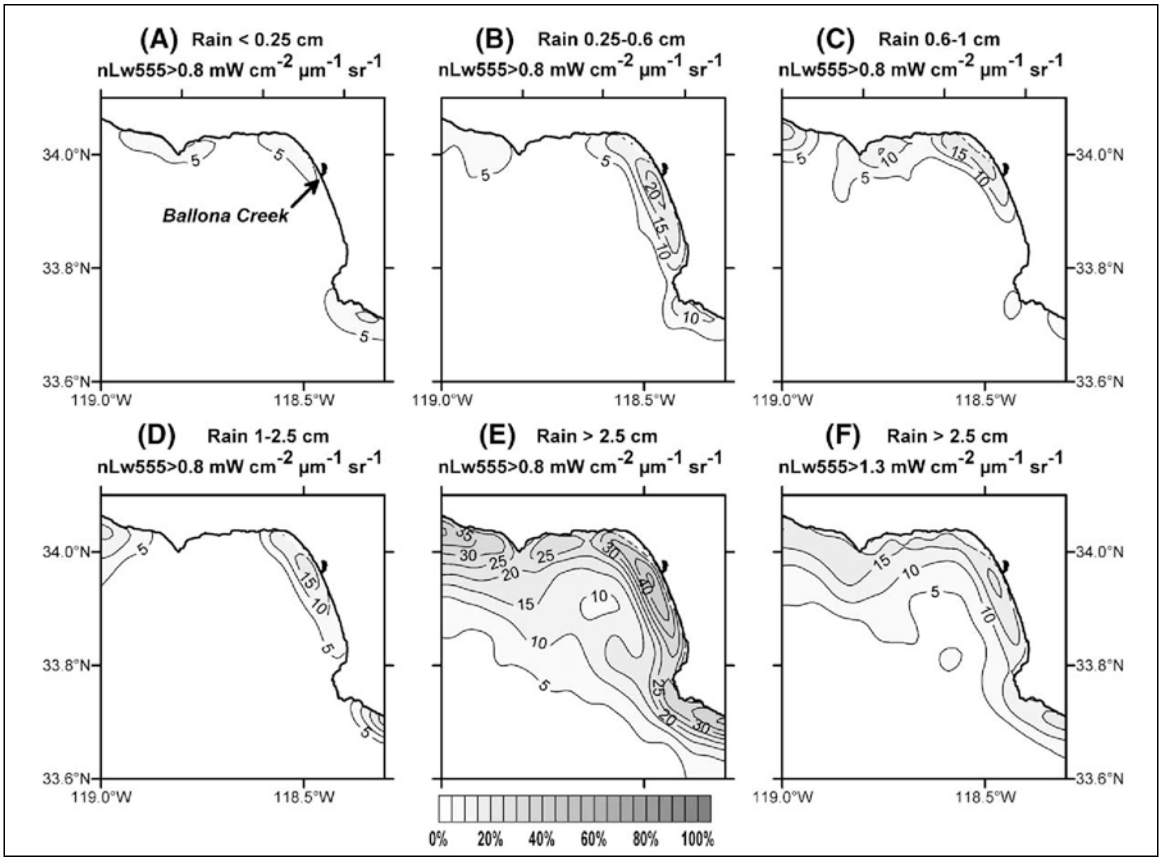


Figure 20. The areas occupied by freshwater plumes after rainstorms of different magnitude in Santa Monica Bay. The isolines indicate the percentage of satellite images with nLw555>0.8 mW cm^{-2} μm^{-1} sr^{-1} (A–E) and nLw555>1.3 mW cm^{-2} μm^{-1} sr^{-1} (F); the resulting grids were smoothed by 5-km cosine-filter. No plumes with nLw555>1.3 mW cm^{-2} μm^{-1} sr^{-1} were detected after rainstorms <2.5 cm (Nezlin et al. 2005).

San Pedro Shelf. Nezlin & DiGiacomo (2005) used 628 SeaWiFS images to delineate suspended sediment plumes originating from the San Pedro Shelf from 1997 to 2003. They discovered that even the smallest precipitation events in this area result in sediment plumes. Furthermore, almost all of the rainwater precipitated over the watersheds of the Dominguez Channel and the Los Angeles, San Gabriel and Santa Ana Rivers was discharged to the coastal ocean during the events they analyzed. Tidal circulation had an insignificant influence on plume area (i.e., did not contribute to offshore advection). Local winds did not influence the plumes in this area. When the San Pedro plumes extended several km offshore, they were typically entrained into a cyclonic eddy dominant in this region, bending the leading edge soutward and inshore (Nikolay Nezlin, Scientist, SCCWRP, pers. comm.). However, a statistical analysis of all plumes in their series showed no preference in the direction of plume propagation poleward or equatorward (Nezlin et. al. 2005). As was done for Ventura and Santa Monica Bay, Nezlin et al. (2005) generated contour plots of the frequency of occurrence of suspended sediment on the San Pedro Shelf according to storm size (Figure 21). These data show that even large plumes are very unlikely to extend offshore as far as Catalina Island, and even less likely to reach Santa Barbara Island.

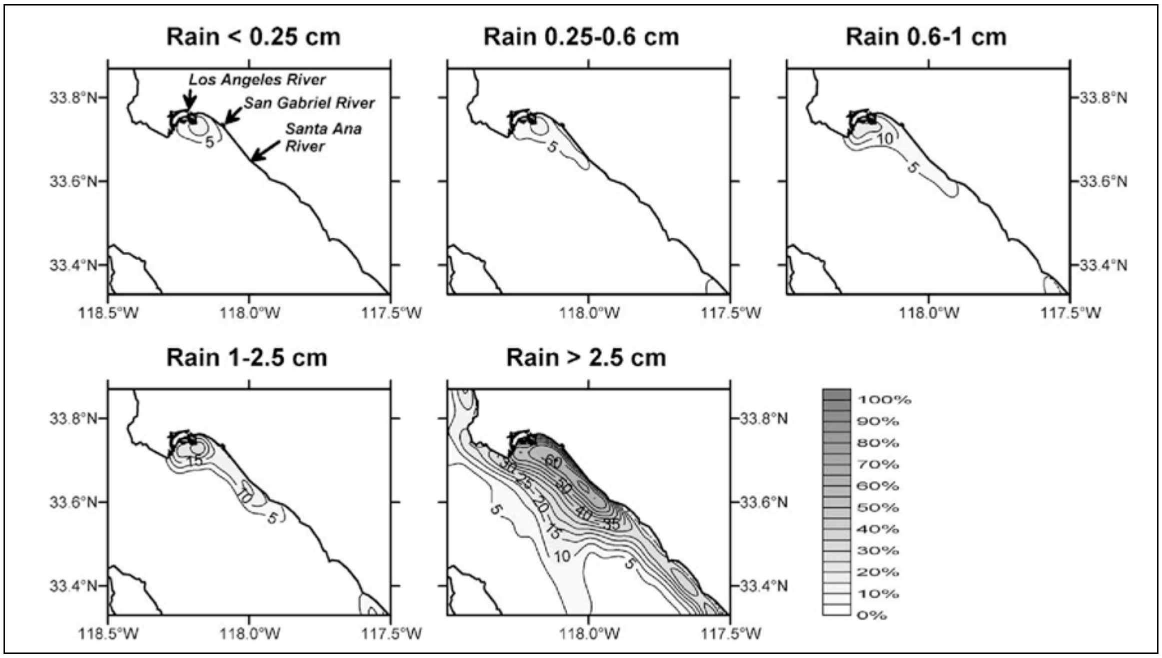


Figure 21. The areas occupied by freshwater plumes after rainstorms of different magnitude over San Pedro Shelf. The isolines indicate the percentage of satellite images with nLw555>1.3 mW cm^{-2} μm^{-1} sr^{-1}; the resulting grids were smoothed by 5-km cosine-filter (Nezlin et al. 2005).

A discharge event in late Feb. 1998 produced the largest plume in the 1997-2003 series of images for San Pedro Shelf (Figure 22). The Los Angeles River and Dominguez Channel (which constitute the southern-most watersheds judged pertinent for this report) would have contributed to this storm plume. Although this particular plume was advected equatorward (and entrained in an eddy), the suspended sediment signal reaches the tip of Catalina Island on Feb. 26, 1998. Santa Barbara Island is about twice as far from the mainland as is Santa Catalina Island. Most sediment plumes in this region will have smaller cross-shelf length scales than the one shown in Figure 22, and are unlikely to extend to Santa Barbara Island.

Watershed conditions in Region 4 (Appendix G) and the lists of pollutants and stressors in Regions 3 and 4 (Tables 10 and 11), indicate that terrestrial runoff from Point Mugu southward potentially carries a wider range, and higher concentrations, of dissolved and particulate contaminants than runoff that directly enters the Channel. If constituents in stormwater from these southerly drainages were advected poleward into the Channel, they might present a greater threat to Park biota than constituents from streams and rivers that directly enter the Channel from watersheds in Santa Barbara and Ventura areas. Poleward flow through the east entrance of the Channel is one of two alternating Channel-scale patterns of circulation that are common during winter ("Flood West" mode, see Figure 8). During spring and fall, poleward flow into the Channel ("Relaxation" mode, see Figure 8) is one of the three Channel-scale patterns of circulation that occur in a repeating sequence roughly every 16 days. Storm-derived contaminants from drainages south of the Channel may have the greatest chance of reaching Park waters if torrential winter rains co-occur with, or are quickly followed by, the winter "Flood West" circulation regime. However, based on the information above, by the time such contaminants were advected to Park waters, they would no longer comprise part of a discernable storm water plume, and should be very dilute, if even detectable.

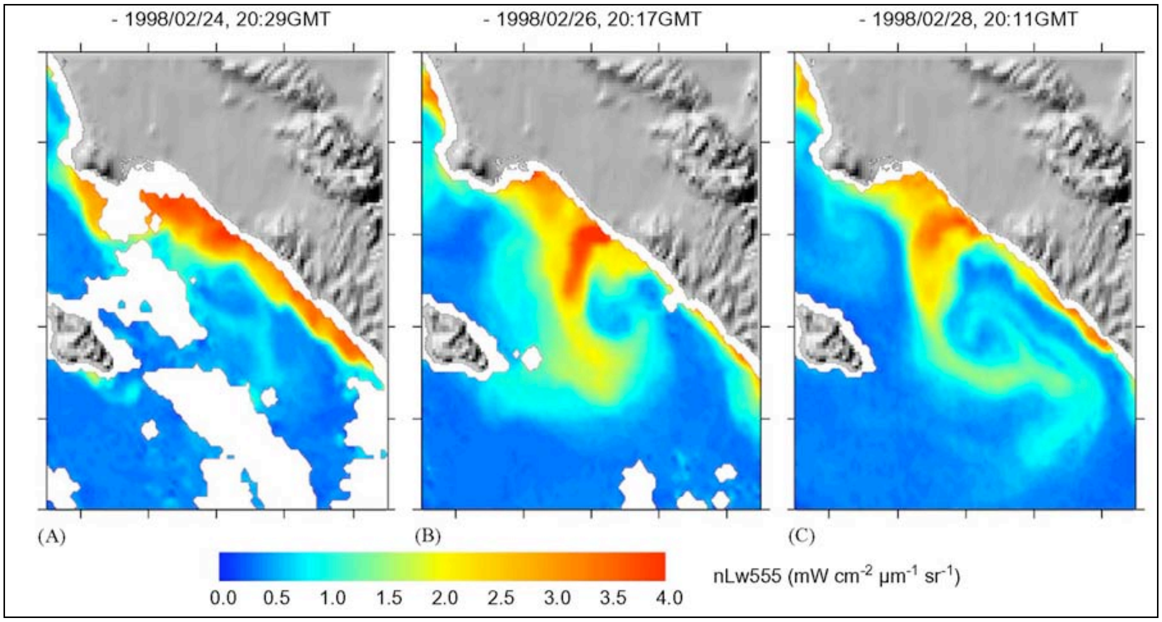


Figure 22. Sediment plume produced on the San Pedro Shelf after an El Niño related storm in 1998. Normalized water-leaving radiance at 555 nm (nLw(555) calculated from SeaWiFS images was used to delineate the plume. Torrential rains (4.2-6.1 cm/day) fell for three days from 2/23/98 to 02/25/98. Figure is from Nezlin & DiGiacomo (2005).

Summary of threats posed by storm plumes to Park waters. Based on plume toxicity, and the limited offshore extent of hypopycnal surface plumes, it seems extremely unlikely that acutely toxic levels of stormwater pollutants would reach any of the five islands in the Park during mainland runoff events. However, fine sediments that are transported to Park waters, and settle there, may, over time, contribute to contaminant loads in sediments and sublethal accumulation of toxicants in benthic organisms and fish. To date, sediments in the Park have not been found acutely toxic to benthic amphipods in survival tests (Bay et al. 2005 - see below). However, sentinel mussels in Park waters have detectable levels of a suite of organic contaminants and trace metals, including some high levels of zinc (see Section II.C.9). The extent to which this reflects exposure to contaminants transported directly to the Park in seawater or suspended sediment *versus* indirect transfer of contaminants from coastal sediments to the Park through the marine food web (see below), is an open question.

B. Offshore Sources of Pollutants

B.1. Polluted Ocean Sediments

Comprehensive surveys of sediment chemistry and sediment toxicity throughout the Bight were conducted in 1994, 1998, and 2003 by the Southern California Coastal Water Research Project (SCCRWP), and are referred to herein as Bight '94, '98, and '03, respectively. Unfortunately, sediment samples were not evaluated from the Channel Islands in Bight '94 and '98 - although multiple sites were included in the Channel in an area of sediments bounded by 200 m isobath and the mainland shore. Bight '03 included a number of sediment sites from depths of 30-120 m at the Channel Islands. At the time of this writing, the full results of the Bight '03 toxicity tests were available, but only partial results from the Bight '03 sediment chemistry survey were published.

a. Geographic patterns of sediment contamination.

Results of sediment chemistry and toxicity from the Bight '94 and Bight '98 surveys were very similar. Nearly 90% of the Bight sediments had evidence of anthropogenic contamination by at least one chemical. Almost 50% of the Bight is contaminated by at least one trace metal. Total DDT was the most widespread anthropogenic contaminant; approximately 82% of the Bight area (roughly 2,878 km^2) contained measurable quantities of this persistent pesticide. Based on the best available DDT-specific sediment quality guidelines, less than 1% of Bight sediments contain concentrations of total DDT expected to cause chronic or acute toxicity to benthic organisms. The highest levels of DDTs were found in stations near the Palos Verdes Peninsula, an area that has historically been known to have high levels of contaminants. Notably high levels of total DDT were also found in LosAngeles/Long Beach Harbor. The highest levels of PCBs were found on the Palos Verdes Shelf and in Los Angeles/Long Beach Harbor. Although sediment contaminants were widespread, less than 1% of the Bight contained contaminants at concentrations presenting a high risk of acute toxicity[11] for benthic organisms. Where biological exceedances occurred, they were usually for total DDT. Most Bight sediments had healthy benthic communities, and were not acutely toxic based on amphipod survival tests[12]. Bight '03 tests revealed that sediments near Park islands were not acutely toxic to amphipods (Figures 23-24).

Geographic patterns of sediment contamination revealed by Bight '94, and '98 are summarized below (discussion adapted from Shiff & Gossett 1998, Noblet et al. 2003). They provide guidance to Park managers regarding which sediment locations near the mainland pose the greatest *indirect* threats to the Park. They also indicate whether river plumes are producing contaminant hot spots near the mainland. Partial results of the Bight '03 sediment chemistry survey (Schiff et al. 2006) were publically available at the time of this writing, and are only summarized for the Channel Islands. For brief explanations of contaminant categories, see Section II.C.9 (Mussel Watches).

[11] acute = sufficient to cause severe biological harm or death soon after a single exposure or dose

[12] Amphipods are often used in sediment tests because they are among the first species to disappear from benthic communities impacted by pollution (Bay et al. 1998).

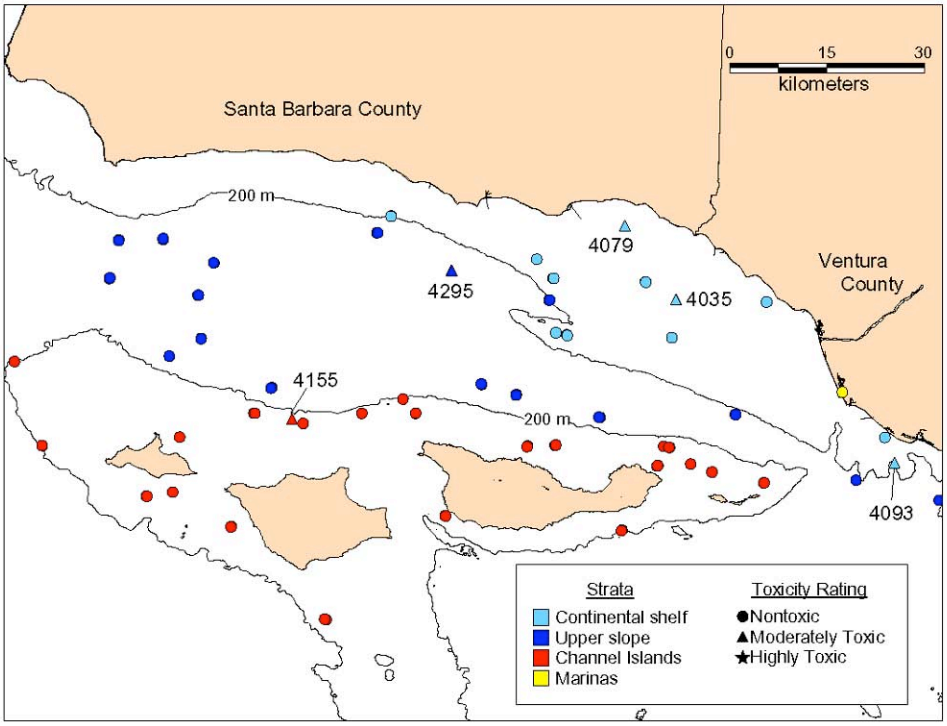


Figure 23. Bight '03 sediment toxicity results for stations in the Channel area. Results are from 10-day sediment exposure survival tests using the amphipod *Eohaustorius estuarius* (Bay et al. 2005).

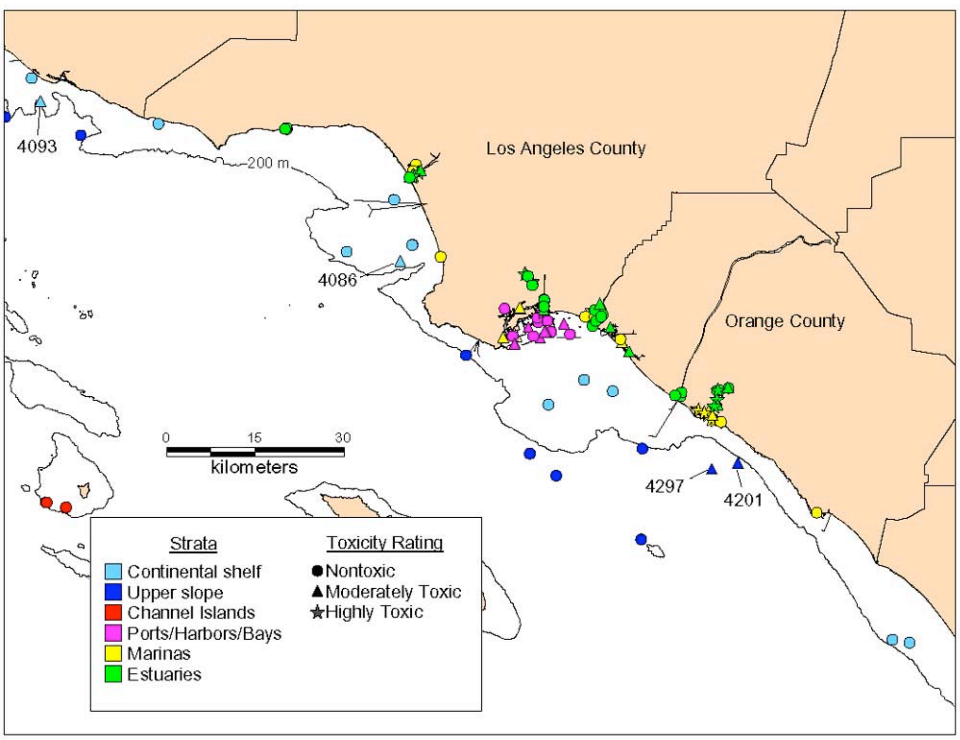


Figure 24. Bight '03 sediment toxicity results for stations nearest Santa Barbara Island. Results are from 10-day sediment exposure survival tests using the amphipod *Eohaustorius estuarius* (Bay et al. 2005).

Channel Islands (Bight '03 only)

With the exception of antimony and nickel, trace metal concentrations in sediments at the Channel Islands were the lowest in the Bight. However, cadmium and nickel exceeded NOAA's ERL in 18.8% and 9.4% of the Channel Island samples, respectively. DDT was detected in sediments at the islands, and the mean for the Channel islands (1.6 µg DDT/kg) was a little higher than the mean for small POTWs (1.2 µg DDT/kg). Thirty-four percent of the stations evaluated at the islands had DDT levels that fell between NOAAs ERL and ERM (Shiff et al. 2006). PCBs were near detection limits in Channel Island sediments, and total chlordane was not detected. Polycyclic aromatic hydrocarbons (PAHs) were relatively high in sediments at the islands (area weighted mean 338 ± 69.6 ng/g). The Channel Islands stations represented 8% of the geographic area sampled in Bight '03 and contained 7.8% of the total mass of PAH residue measured (compared to 0.4% and 0.9% of the total mass for DDT and PCBs, respectively). The molecular signature of the PAH residues in the island sediment samples (i.e., the relative distribution of low vs high molecular weight PAH homologs) was more congruent with petrogenic sources than with combustion byproducts (such as from the transportation sector). This suggests that PAHs in sediments at the islands originate from offshore oil and gas facilities and/or the natural hydrocarbon seeps at the islands and in the Channel.

Santa Barbara Channel

With very few exceptions, concentrations of metals and organic contaminants measured during Bight '98 in sediments from sites in the Channel were below background concentrations. Inspection of figures in Noblet et al. (2003) indicates that silver, nickel, zinc, lead, copper and chromium were above background concentrations (and thus judged anthropogenically enriched) at 1, 1, 2, 2, 2, and 9 sampling sites, respectively, shoreward of the northern 200 m isobath in the Channel.

Santa Monica Bay

The extent of sediment contamination inside of Santa Monica Bay was much greater relative to the extent of contamination outside of Santa Monica Bay. One hundred percent of the area inside of Santa Monica Bay was enriched in at least one sediment contaminant. Fifty percent of the area inside the bay contained sediment concentrations of at least one constituent that exceeded screening thresholds for potentially adverse biological effects. TOC, TN, cadmium, chromium,copper, lead, mercury, nickel, silver, zinc, total DDT, and total PCB were significantly higher inside than outside of the bay. Mean sediment concentrations for these constituents were 50% to 1,000% higher inside than outside of the bay. Organic constituents contaminated large areas of Santa Monica Bay (98%). Total DDT was responsible for most of the exceedances of thresholds for biological effects, although PCBs also contaminated nearly three-quarters (72%) of the Bay sediments.

Bays and Harbors, generally

The highest sediment concentrations for most target analytes were found in bays and harbors. Although bays and harbors constituted only about 6% of the area, they contained 22% of total Bight-wide contamination. The most elevated contaminants inbays and harbors were copper, lead, zinc, mercury, chlordanes, PAHs, and PCBs.

POTW Outfall Areas

Approximately 87% of the total POTW outfall area was anthropogenically enriched compared to 90% of the area distant from POTW outfalls at similar depths (25-100 m). Mean TOC and TN content were higher in sediments near POTW outfall areas than distant from them, however, the difference was not significant. Likewise, mean concentrations of cadmium, chromium, and lead were higher in sediments near POTW outfalls than areas distant from them, but not significantly different. Concentrations of copper, mercury, silver, total DDT, and total PCB were significantly higher in sediments nearest POTW outfalls compared to sediments farther away; mean sediment concentrations were higher by a factor of 100% to 1,000% for these constituents. Much of this is reflective of historically deposited DDT and PCB in areas near outfalls for two POTWs: the Hyperion Wastewater Treatment Plant and Joint Water Pollution Control Plant (the latter referred to as the *White's Point*, or *White Point* outfall, see Table 7). In contrast, sediment concentrations of arsenic, nickel, and zinc were higher distant from POTW outfall areas than areas closer; mean concentrations of arsenic and nickel were significantly higher.

Stormwater Discharge Areas

Weighted mean sediment concentrations in areas near stormwater discharges were higher for every constituent measured compared to sediments farther from stormwater discharges. Mean TOC and TN contents of these stormwater-influenced sediments were 50% higher than sediments farther from stormwater discharges. The greatest disparity between stormwater discharge areas and shallow water areas more distant was the enrichment of trace metals, in particular, cadmium, chromium, copper, lead, and zinc. Ten percent of the stormwater discharge area was enriched in at least one trace metal to the point where biological effects may occasionally occur. Although the trace metal concentrations averaged 60% higher in sediments near stormwater discharges, only copper concentrations were significantly higher there than in sediments farther away. Mean concentrations of total DDT and total PCB were only marginally higher near stormwater discharges than mean sediment concentrations farther away. The areas affected by river discharges make up about 1% of the Bight, but contribute an estimated 1.3% of the total contamination.· In the river discharge zones, only the mass contributions of lead (1.2%), chlordanes (7.4%) and PAHs (1.5%) were in excess of their proportional area contributions to the Bight.

b. The White's Point Outfall

History of White's Point

As indicated above, the shelf sediments off the coast of the Palos Verdes Peninsula comprise the most significant source of total DDT and PCBs in the region near the Park. From 1947 until 1971, the Montrose Chemical Corp. plant, in the City of Torrance discharged DDT manufacturing waste, containing an estimated 1,800 tons of DDT, through Los Angeles County's ocean outfall from the Joint Water Pollution Control Plant (JWPCP), commonly referred to as the *White's Point Outfall*, or the *White Point Outfall* (Shiff & Gossett 1998). Although the discharges to public sewers ended in 1971, the Montrose plant continued to manufacture DDT until 1982. In addition to discharges from the JWPCP outfalls, DDT was also introduced into the Bight through direct ocean dumping of acid sludge that originated from the Montrose facility

(Figure 25). It is estimated that between 1947 and 1961, barrels of acid sludge containing 350 to 700 metric tons of DDTs were dumped into the San Pedro Basin off of Catalina Island by the California Salvage Company (NRT 2005). The barrels were punctured at sea to make them sink, which undoubtedly released large amounts of DDTs to surface waters (NRT 2005).

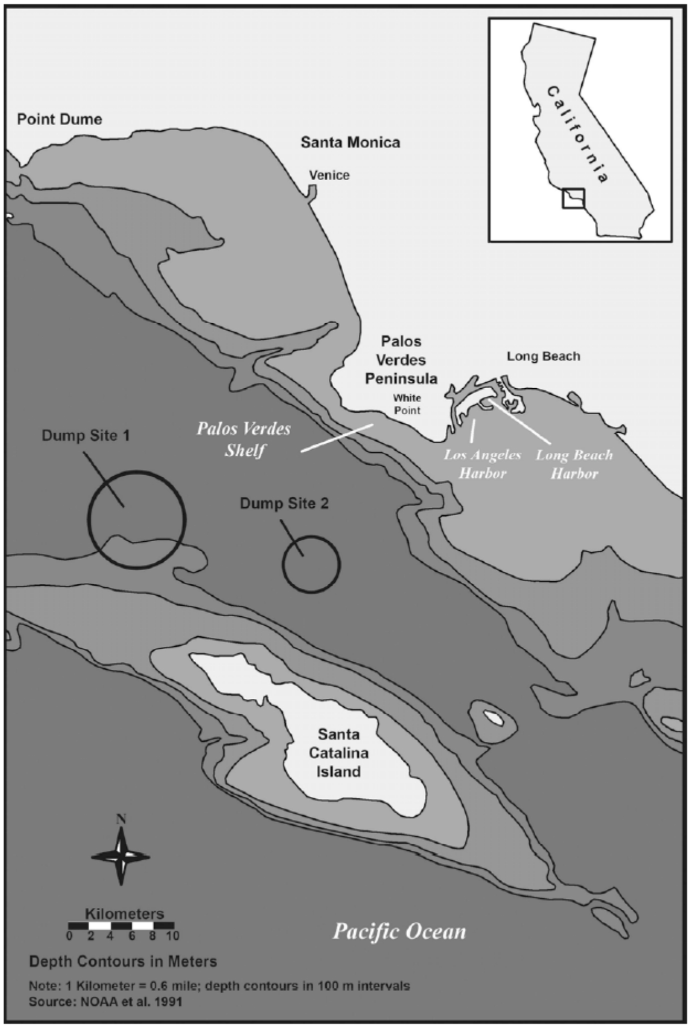
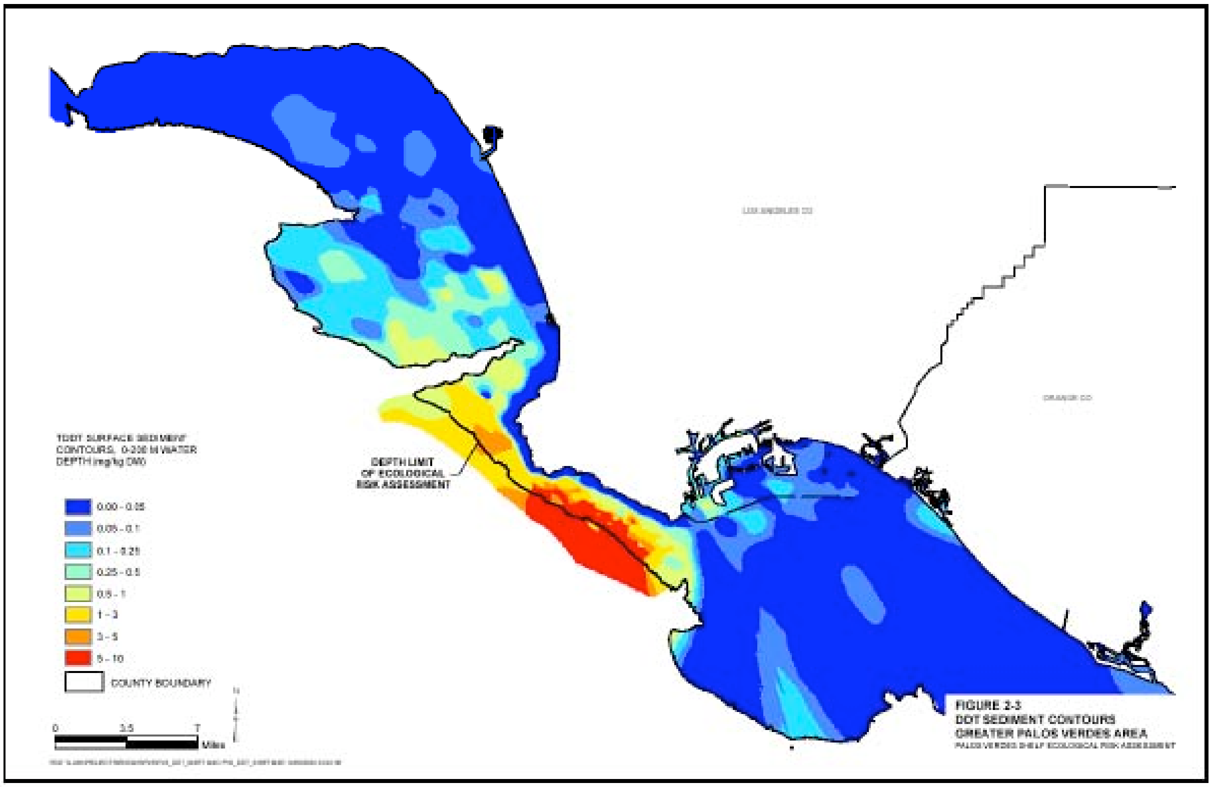


Figure 25. Location of the Montrose Chemical Corporation's DDT ocean dump sites (NRT 2005).

In 1992 and 1993, surveys by the USGS found that more than 100 metric tons of DDTs and 10 metric tons of PCBs remained in ca. 9 million cubic meters of contaminated sediment over a 44 square kilometer area of both the continental shelf and continental slope off the Palos Verdes peninsula, although DDT-contaminated sediment also extends northward into Santa Monica Bay and to the southeast (EPA 2003). The highest concentrations of DDTs and PCBs were near the mouth of the White's Point outfall (Figure 26). The contaminated sediment ranges in thickness from 5 cm to >60 cm. On the continental shelf, where most of the contamination resides, the contaminated sediments are in water 30 to 100 m deep, with the highest concentrations along the 60 m isobath. Bight '94 results showed that elevated concentrations of DDTs and PCBs in bottom sediments extended from the Palos Verdes Shelf into Santa Monica Bay.



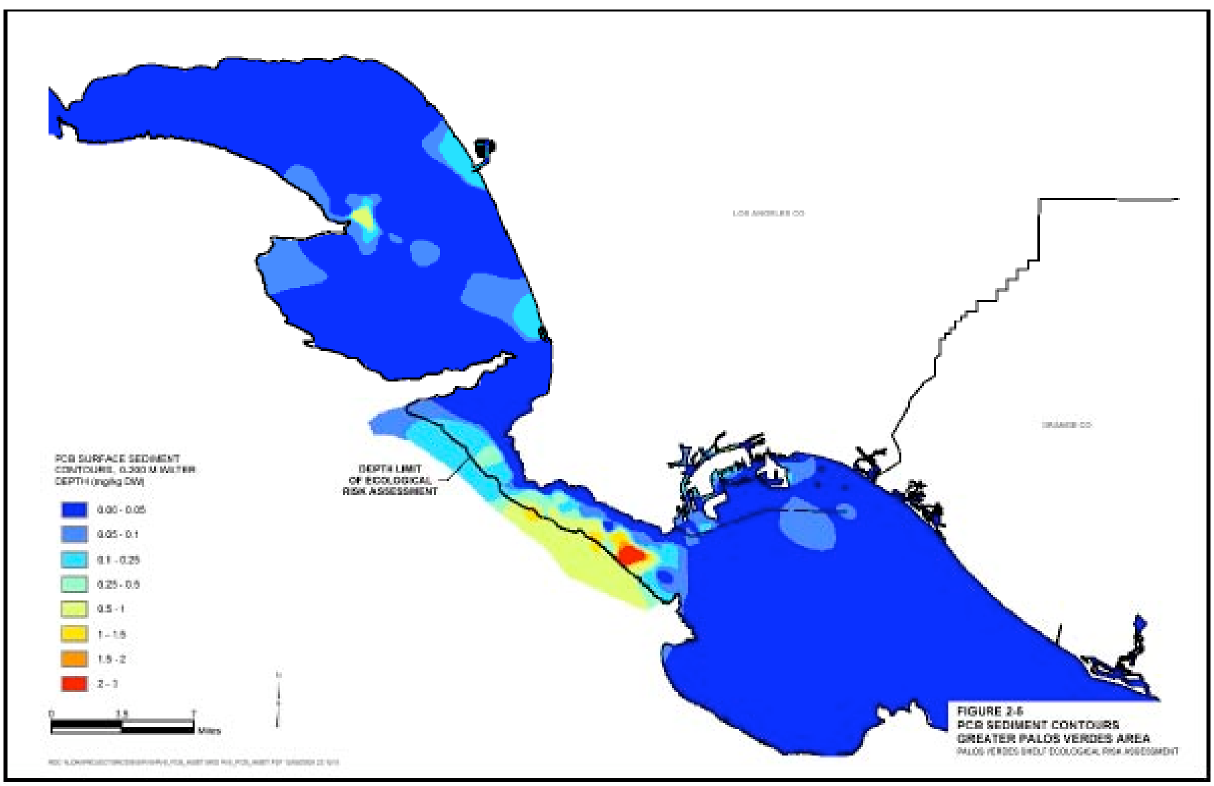


Figure 26. DDT contours (top) and PCB contours (bottom) in sediments of the greater Palos Verdes Shelf area (NRT 2005).

Pollutants detected in Park biota

Molluscs. Organic contaminants, including DDTs and PCBs, and elevated levels of trace metals have been detected in sentinel mussels at a variety of sites in the Park, and at Catalina Island, during State-run and NOAA-run mussel watch programs. These results, in particular, indicate that contaminants originating outside Park boundaries eventually occupy the water column at the Park, and are evaluated in detail in Section II.C.9.

Fish. Only one published study was located in which organic contaminants were measured in fish taken from the Channel Islands (Brown & Steinert 2003), although a figure in Connolly & Glazer (2002) shows that DDE was detected in kelp bass at Anacapa and Santa Barbara (the figure cites a 1987 report by RW Risebrough, submitted to the SWRCB, as the source of the data points). Brown & Steinert (2003) measured quantities of fluorescent aromatic compounds (FACs), which are metabolites of PAHs, in fish bile from Pacific sanddabs (*Citharichthys sordidus*) collected by otter trawl in 1998 from 11 stations near San Miguel, Santa Cruz, Anacapa and Santa Barbara at depths between 31 to 202 m. Channel Island sanddabs contained far less (up to an order of magnitude) FACs than California halibut collected in mainland bays and harbors (Figures 27-28). As noted above, the molecular signature of PAHs in Channel Island sediment samples suggests a petrogenic, rather than a pyrogenic origin for these compounds (Shiff et al. 2006). Thus the PAHs in sediments, fish, and mussels (for the latter, see Section II.C.9) may be resulting from the offshore oil operations (or natural oil seeps), rather than from the combustion of fuels on the mainland or in the shipping lanes.

Many common sport fish caught from the ocean in the Los Angeles area have levels of DDTs and PCBs high enough that the State of California has issued health advisories to limit or avoid consumption of these fish when caught at certain coastal locations in Los Angeles and Orange Counties. In addition, because of especially high levels of DDTs and PCBs in the white croaker, the State has banned commercial fishing for white croaker in the vicinity of the Palos Verdes Shelf. The affected fish are as follows:

limited consumption advised (one meal every two weeks)	
sculpin	black croaker
white seaperch	California corbina
barred surfperch	Queenfish
calico surfperch	rubberlip seaperch
pile perch	shiner perch
black perch	walleye surfperch
rainbow seaperch	silver surfperch
dwarf perch	spotfin surfperch
striped seaperch	water column surfperches
kelp perch	all rockfish (*Sebastes*)
kelp bass	

no consumption advised
white croaker

Pinnipeds. Concentrations of p,p'-DDE and PCBs in the blubber of sea lions from San Miguel have been measured in three separate studies: DeLong et al. (1973), Gilmartin et al. (1976), and Costa et al. (1994); the reader is directed to these sources for more detail. Connolly & Glaser (2002) modeled the relationship between p,p'-DDE body burdens in female sea lions from San Miguel and regional prey contaminant levels and determined that the more highly contaminated lactating females must have consumed prey with levels of DDE only found in fish from the Palos Verdes Shelf and the Santa Monica Bay.

Avifauna. DDT, and its final metabolite DDE, were strongly implicated in the decline of two federally-listed endangered species in the Park (the California brown pelican and the bald eagle, [*Haliaeetus leucocephalus]*), and in the loss of peregrine falcons (*Falco peregrinus*) from the Park. On the West coast of North America, the only breeding colonies of California brown pelicans occur in the Park (on Anacapa, Prince Island [an islet off San Miguel], and Santa Barbara), and in Mexico on islands off the coast of Baja California. The colonies in the Park almost disappeared in the 1970's, owing to egg-shell thinning and hatching failure. Historically, bald eagles were a resident breeding species on all of the California Channel Islands, with roughly 35 eagle nest sites existing earlier in this century (Kiff 2000). After the 1972 ban on DDT use, bald eagle populations rebounded across the U.S., except in Southern California. Breeding bald eagles on Catalina are still reproductively impaired and are not self-sustaining. Kiff (1980) and Hunt (1994) present evidence for 15 documented pairs of peregrines on the California Channel Islands during the first half of the century and estimate that between 20 and 30 pairs nested on the Channel Islands prior to 1945. The population of peregrine falcons on the Channel Islands was eliminated between the mid-1940s and the early 1960s due to shooting, harvest for falconry, egg collecting, and DDT contamination (Kiff 2000).

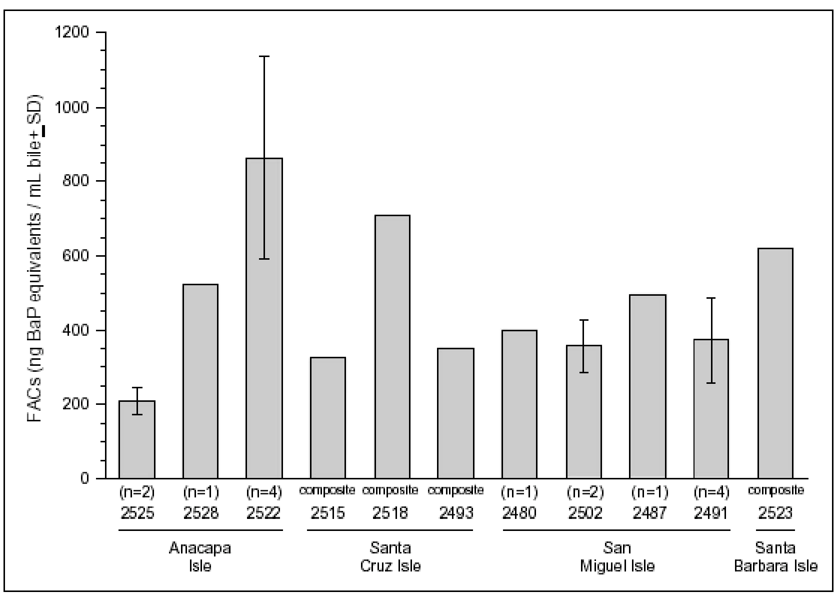


Figure 27. Concentration of bile FACs in Pacific sanddab from Channel Islands stations. *n* = number of fish at a given station (Brown & Steinert 2003).

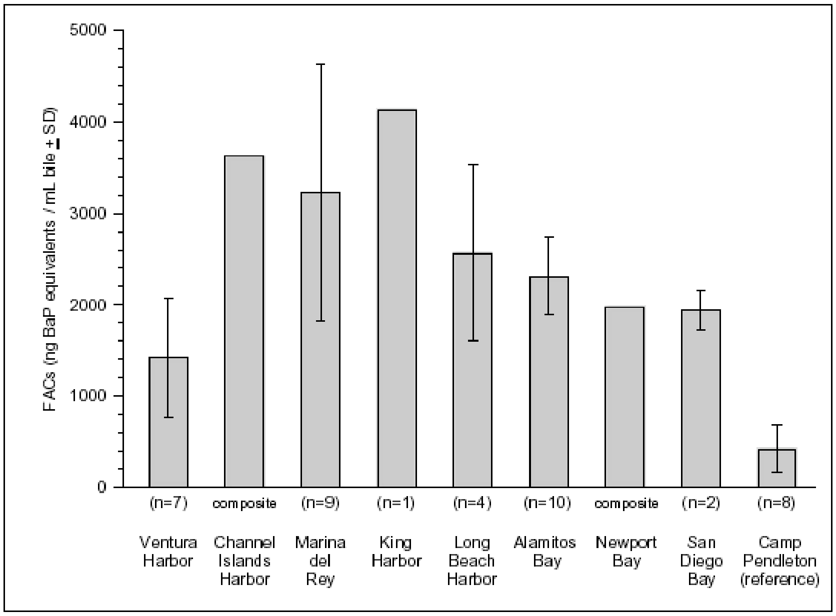


Figure 28. Concentration of bile FACs in California halibut for mainland bay and harbor locations, and the Camp Pendleton reference site. Camp Pendleton fish were collected in 1999, while the fish from the other locations were collected in 1998. *n* = number of fish at a given location (Brown & Steinert 2003).

The Montrose Settlement

The former Montrose plant property was named a federal Superfund site in 1989, and the affected region of the shelf has been designated the Montrose/Palos Verdes Shelf Contaminated Sediment Superfund Site (EPA 2003). As a result of a federal and state lawsuit filed in 1990, a settlement was reached with Montrose Chemical Corp. and three other companies that ran the DDT plant (Aventis Crop Science USA, Chris-Craft Industries Inc. and Atkemix Thirty Seven Inc.). Under the terms of four separate settlement agreements, Montrose and the other defendants agreed to pay $140.2 million plus interest to the federal and state governments. Of this amount, the USEPA and the California Department of Toxic Substances Control received $66.25 million, the Natural Resource Trustees (NRT) for the Montrose case received $63.95 million, and $10 million of “swing money” was earmarked for EPA response actions, although the swing money may instead go to natural resource restoration, depending on the outcome of the EPA’s ongoing remedial investigation (NRT 2005). Of the ~$73 million awarded to the NRT, $30 million is earmarked to restore natural resources, and $43 million will be used to clean up the DDT left in the ocean. As of 9/2005, a pilot study of the efficacy of capping the polluted sediments was underway.

Avifauna recovery

In 1980, the Institute of Wildlife Studies, the USFWS, and the CF&G initiated a program to reintroduce bald eagles to Catalina Island. Montrose settlement money has funded recent years of this program. Between 1980 and 1986, 33 chicks from wild nests were brought to the island, reared on artificial nest platforms, and released. Several of these eagles have survived and formed nesting pairs. However, none of their eggs have been hatched normally to date, as the eggshells were too thin for normal incubation, would have broken under the weight of the adults, and the embryos would have suffered water loss through the thin eggshells (NRT 2005). From

1989 to 2005, the population was maintained by collecting the eggs, transporting them to the San Francisco Zoo for artificial incubation, and re-introducing the chicks back to the nests. In 2005, an incubation facility was built on the Catalina, and the eggs were hatched on-site. Beginning in 2002, the Montrose Settlements Restoration Program, in partnership with NPS, decided to reintroduce bald eagles to the northern Channel Islands, and brought on the Institute of Wildlife Studies as the cooperator. Every summer through 2006, a dozen eaglets from Alaska or the San Francisco Zoo will be transferred to screened hack towers on the island. The chicks typically remain in the towers for a month before the tower gates are lifted. The juvenile eagles released on the islands will be monitored for DDT exposure and ability to reproduce over a five to seven year period. Because eagles generally first breed between 4-5 years of age, the initial results of breeding are expected in 2007-2008. As of 2005, about 23 released eagles remain on Santa Cruz and the other Northern Channel Islands, along with a pair of eagles that were raised in captivity on Catalina Island, and flew to Santa Cruz. On April 12, 2006, a chick was successfully hatched on Santa Cruz by the pair of eagles that flew in from Catalina Island. As of this writing, an additional chick was hatched from a second nest on Santa Cruz in 2006.

California brown pelicans are showing signs of recovery in the Park. In 2002, the number of nests and fledglings produced by the southern California nesting population was estimated at 6,440 and 3,220 individuals, respectively. From 1983-2002, nest attempts have ranged from 628 to 6440, and fledglings produced has ranged from 372 to 6390 (Gress et al. 2003). This is in sharp contrast to the early 1970's in which there were only about 100 nest attempts.

The peregrine falcon has made a dramatic recovery in the Park since 1975, in large part due to an active release program conducted by the Santa Cruz Predatory Bird Research Group. Artificial incubation of thin-shelled eggs removed from wild nests and a captive breeding program provided source birds for the release program. Between 1985 and 1993, six peregrine falcon hatchlings were released at sites on San Miguel, and 17 hatchlings were released on Catalina Island (NRT 2005). The minimum breeding age for peregrine falcons is two years. In 1987, the first reestablished peregrine falcon pair was recorded on San Miguel. In 1989, active nests were recorded on Anacapa and Santa Cruz (Hunt 1994). Between 8 and 10 pairs were noted on the Northern Channel Islands between 1992 and 1994 (Hunt 1994). In 2004, approximately 21 peregrine falcon pairs were occupying breeding territories on six of the eight Channel Islands (PBRG 2004). The majority of the pairs (18 of 21) occur on the Northern Channel Islands, and 3 pairs occur on the Southern Channel Islands (2 pairs were recently confirmed on Catalina and 1 on Santa Barbara). Although peregrine falcons now appear to be self-sustaining on the Northern Channel Islands, they have not fully recovered to historical levels throughout the Channel Islands. In addition, data collected in 1992 indicated that contamination in the food web was still at sufficient levels to result in substantial eggshell thinning for peregrine falcons on the Channel Islands.

c. Ocean Dumps

In addition to the Montrose ocean dump sites near Catalina Island, the Channel region contains several sites that were used for dumping of wastes from the 1940's through 1960's. Two sites, one in the vicinity of the Santa Lucia Bank and another south of Santa Cruz Island, have been identified as locations formerly designated for U.S. chemical munitions dumping (Ugoretz 2002). A site southeast of Santa Barbara Island might have been used as an explosives dumping area and a location offshore of Port Hueneme might contain 3,100 containers of low-level radioactive waste at a depth of 4,750 m (Polgar et al. 2005). Active dredge material discharge sites are located in the Los Angeles/Long Beach area which are contributing to contaminant loads (e.g. levels of certain heavy metals, PCBs, PAHs) in area sediments (Steinberger et al. 2000). All three of the currently designated dredge material disposal sites are located in depths greater than 200m, which reduces the extent to which contaminants from these sites will be advected out of the basin (Shiff et al. 2006).

B.2. Offshore Oil and Gas Facilities

a. Location of Platforms

There are 19 oil and gas platforms located off the coast of Santa Barbara and Ventura Counties (Figure 29). Twenty-two fields have been discovered in the Santa Barbara Channel, and two fields in the offshore Los Angeles Basin (MMS 2001). Most of the oil platforms in the channel are 15 to 25 miles from the Sanctuary boundary, but Platform Gail is just over 6 miles from Anacapa Island. In addition to the existing operations, there are 37 federal and 5-6 state leases that may be developed over the next 25-40 years.

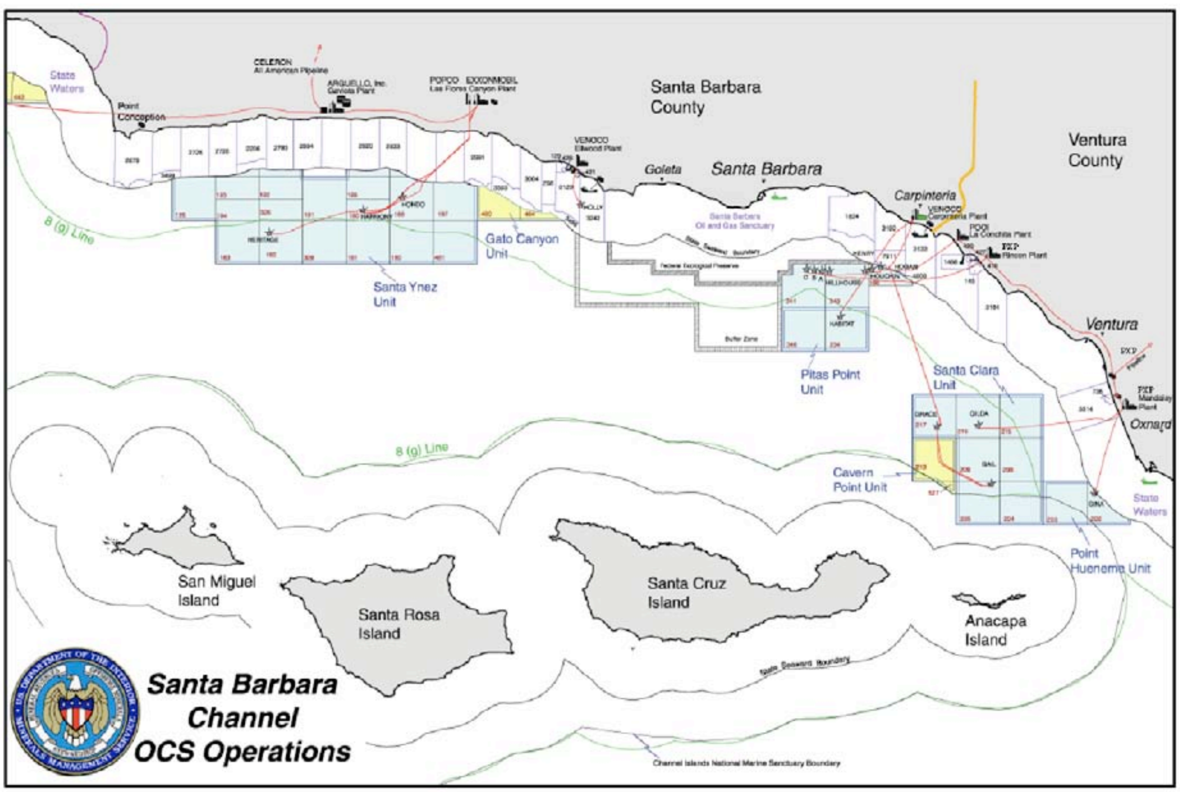


Figure 29. Location of federal and state offshore leases, and active oil and gas platforms, in the Santa Barbara Channel (from http://www.mms.gov/omm/pacific/lease/maps.htm).

b. Oil Spills

The Santa Barbara Oil Spill of 1969. On Jan 28, 1969, an 80,000-barrel oil spill occurred at Union Oil Platform A, six miles off the coast of Summerland, 64 miles south of the city of Santa Barbara. Eight hundred square miles of ocean were impacted, and 35 miles of mainland coastline were coated with oil up to six inches thick. Rescuers counted >3,600 dead seabirds, and a large numbers of poisoned seals and dolphins were removed from the shoreline (Clarke & Hemphill 2002). Most of the dead birds were grebes and loons, followed by waterfowl (presumably largely scoters), cormorants, and pelicans (Straughan 1971). Western Grebes accounted for nearly 41 percent (176) of a sample of 432 birds whose species were known. In addition, gulls, alcids (mostly Common Murres), shorebirds, and herons are known to have been oiled and died. By February 3, a large oil slick had surrounded Anacapa Island and was encircling the eastern end of Santa Cruz Island. During February 5-13, CF&G divers established 14 transects around the islands: 4 at Anacapa and 10 at Santa Cruz (Straughan 1971). The transects extended from the high tide line to a depth of ca. 50 ft. Short term impacts observed at the islands are summarzied below:

> <u>Extent of Oil.</u> Oil slicks were observed in slight to moderate amounts around both islands, particularly on both sides of the middle of Anacapa Island. These slicks of coalesced oil droplets formed dense patches up to 1/4 inch in thickness which extended seaward from the shore for several hundred feet. Beached oil adhered to the intertidal rocks and driftwood in patches several hundred feet long. These patches were up to 20 feet wide, and were in lumps up to 1/2 inch thick. Patches were most common on the north side of the middle of Anacapa Island and on Santa Cruz Island at Punta Arena, Yellowbank Anchorage, Smugglers Cove, and Scorpian Anchorage. At Santa Cruz Island, major concentrations of floating oil were observed in the kelp canopy at Scorpion Anchorage and in the nearshore waters between Sandstone Point and Middle Anchorage. On the north shore of Anacapa, numerous oil droplets were suspended in the water column from shore seaward about 100 feet. These droplets appeared to be adhering to organic detritus, wood chips and grass, which had washed into the sea during the recent rains. Although visible in the surge zone throughout the water column, the droplets did not adhere to the substrate, plants or animals.
>
> <u>Birds and pinnipeds.</u> Several dead birds were observed in the kelp canopy at Scorpion Anchorage and three dead surf scoters were observed on the beach. About 35 California sea lions, coated with oil, but in no apparent distress, were observed at Sandstone Point. Another group, about 300, observed in the vicinity of Coche Point, had no evidence of oil on them.
>
> <u>Intertidal zone</u>. In Feb., some plants and animals in the intertidal area, from the splash zone to just below low tide, were coated with varying amounts of oil. The black abalone, Haliotis cracherodii ; gooseneck barnacles, Pollicipes polynerus; and numerous other intertidal animals as well as the algae, Hesperophycus harveyanus, Pelvetia fastigiata, and surf grass, P. torreyi, were heavily coated with oil at Punta Arena. Surf grass at Anacapa Island was heavily coated with oil when the initial survey was made on February 5, 1969. By February 14, 1969, the plants were free of oil.
>
> <u>Subtidal zone</u>. Subtidal plants and animals appeared untouched by the oil. Oil was observed on the surface canopy of many of the kelp beds, but most of this oil could be easily shaken off. During a storm that followed, the kelp beds were cleaned by the rough waters. Topsmelt, Atherinops afinis, would swim up under the coalesced floating oil and investigate its lower surface.
>
> <u>Recovery.</u> Surveys in Apr. 1969 and Feb. 1970, indicated that invertebrates appeared to remain viable and healthy, surf grass and algae had recovered, fish were free from oil and showed no signs of starvation due to oil on prey items.

Other oil spills. Since 1969, there have been 843 small oil spills off southern California (Table 12). However, only one spill resulted in documented seabird mortality: the 163-barrel Platform Irene pipeline spill off Point Arguello in 1997, which resulted in the loss of more than 700 birds

(McCrary et al. 2003). Natural oil seepage from the Coal Oil Point seep field (see Section II.B.3) releases as much as 100 barrels of oil per day (Libe Washburn, Professor, Dept. of Geography, UCSB, pers. comm.), although the volume appears to be decreasing over time (see Section II.B.3). Birds and pinnipeds apparently avoid the resulting slicks, as they do not result in oiled or beached animals.

Table 12. Crude, diesel, or other hydrocarbon spills (volume in barrels) recorded off southern California in the MMS Pacific OCS Region, from 1969 to 1999. Note that the data cover an area larger than the Santa Barbara Channel. Table is from McCrary et al. 2003.

	≤ 1 bbl		> 1 bbl < 50 bbl		≥ 50 bbl		Total	
Year	No.	Volume	No.	Volume	No.	Volume	No.	Volume
1969	0		0		2	80,900.0	2	80,900.0
1970	0		0		0		0	
1971	0		00		0		0	
1972	0		0		0		0	
1973	0		0		0		0	
1974	0		0		0		0	
1975	1	0.1	0		0		1	0.1
1976	3	1.1	1	2.0	0		4	3.1
1977	11	2.2	1	4.0	0		12	6.2
1978	4	1.2	0		0		4	1.2
1979	5	1.7	1	2.0	0		6	3.7
1980	11	4.9	2	7.0	0		13	11.9
1981	21	6.0	10	75.0	0		31	81.0
1982	24	3.2	1	3.0	0		25	6.2
1983	56	7.7	3	6.0	0		59	13.7
1984	65	4.7	3	36.0	0		68	40.7
1985	55	9.3	3	9.0	0		58	18.3
1986	39	5.5	3	12.0	0		42	17.5
1987	67	7.5	2	11.0	0		69	18.5
1988	47	3.7	1	2.0	0		48	5.7
1989	69	4.1	3	8.0	0		72	12.1
1990	43	3.6	0		1	100.0	44	103.6
1991	51	5.8	1	10.0	1	50.0	53	65.8
1992	39	1.2	0		0		39	1.2
1993	32	0.7	0		0		32	0.7
1994	18	0.4	2	33.0	1	50.0	21	83.4
1995	25	0.9	1	1.4	0		26	2.3
1996	39	0.9	1	5.0	1	150.0	41	155.9
1997	20	2.5	0		1	163.0	21	165.5
1998	29	1.0	0		0		29	1.0
1999	22	0.5	1	10.0	0		23	10.5
Total	**796**	**80.4**	**40**	**236.4**	**7**	**81,413.0**	**843**	**81,729.8**

c. Permitted Discharges from Oil & Gas Platforms

Nature of Discharges. Certain types of ocean discharges are allowed from offshore oil and gas platforms off the coast of Southern California under NPDES General Permit No. CAG280000. Owing to the location of these facilities in federal waters, this permit was issued by the U.S.EPA Region 9, instead of the State. The permitted discharges include:

Drilling Fluids and Cuttings
Produced Water

Well Treatment, Completion and Workover Fluids
Deck Drainage
Domestic and Sanitary Waste
Blowout Preventer Fluid
Desalination Unit Discharge
Fire Control System Water
Non-Contact Cooling Water
Ballast and Storage Displacement Water
Bilge Water
Boiler Blowdown
Test Fluids
Diatomaceous Earth Filter Media
Bulk Transfer Material Overflow
Uncontaminated water
Water Flooding Discharges
Laboratory Waste
Excess Cement Slurry
Muds, Cuttings and Cement at Sea Floor
Hydrotest Water
H_2S Gas Processing Waste Water

During the drilling process, water- or oil-based lubricants and cleaners combine with rock and other drilling wastes to form slurries. These slurries, or drilling muds, are composed of water or oil and clays (e.g. barite and bentonite), or polymers, as well as heavy metals, traces of hydrocarbons and organophosphates (Polgar et al. 2005). Drilling muds and cuttings (solid byproducts from the drilling process) are discharged from the platforms. The wastes settle over the ocean floor adjacent to the platforms and contribute to the formation of large debris mounds. Barium, in the form of barite (barium sulfate) is a non-toxic additive in drilling muds. Owing to the fact that barium was 150 times more concentrated in discharged drilling fluid than in the sea floor, Coats (1994) used barium as a tracer in sediment trap deployments to track the dispersal of drilling fluid from drilling platforms off the coast of Point Arguello. Drilling solids were detected in traps 3.5 and 6.8 km from the platforms. The support activities associated with oil production are also sources of potential water quality degradations. Although support activities to the platforms are often coordinated, the numbers of transports required to change crews and restock supplies include >1300 ship and >1800 helicopter transports per year (Polgar et al. 2005).

Produced water

How generated. Produced water is the water extracted along with oil during oil production. Produced water consists of naturally occurring groundwater or seawater that is injected into the wells during the extraction process. Large volumes of produced water are often generated during pumping because many oil deposits reside in or around groundwater aquifers. The MMS estimated a yearly average of 330 million gallons produced per platform in the Channel (MMS 2001). As a reservoir of oil is emptied, produced waters constitute a growing percentage of the total material pulled up from a well, potentially reaching 98% (Polgar et al. 2005). Each platform sends an emulsion of gas, oil, and produced water to a tank for separation of the gas. The gas is used for fuel, sent to shore, or re-injected. The emulsion may be sent to shore for processing or some or all processing may occur on the platform. Processing of the emulsion removes impurities (including the produced water) and results in oil of a quality to be accepted into a pipeline for transport to a refinery. Produced water removed at a platform can be reinjected into wells and/or discharged overboard. Ten of the platforms in the Channel regions discharge produced water on site (MMS 2001). Produced water removed in onshore facilities can be can be discharged through submarine outfalls and/or sent to a platform offshore for injection or overboard discharge.

Contaminants in Produced Water. Produced water contains many contaminants including hydrocarbons, heavy metals, and chemical additives such as corrosion inhibitors to prevent damage to refinery equipment (Higashi et al. 1992). Weekly measurements of oil and grease, and quarterly measurements of metals, phenols, and other constituents in produced water are required under the General NPDES Permit for offshore oil lease permitees. Produced water can contain PAHs (e.g. benzene, toluene, naphthalene, phenols), metals (e.g. As, Cr, Ni, Ag, Cd, Cu, Pb, Se, Ba), cyanides, ammonia, organosulfur compounds (in particular, thiocarboxylic acids and novel thiopyranones), organopolysulfides, and inorganic forms of sulfur, such as sulfides, thiosulfates, and polysulfides (Raimondi & Boxshal 2002; and results from MMS Contract No. 14-35-0001-30761: Characterization of Organic Constituent Patterns at a Produced Water Site / Barium Relations to Bioeffects of Produced Water). Phenol, cyanides and nickel are commonly reported in discharge monitoring reports (Panzer 1999). However, according to estimates by Shiff et al. (2000), with the exception of lead, combined total mass emissions of trace metals, and many other constituents, from oil platforms is dwarfed by combined total mass emissions from large POTWs in the region (Table 8).

Toxicity of Produced Water. Until recently it was believed that the most significant biological impacts of produced water resulted from solids released with the discharge, which quickly settle out of the plume (Washburn et al. 1999). However, several studies indicate the toxicity of dissolved constituents in produced water. Key findings concerning potential deleterious effects of produced water in the Channel region are summarized below:

- Raimondi & Schmitt (1992): Survivorship, settlement, metamorphosis and viability of pre-competent red abalone larvae were directly correlated with distance from a near shore produced water outfall up to at least a distance of 1 km from the diffuser. Impacts extended to the 100-500 m isobaths surrounding the diffusers. The diffuser was ca. 1 m above the sea floor in 12 m of water off the mainland coast near Carpinteria.
- Raimondi & Boxshal (2002): Behaviors (swimming, settlement, metamorphosis) of larvae of bryozoans, ascidians, sea stars and red abalone were altered by exposure to produced water in laboratory experiments. These sublethal effects were accompanied by little mortality. In some cases, the changes in behavior may have been due to a narcotic effect of the produced water, as larvae regained normal behaviors after placement in clean, filtered seawater.
- Osenberg et al. (1992): Growth rates, general condition and tissue production of mussels was decreased within 1000 m of the same diffuser described above. Benthic invertebrate species composition was altered within 100 m of the diffuser.
- Krause et al. (1992), Krause (1993): Reproductive success of purple sea urchins was inversely proportional to produced water concentrations in egg fertilization tests. Egg fertilization was reduced by 10% in water containing as little as 0.0001% produced water (dilution factor of 10^6:1).
- Washburn et al. (1999) In fall and winter, when density stratification is weak, plumes of produced water from the diffuser described above may extend through most of the water column, and plumes may surface. Plumes are trapped below the surface in spring and summer and intermittently in winter owing to freshwater runoff during winter storms. Plumes are rarely within 2 m of the bottom. Considering the results of Krause (1992), the authors concluded that measurable toxic effects may extend beyond 1 km from the diffuser.

Dilution of Produced Water. Industry estimates of expected dilutions of produced water at the edge of a 100-m mixing zone range from 500 to >3000:1 (EPA 2004). Washburn et al. (1999) report smaller dilution factors (100 and 500:1 at 80 m distance in summer and winter, respectively) for produced water entering shallow water (12 m deep) through a coastal outfall diffuser. At 1 km distance from the outfall, dilution factors ranged from 4000 to 400,000:1. USEPA assessments of acute toxicity from produced water discharged (using data from the Gulf of Mexico) indicate that a dilution of approximately 140:1 is needed to dilute discharge below acutely toxic levels (EPA 2004). Based on dilution factors calculated for two example California platforms, acute toxicity would be confined to distances of <12.5 m or <7.5 m from the outfalls. Using data for three California species (unidentified in the source cited), the USEPA contends that chronic toxicity would be encountered within 30-35 m from California platform outfalls (EPA 2004). Based on the information above, and given that the oil platforms nearest to the Park are ~10 km from Anacapa (the nearest island), it is apparent that acute or chronic toxicity arising from produced water discharges does not reach Park boundaries. Although they would be extremely dilute tens of kilometers from their sources, do constituents from oil and gas platforms accumulate in the Park ecosystem? PAHs in bottom fish (Section II.B.1), mussels (Section II.C.9), and sediments (see Section II.B.1) in the Park *may* constitute far field effects of oil platform discharges. However, a sophisticated biochemical approach would be necessary to separate the hydrocarbon signal from offshore oil and gas operations from that produced by prolific natural hydrocarbon seeps close to the islands themselves and elsewhere in the Channel (see Section II.B.3).

Pollutants detected in fish and invertebrates at oil platforms

The wide range of ocean discharges from offshore oil platforms raises the possibility that invertebrates and fish that reside at platforms may accumulate sub-lethal concentrations of contaminants[13]. If so, they might serve as entry points for contaminants into the Park food web.

Fish. Oil platforms in the Channel serve as nursery habitat for a suite of rockfish and other fish species, often have higher densities of fish than nearby natural outcrops (Figure 30), and can serve as *de facto* fishing reserves, owing to the avoidance of them by commercial fishermen using gear that could be snared by the platform (Love et al. 1999a,b; 2003, 2005; Schroeder & Love 2004, Love & Westphal 1990). Although fish densities are not elevated at every platform, in general, canary, copper, flag, greenblotched, greenspotted, greenstriped, halfbanded, and vermilion rockfishes; bocaccio; cowcod; widow rockfish young-of-the-year; painted greenling and all life history stages of lingcod are more abundant at platforms than at natural outcrops (Love et al. 2003). The main diet of California sea lions consists of anchovies, sardines, whiting, mackerel, rockfish and market squid. Although sea lions spend time at oil platforms, they have not been directly observed persuing fish in the vicinity of the platforms (Donna Schroeder, Associate Researcher, UCSB, pers. comm.). Harbor seals are frequently seen at depths of several hundred feet around platforms, behavior which is suggestive of fish pursuit (Milton Love, Professor, Dept. Ecology, Evolution & Marine Biology, UCSB, pers. comm.). Cormorants may be catching juvenile rockfish (widow, blue, bocaccio, olive and squarespot) and blacksmith, when recruitment classes for these species are large (Donna Schroeder, Associate

[13] An exhaustive review of oil platform fauna was not conducted for this report.

Researcher, UCSB, pers. comm.). Piscivorous sea birds and pinnipeds may be more likely to forage at platforms when pelagic species (sardines, anchovies) are in their vicinity.

Figure 30. Photo showing extremely high densities of young bocaccio and vermillion rockfish at Platform Gilda in the Santa Barbara Channel during Oct. 2003 (photo by Donna Schroeder, Marine Science Institute, UCSB)

Bascom et al. (1976) sampled liver, muscle, kidney, gonad, and whole soft tissues from rockfishes, crabs, and mussels from rocky reef control sites and Platforms Hazel and Hilda in the Channel. Two hundred thirty-two samples were analyzed for trace metals (cadmium, chromium, copper, lead, molybdenum, nickel, silver, vanadium, and zinc). Concentrations of trace metals were not different between control and impact sites, with the exception of vanadium in rockfishes which was significantly higher. Vanadium levels were not toxic at the levels measured. Concentrations of hexane-extractable materials, volatile solids, copper, and zinc showed no obvious anomalies near the platforms. Hydrocarbons were not detectable in the mussels or crabs regardless of collection site, but very high in the rockfish. Owing to gas chromatographic fingerprints, the authors concluded that the hydrocarbons in the rockfish were biogenic, rather than from petroleum. The MMS is currently funding studies of platform rockfish body burdens (Dr. Milton Love at UCSB, is the grantee). Initial funding is for measurements of tissue concentrations of heavy metals (including mercury). PAHs and PCBs may be measured later in archived tissue samples (Ann Bull, Minerals Management Service, pers. comm.). At the time of this writing (1/2006), results of this study were not available.

Epibiota Epibiota (e.g., mussels, barnacles, bryozoans, anenomes, scallops) grow prolifically on offshore platforms, resulting in large shell mounds at the base of the structures. Approximately 85% of the statewide commercial mussel production originates on offshore oil platforms

(Ugoretz 2002). For many years, the locally based company Ecomar (now out of business) harvested up to 500,000 lbs per year of Mediterranean mussels, rock scallops, and oysters from Platform Holly and other oil platforms in the Channel, for sale to area restaurants. Commercial shellfish harvesters in California must be certified by the California Department of Health Services, a process which requires testing only for bacteria and paralytic shellfish toxin. Initially, Ecomar had to translocate batches of mussels to a "clean" site away from the platforms and compare the contaminant loads (most likely fecal coliform) between the mussels taken from the platforms and those at the clean site. After a year of testing there was little if any difference between mussels at the two sites and Ecomar was certified to harvest directly from the platforms and sell to the public (John Richards, Marine Advisor, Sea Grant Extension Program, UCSB, pers. comm.)

B.3. Natural Oil Seeps

Oil and gas escapes naturally from seep fields at several locations in the Channel region, including at sites within the Park (Hostetler et al. 2004). The seep field at Coal Oil Point off the mainland coast is the most prolific seep field in the region (Figure 31) and is among the largest and best documented seeps in the world (Quigley et al. 1999), releasing approximately 100,000 m^3 of gas (Leifer et al. 2003) and more than 100 barrels of oil per day (Libe Washburn, Professor, Dept. of Geography, UCSB, pers. comm.). The nearshore seeps at Coal Oil Point are predominantly oil exuded directly from the outcrop of the Monterey Formation exposed in the axis of the Coal Oil Point anticline. Further offshore, seepage passes through overlying Sisquoc Formation cap rock and includes both oil and gas. Oil slicks produced by the Coal Oil Point seep were mapped by side aperature radar (SAR) imagery from 1995-1998 by DiGiacomo et al. (2004). Their image set included an oil slick that extended 50 km in the alongshore direction that was 100 km^2 in area, as well as a slick that was entrained 15 km offshore. Cross-shore entrainment of slicks was seaward or landward, depending on how the slick interacted with surface eddies. Oil slicks from the Coal Oil Point seep field would have to be entrained ca. 50 km in the cross-shore direction before entering the Park.

There is evidence that oil extraction at Platform Holly (Figure 29) has decreased the areal extent and volume of natural seepage at the Coal Oil Point seep field. Sonar backscatter can be used to measure the extent of plumes of bubbles in seep fields. Using transects of sonar data from 1973 and 1996, Quigley et al. (1999) discovered a 50% decrease in seepage area at Coil Oil Point that was accompanied by a decline, since 1989, in the volume of gas being collected in underwater seep tents.

Active, unmapped seeps occur near the shores of the Channel Islands. Hostetler et al. (2004) used chromatographic signatures to examine the possible origins of 128 tar balls deposited on the beaches at Santa Cruz, Santa Rosa, San Miguel and the mainland. They were able to assign the tar balls to four chemically distinct seepage sources - at least one of which may be releasing tar from sites separated by as much as 60 km. Most of the tar balls collected on Park islands originated from seeps near the islands. The dominant shallow seepage around the Channel Islands appeared to originate off Fraser Pt. on Santa Cruz and accounted for about 65% of the sample set. Tar balls originating from Channel Island seeps were transported as far north as Pt. Reyes and as far south as San Diego.

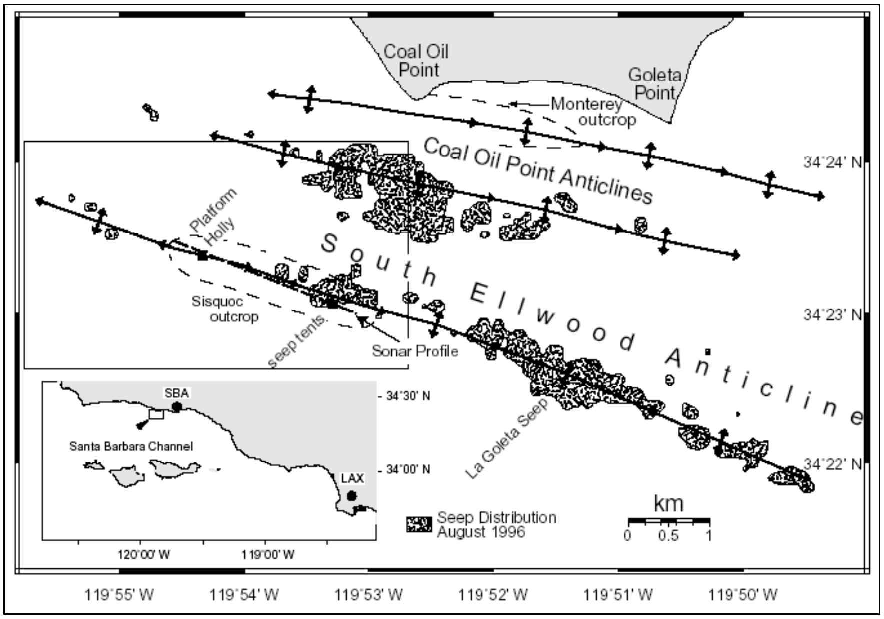


Figure 31. Coal Oil Point hydrocarbon seep area. Fault locations and anticline/syncline pairs in Monterey and Sisquoc Formations of northern Santa Barbara Channel shelf determine seep distribution. Mapped distribution of seepage is from 3.5 kHz sonar survey during August 1996 (Quigley et al. 1999).

B.4. Shipwrecks

An inventory of over 140 shipwrecks dating from 1853 to 1980 has been documented in the Sanctuary (Ugoretz 2002). To date, about 20 sites have been located (Appendix H) and include Chinese junks, Russian and Mexican sailing ships, American coastal traders and Gold Rush-era steamships. In 1987, the Pacbaroness (540 ft) collided with an automobile freighter and sank offshore near Point Conception with approximately 80,000 lbs of copper powder concentrate onboard (the auto carrier did not sink). Although this shipwreck has not been identified as a source of pollution, settling and corrosion of the sunken vessel could lead to releases of copper in the future. Furthermore, the Pacbaroness sank with 30,000 gallons of remaining bunker fuel (Polgar et al. 2005).

B.5. Water Quality Threats posed by Large and Small Vessel Traffic

A good review of the potential threats to Sanctuary water quality posed by large vessel and small vessel traffic appears in a recent report: Polgar et al. (2005). For details, and sources of data therein, the reader is directed to this report which was available online in Jan. 2006 at: http://www.edcnet.org/ProgramsPages/pressrelease.html.

Special concerns associated with vessel categories are listed below:

Large Vessels: Container Ships, Bulk and Cargo Ships, Oil Tankers

- Pass through the east end of the Sanctuary, and approach Park boundaries around Anacapa, via the southbound international shipping lane
- Frequency: ~20 per day
- Potential Releases: bilge water, ballast water, diesel exhaust

Cruise Ships

- Anchor off of the City of Santa Barbara, do not enter the Park
- Frequency: ~ 2 per year
- Potential Releases: bilge water, diesel exhaust, large volumes of untreated sewage, black and gray water, and hazardous wastes from on-board facilities for dry cleaning, photo-developing, etc., anthropogenic debris

Commercial Fishing Vessels, Commercial Passenger Fishing Vessels (CPFVs), Whale watching Vessels

- Enter the Sanctuary and the Park
- Potential Releases: bilge water, diesel fuel spils, faulty operation of Type I or Type II marine sanitation devices or releases from Type III-holding tanks, anthropogenic debris, discarded fishing gear, leaching of copper or tributyltin from anti-fouling paint on hulls (tributyltin only from vessels > 75 m in length).

Recreational Motor Boats and Sailboats

- Enter the Sanctuary and the Park, use Park anchorages
- Potential discharges: untreated sewage from Type III marine sanitation devices, bilge water, anthropogenic debris, diesel fuel spils, leaching of copper from anti-fouling paint on hulls.

According to Polgar et al. (2005), the Sanctuary plans to monitor large vessel traffic using an Automated Identification System base station on Santa Cruz, which tracks the identities, position and cargo types of large vessels using legally required identification transponders. Weekly, since August 1997, Sanctuary staff conduct aerial surveys of commercial and recreational vessels (location, number, type) as part of the Sanctuary Aerial Monitoring Spatial Analysis Program. Spatial patterns of Park use by commercial and recreational fishermen, sightseeing boats, and kayakers are discussed in Sections III.B. and III.C.

Since the writing of Polgar et al. (2005), new legislation, the California Clean Coast Act of 2005 (SB 771), took effect on Jan. 1, 2006, which targets discharges from "oceangoing ships" (private, commercial, government, or military vessel of 300 gross registered tons) and cruise ships. Discharges of (1) hazardous waste, (2) oily bilgewater, (3) "other waste" (dry-cleaning, photographic film-developing and medical), and (4) graywater, are now prohibited within state marine waters. The SWRCB will request the Administrator of NOAA to extend these prohibitions to California’s four national marine sanctuaries (Cordell Bank, Gulf of the Farallones, Monterey Bay, and Channel Islands).

C. Water Quality within the Park

C.1. State designated beneficial uses or classifications of Park waters

State designated beneficial uses of upland waters on Park islands are:

- Municipal drinking water supply
- Agriculture (Santa Rosa creeks only)
- Contact & noncontact water recreation
- Warmwater habitat
- Wildlife habitat
- Preservation of rare & endangered species

State designated beneficial uses of coastal waters at Park islands are:

- Contact and noncontact water recreation
- Navigation
- Marine habitat
- Shellfish harvesting
- Commercial and sport fishing
- Rare, threatened or endangered species
- Wildlife habitat
- Areas of special biological significance (see below)

State Water Quality Protection Areas (SWQPA)

Authorized by Assembly Bill 2800, SWQPAs are marine or estuarine areas designated to protect marine species or biological communities from an undesirable alteration in natural water quality, including, but not limited to, "areas of special biological significance" (ASBS) designated by the SWRCB through its water quality control planning process. The Park is fully contained within two SWQPAs:

ASBS No. 17, within Region 3, includes the waters surrounding San Miguel, Santa Rosa, and Santa Cruz Islands to a distance of one nautical mile offshore, or to the 300-ft isobath, *whichever is the greatest.*

ASBS No. 22, within Region 4, includes the waters surrounding Santa Barbara and Anacapa Islands to a distance of one nautical mile offshore, or to the 300-ft isobath, *whichever is greatest.*

An ASBS designation implies the following requirements:

- Discharge of elevated temperature wastes in a manner that would alter water quality conditions from those occurring naturally will be prohibited.
- Discharge of discrete, point source sewage or industrial process wastes in a manner that would alter water quality conditions from those occurring naturally will be prohibited.
- Discharge of waste from nonpoint sources, including but not limited to storm water runoff, silt, and urban runoff, will be controlled to the extent practicable. In control programs for waste from nonpoint sources, Regional Boards will give high priority to areas tributary to ASBS.

C.2. 303(d) listed water quality limited segments

There are no 303(d) listed water bodies or segments in the Park.

C.3. Streams and Riparian Corridors

a. Stream Sampling History

Stream water quality data are available for only one site on Santa Cruz (in 1993), and none on San Miguel. On Santa Rosa, streams in several canyons (Figure 32) were sampled with varying frequency from 1993-1998, and again in 2002 and 2005. Until recently, streams and riparian zones on Santa Rosa were impacted by almost two centuries of livestock grazing (see Section I.A.5 for a history of livestock operations). Starting in the early 1800's, sheep ranching was conducted by Spanish occupants on Santa Rosa. In 1902, the island was converted to cattle grazing by the Vail & Vickers Co. In addition, Roosevelt elk and kaibab mule deer were introduced in the late 1920s to support a commercial hunting operation. Vail & Vickers Co. was allowed to continue its cattle operation for 18 years after Santa Rosa became part of the Park. A settlement agreement between the NPS, the SWRCB, Vail & Vickers Co. and the National Parks & Conservation Association resulted in the removal of the cattle in 1998. The commercial hunting operation for deer and elk continues under a special use permit that is due to expire in 2008, although the NPS may allow the continued hunting of elk and deer until 2011, at which time all elk and deer will be removed from the island.

Owing to a paucity of water developments, the cattle on Santa Rosa used, and substantially damaged, the riparian areas (Wagner et al. 2004). Cattle use of streams and riparian areas increased substantially during the hotter summer months. From 10/1993 to 5/1998 water quality monitoring of three streams on Santa Rosa was conducted in Lobo Canyon, Water Canyon and Quemada Canyon. During this period, water quality standards for turbidity, microbial content, nutrients, and pH were exceeded frequently (Table 13). In May, 1995, the Central Coast RWQCB (Region 3) issued Cleanup and Abatement Order 95-064 in response to non-point source pollution caused by grazing and road management practices on Santa Rosa. That year, an assessment of riparian corridor functionality was conducted by staff from the Park, the NPS Water Resources Division, the U.S. Forest Service, and the Bureau of Land Management, in 10 stream reaches on the island, partly in order to assist with recommendations to alter cattle management (Wagner et al. 2004; see Section I.C.1. for details). Instead, in 1998, the NPS eliminated cattle on the island. During July - Sept. 2002, the streams in Lobo, Water and Quemada Canyons were resampled monthly for physical, chemical, and biological parameters in order to assess the consequences of cattle removal on water quality and riparian health. The assessment of riparian corridor vegetation, geomorphology, and functionality was repeated in 2004 (Wagner et al. 2004). A road inventory was conducted to determine the condition of all stream crossings on the island and assess the effect road management activities were having on stream conditions.

Figure 32. Stream sampling sites on Santa Rosa Island. Station numbers are those used in Table 13.

Stream sampling history for the Park, and water quality exceedances, are summarized in Table 13. With the exception of three sites (CHIS0011, CHIS 0013, CHIS 0001), time series plots of physical, chemical, and bacteriological parameters, and tables including data from 1993-2002 are available in CINP (2002b); a subset of these figures are presented in Appendix I. For this report, all available individual observations were compared to EPA "water quality criteria for aquatic life" (pH, DO), EPA and state criteria for "freshwater recreational contact" (total coliform and fecal coliform bacteria), state water quality "objectives for inland surface waters" (turbidity, DO and high pH), and EPA "suggested criteria" for TN and TP in streams and rivers of the "Xeric-West Ecoregion". Through 1998, total coliform and fecal bacteria frequently exceeded standards for recreational water contact at every site where they were measured (Appendix I). Turbidity exceedances were common during 1993-1998, and also observed at three sites post-cattle removal (Appendix I). pH was intermittently higher than 8.3 (CA upper limit) and occasionally higher than 9.0 (EPA upper limit). TN and TP frequently exceeded EPA-recommended levels before cattle removal (Appendix I).

b. Effects of cattle removal on stream water quality on Santa Rosa

In CINP (2002b), the 2002 ("post-removal") results were compared to average results for the same stations from 1993-1998 ("pre-removal"). Only pre-removal data obtained during summer months (Jul.-Sep.) were used in the comparisons. Stream discharge was significantly lower in 2002 at five of the stream sites compared to pre-removal mean values. However, this result was ascribed to unusually low precipitation on Santa Rosa in 2002 (62% below normal), rather than to phenomena associated with cattle removal. In fact, owing to the removal of grazers, and the recovery of riparian zones on Santa Rosa (see more below), many seasonal streams are reportedly experiencing a longer period of flow (Kate Faulkner, Chief of Natural Resources, Channel Islands National Park, pers. comm.). Post removal stream temperatures (relative to air temperature) were significantly lower at six sites than pre-removal stream temperatures. Cooler water temperatures are probably resulting from the recovery of riparian vegetation, and consequent streambed shading (Wagner et al. 2004). The two sites where this change was not observed were (1) where the stream bed was sharply incised in bedrock, and lacked a riparian zone, and (2) at a spring (where pre-removal temperatures were unaffected by a lack of riparian vegetation). Post-removal, TSS was 100% lower at two of the three sites where it was measured, and both of these sites were also cooler. However, post-removal *turbidity* was significantly higher than pre-removal turbidity at two of the six cooler stream locations, and not significantly different at three others. CINP (2002b) expresses more confidence in the results for TSS than for turbidity - citing low flows and sediment resuspension as having interfered with turbidity measurements (although presumably not with water sampling for TSS). Results for dissolved nutrient concentrations appear unambiguous; TP was no longer detected and TN was 89%-100% lower, post-removal. Two sites (both near the stream mouths in Water Canyon and Lobo Canyon) displayed signficantly lower mid-day dissolved oxygen levels during the post-removal survey. This result may indicate a reduction in within-stream photosynthesis following post-removal reductions in dissolved nutrients CINP (2002b), although measurements of periphytic algal biomass are not available to support this hypothesis. Total coliform bacteria were 73%-82% lower and fecal coliform bacteria >98% lower at two of the sites where measured, and unchanged at the third site (in both former cases, the changes were significant).

Table13. Stream sampling history for Channel Islands National Park. Sites in drainages are listed from highest (upstream) to lowest (downstream) in the drainage. (Whether or not exceedances were observed in 2005 was not known at time of writing)

Stream Sampling Site	Latitude Longitude	NPS station in Horizon Report	other site names	parameters measured	Sampling Era[a]	list of years sanpled (# obs)	types of Water Quality Exceedances observed during Sampling Era[b]
Quemada Canyon - Santa Rosa Island							
Clapp Springs- head of San Augustine Canyon - diverted to Vail & Vickers Ranch and into Quemada Canyon	33.951087 -120.060005	CHIS0012	Clapp Springs	temp, pH conductivity salinity turbidity, DO	pre-removal	1993 (5) 1994 (16) 1995 (5) 1996 (7) 1997 (2) 1998 (1)	Turbidity-EPA pH (high)-EPA DO
					post-removal	2002 (3) 2005 (1)	Turbidity-EPA
Quemada Canyon-50 m below ranch water development	33.954588 -120.056255	CHIS0011		temp, pH conductivity salinity turbidity, DO	pre-removal	1993 1994 others?[c]	Turbidity-EPA
Quemada Canyon near Las Cruces Corral	33.965727 -120.034365	CHIS0007	Quemada #2 (2002)	temp, pH conductivity salinity turbidity, DO	pre-removal	1993 (5) 1994 (16) 1995 (5) 1996 (7) 1997 (2) 1998 (1)	Turbidity-EPA pH (high)-CA, EPA
					post-removal	2002 (3) 2005 (1)	none

Stream Sampling Site	Latitude Longitude	NPS station in Horizon Report	other site names	parameters measured	Sampling Era[a]	list of years sanpled (# obs)	types of Water Quality Exceedances observed during Sampling Era[b]
Quemada Canyon near Old Ranch Canyon Corral	33.970142 -119.998253	CHIS0006	Quemada #3 (2002)	temp, pH conductivity salinity, turbidity DO, TN, TP, TSS, TDS total coliform fecal coliform	pre-removal	1993 (6) 1994 (19) 1995 (8) 1996 (7) 1997 (2) 1998 (1)	Turbidity TN TP total coliform fecal coliform
					post-removal	2002 (8) 2005 (1)	none
Quemada Canyon -half mile from stream mouth	33.964421 -119.983142	CHIS0005	Quemada #4 (2002)	temp, pH conductivity salinity turbidity, DO	pre-removal	1993 (6) 1994 (11) 1995 (7) 1996 (7) 1997 (2) 1998 (1)	pH (high)-CA, EPA Turbidity
					post-removal	2002 (3) 2005 (1)	Turbidity
Water Canyon Drainage - Santa Rosa Island							
Water Canyon - below Army Camp	33.964421 -120.053920	CHIS0010	Water #2 (2002)	temp, pH conductivity salinity turbidity, DO	pre-removal	1993 1994 others?	none
					post-removal	2002 (flow only) 2005 (1)	

Stream Sampling Site	Latitude Longitude	NPS station in Horizon Report	other site names	parameters measured	Sampling Era[a]	list of years sanpled (# obs)	types of Water Quality Exceedances observed during Sampling Era[b]
Water Canyon - adjacent to corral	33.978587 -120.049642	CHIS0009	Water #3 (2002)	temp, pH conductivity salinity turbidity DO, TN, TP, TSS, TDS total coliform fecal coliform	pre-removal	1993 (6) 1994 (20) 1995 (7) 1996 (6) 1997 (2) 1998 (1)	Turbidity pH (high)-CA, EPA TN TP total coliform fecal coliform
					post-removal	2002 (7) 2005 (1)	Turbidity pH (high)-CA
Water Canyon - below NPS campground	33.992059 -120.045225	CHIS0008	Water #4	temp, pH conductivity salinity turbidity DO, TSS, TDS total coliform fecal coliform	pre-removal	1993 (6) 1994 (19) 1995 (7) 1996 (7) 1997 (2) 1998 (1)	Turbidity pH (high) CA total coliform fecal coliform
					post-removal	2002 (5) (bacteria not done)	pH (high) CA
Lobo Canyon Stream - Santa Rosa Island							
Lobo Canyon - 100 m upstream fr Smith Highway	34.002087 -120.087365	CHIS0013		temp, pH conductivity salinity turbidity, DO	pre-removal	1993 1994 others?	none

Stream Sampling Site	Latitude Longitude	NPS station in Horizon Report	other site names	parameters measured	Sampling Era[a]	list of years sanpled (# obs)	types of Water Quality Exceedances observed during Sampling Era[b]
Lobo Canyon - below Smith Highway	34.005253 -120.090699	CHIS0014	Lobo #3	temp, pH conductivity salinity turbidity DO, TN, TP, TSS, TDS total coliform fecal coliform	pre-removal	1993 (6) 1994 (19) 1995 (7) 1996 (7) 1997 (2) 1998 (1)	Turbidity TN TP total coliform fecal coliform
					post-removal	2002 (7) 2005 (1)	none
Lobo Canyon - near lower end of cattle exclosure	34.017420-120.097865	CHIS0015	Lobo #4	temp, pH conductivity salinity turbidity, DO TN (once, post-removal)	pre-removal	1993 (6) 1994 (19) 1995 (7) 1996 (7) 1997 (2) 1998 (1)	Turbidity
					post-removal	2002 (4) 2005 (1)	Turbidity, TN
Santa Rosa Island - Arlington Canyon, La Jolla Vieja Canyon, Verde Canyon, Windmill Canyon, Tecelote Canyon, Wreck Canyon -				temp, pH conductivity salinity DO, TN, TP, TSS, total coliform fecal coliform	post removal	2005 (1)	

Stream Sampling Site	Latitude Longitude	NPS station in Horizon Report	other site names	parameters measured	Sampling Era[a]	list of years sanpled (# obs)	types of Water Quality Exceedances observed during Sampling Era[b]
Santa Cruz Island-Joyce Springs Canyon Mouth	34.008781 -119.554726	CHIS0001		temp, conductivity, TSS		1993 others? [a]	data not inspected

[a]Pre- and post-removal refers to the removal of cattle by the Vail & Vickers ranch from Santa Rosa Island in Sept. 1998.

[b]Water Quality Criteria from the EPA or from CA-RWQCB-Region 3 (Inland Surface Water Quality Objectives in Basin Plan, Region 3)

- Total Coliform: EPA: 1000 MPN/100ml (geometric mean)
- Fecal Coliform: 200 MPN/100 ml (geometric mean), 400 MPN/100ml (single sample)
- Turbidity: 50 FTU/NTU
- DO-EPA: <4.0 mg/L
- DO-CA: <5.0 mg/L
- pH (low) EPA&CA: < 6.5
- pH (high) EPA: >9.0, CA: >8.3
- TP: >0.022 mg/L (EPA recommended criteria for rivers and streams in xeric west)
- TN: >0.38 mg/L (EPA recommended criteria for rivers and streams in xeric west)

[c]Period of observations reported in 1999 inventory of water quality data for the Park ("Horizon Report", NPS 1999) . Based on sampling history reported in CINP (2004) for the other Santa Rosa sites, there may be other observations at the site that are not included in the Horizon Report.

C.4. Vernal pools

Water quality has been examined only once in vernal pools in the Park (Furlong 1996). In April, 1995, some basic measurements were made during a survey of 12 vernal pools on Santa Rosa (Table 14). Pools on the west end of the island were being used by cattle at that time. Turbidity was high (80 to >1000 NTU) in these pools, however, no corresponding measurements were made in pools on the east side of the island that were apparently less impacted, or unimpacted, by cattle. Water temperature ranged from 11.8 to 18.5°C, and pH ranged from 7.37-8.55. Water quality in the generally deeper vernal pools on the east end of the island was not evaluated. However, macroinvertebrate diversity was higher in pools on the east end, primarily owing to higher numbers of insect taxa.

Table 14. Santa Rosa vernal pool information from an April, 1995, survey (Furlong 1996).

			Pocket Field Pools				Water Canyon Pool		Skunk Point Pools			Abalone Rock Pool
	1	2	3	4	5	6		1	2	3	4	
estimated size*	L	L	L	M	S	S	L	M	S	M	M	L
Depth (cm)	55	35	35	10	35	20	60	60	45	150	80	40
Bank characteristics**	G,L	M,G	M,G	M	M	L	C,L	D,L	D,L	D,L	D,L	L
Cattle Impact	H	H	H	H	H	M	N	N	N	N	N	O
Clarity (subjective score)	S	S	S	T	T	T	S	C	C	C	C	C
Turbidity (NTU)	111	260	80	>1000	>1000	>1000						
Water temp. °C	11.8	12.1	13.4	16.7	16	18.5						
pH	8.55	7.94	7.97	7.86	7.64	7.37						
Salinity (%)	0.08	0.01	0.01	0.01	0.02	0.02						
Dissolved O2 (mg/l)	11.1	9.73	9.52	8.65	8.27	7.21						
Crustatcean Taxa	1	2	3	3	2	2	5	1	2	3	2	3
Insect Taxa	5	8	6	7	6	2	7	17	14	10	13	17

*L > 3000 m^2; M >1500 m^2; S <1500 m^2 (estimated)
**M = mud, G=introduced grasses, L=littoral species, D=dune vegetation
***H=high impact observed/assumed, O=occasional impact assumed, N=no or rare impact assumed

C.5. Groundwater

No principal aquifers underlie the islands of the Park (Planert and Williams 1995) and groundwater from the mainland does not discharge into the Park. A search of the USGS ground water site inventory yielded no well water, test bore, or other ground water data for the Park (Santa Barbara Channel Island HUC 18060014). The Park maintains wells on Santa Cruz (at Prisoner's Harbor and Scorpion Bay), on Santa Rosa (in Windmill Canyon), and on San Miguel (in Nidever Canyon). Other than bacterial levels, water quality is not monitored at these sites (Kate Faulkner, Chief of Natural Resources, Channel Islands National Park, pers. comm.). In July, 2005, a network of 18 shallow groundwater wells was installed in the coastal wetland at

Prisoner's Harbor on Santa Cruz in order to monitor the water table in anticipation of restoration work there (Noon 2005). No data from these wells was available at the time of this writing. However, owing to the *Eucalyptus* stands on the riparian terrace at this site, these wells provide an opportunity to study any future changes in the water table, should restoration work include removal or reduction of *Eucalyptus*.

C.6. Lagoons and coastal wetlands

The only lagoons and wetlands that are studied in the Park are on Santa Rosa. A monitoring protocol for Santa Rosa lagoons was created in 1990 (Dugan et al. 1990), and three lagoons have been sampled with variable frequency since then: Old Ranch House Canyon Lagoon, Old Ranch Canyon Lagoon and Oat Point Lagoon (variably called a lagoon or a wetland, Dugan and Hubbard, 1990). Lagoon monitoring by Park staff takes place in conjunction with sandy beach monitoring and occurred in 1994 (Richards 1996), 1995 (Richards and Lerma 1996), 1997 (Lerma and Richards 2000), 1999 (Lerma et al. 2001), 2000 (Lerma and Richards 2002), and 2004 (Richards 2004) (Figure 11). Physical measurements are water depth, secchi depth, salinity (surface and 10 cm) and water temperature. No chemical measurements are made. The main water input to the lagoons is berm overwash, which can change the volume and areal extent of the lagoons during single tidal cycles. An ephemeral freshwater seep sometimes lowers surface salinity in part of Old Ranch House Lagoon. Freshwater inputs from creek inflow cause the other two lagoons to be brackish some of the time. Oat Point Lagoon does not receive creek water, is always hypersaline, and fills with either rainfall or berm overwash (Dan Richards, Marine Biologist, Channel Islands National Park, pers. comm.). Old Ranch Canyon Lagoon and Oat Point wetland are susceptible to complete drying. The lagoons are usually 5-10°C warmer than the ocean. The lagoons were sampled with greatest frequency from 1988-1990. During that time, salinity ranged from ~40 to ~150 ppt at Oat Point and from 0 to ~50 ppt in Old Ranch Canyon Lagoon. Overall, salinity ranges from 0 to >200 ppt at the three lagoons (Dugan and Hubbard 1990).

C.7. Beach water

Water quality at Park beaches or anchorages is not monitored by the Park. Between 5/26/2005 and 9/5/2005, Santa Barbara Channelkeeper, an area non-profit organization, sampled total coliform, *E.coli* and *Enterococcus* in ocean water (surface grab samples) at several anchorages around the eastern end of Santa Cruz and at Anacapa. The following anchorages were sampled (each more than once, for a sample set of 34 grab samples):

Santa Cruz	**Anacapa**
Coches Prietos	Landing Cove
Little Scorpion	Frenchy's Cove
Big Scorpion	
Seals	
Prisoners	
Pelican	
Smugglers	
Cueva Valdez	
Diablo	
Frys	
Yellowbanks	

Total coliforms were high only twice, on July 2, 2005 at Pelican and Yellowbanks anchorages (933 and 6488 MPN/100 ml, respectively). The state standard for total coliform for ocean water contact recreation is a runnning average of 1000 MPN/100 ml, with no single, verified, sample being >10,000 MPN/100ml. *E. coli* and *Enterococcus* were each detected in only four samples during the summer, and *E. coli* was only high on one occasion (813 MPN/100 ml, at Pelican Anchorage on July 2, 2005). These higher values were attributed to high numbers of boats at most anchorages on the 4th of July weekend-especially at Pelican and Smugglers/Yellowbanks anchorages (Jessica Altstatt, Science Director, Santa Barbara Channelkeeper, pers. comm.). Fourteen boats were counted at Pelican Anchorage that weekend (which is crowded for that site) and 23 boats were anchored at Yellowbanks (which is a roomier anchorage).

C.8. Ocean water quality

a. Sources of Oceanographic Data from Park waters

Four oceanographic research programs measure oceanographic parameters at regular intervals near, or within, Park waters. These are summarized below. The Park has temperature logger data from some kelp forest monitoring sites dating back to about 1985. In addition, for the last decade, year-round temperature logger data has been collected at 16 sites.

Santa Barbara Coastal Long-Term Ecological Research Project (LTER) The LTER, which was initiated in 2000, is headquartered at the University of California, Santa Barbara (UCSB) and is part of the National Science Foundation's Long-Term Ecological Research Network. The LTER collects hydrographic and biological data four times per year during Channel-wide surveys (Figure 33), principally to determine how oceanographic processes influence material transport to and from mainland kelp forests. During each cruise, an undulating towed vehicle called a Scanfish is deployed to obtain high resolution, two-dimensional maps of temperature, salinity, beam attenuation at 660 nm (a measure of water turbidity), and chlorophyll from the surface to ~100 meters depth. Cross-channel transects of CTD (conductivity/ temperature/depth instrument) profiles along the Scanfish tracks provide vertical profiles of the same water properties measured by the Scanfish, but from the surface to the sea floor. Nutrient and particle concentrations, and primary production rates, are derived from bottle samples obtained during the CTD surveys. Other instruments attached to the CTD measure optical properties used to characterize the particle fields and dissolved components of the water column. Spatial variation in currents is measured continuously during the cruises with ship-board instrumentation. Local area SeaWiFS and AVHRR images are collected and analyzed as part of the LTER program in collaboration with joint funding from NASA. This imagery provides 1-km scale synoptic views of ocean chlorophyll concentrations (Chl) and sea surface temperature (SST). Co-registered five-day composite fields for SST and Chl are created on a routine basis for the Channel.

UCSB Plumes & Blooms Project. The Blooms & Plumes project (PnB) is a joint collaboration among UCSB faculty, student and staff researchers at the Institute of Computational Earth System Science, NOAA researchers at the Coastal Services Center (Charleston, SC) and the Sanctuary. Since 1996, twice-monthly research cruises have taken place from the shelf waters north of Santa Rosa island to Goleta Point on the mainland (Figure 33). Measurements include temperature and salinity, ocean color spectra, water column profiles of red light transmission and chlorophyll fluorescence, and depth profiles of nutrients from bottle samples. PnB and LTER cruises are frequently combined.

CalCOFI. The California Oceanic Cooperative Fisheries Investigations (CalCOFI) are a partnership of the CF&G, the NOAA Fisheries Service and the Scripps Institution of Oceanography (Scripps). The organization was formed in 1949 to study the ecological aspects of the collapse of the sardine populations off California. Today its focus has shifted to the study of the marine environment off the coast of California and the management of its living resources. Since 1949, hydrographic and biological data of the California Current System have been collected on CalCOFI cruises. The 54+ year hydrographic time-series includes temperature, salinity, oxygen and phosphate observations. In 1961 nutrient analysis expanded to include silicate, nitrate and nitrite; in 1973, chlorophyll was added; in 1984, C_{14} primary productivity incubations were added. Currently, two to three week cruises are conducted quarterly. Scripps and NOAA provide equally in terms of ship time, personnel, and other cruise-related costs. On each cruise a grid of 66 stations off Southern California is occupied (Figure 33).

PISCO. The Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) is a research consortium involving marine scientists from Oregon State University, Stanford University, UCSB, and UC Santa Cruz. PISCO was established in 1999 primarily with funding from the David and Lucile Packard Foundation. Among other things, PISCO studies recruitment processes and other factors that pattern communities of fish, invertebrates and algae at the Northern Channel Islands (and along the U.S. Pacific Coast). With respect to water quality, PISCO collects continuous measurements of temperature, and current speed and direction using moored instruments at various sites at the Channel Islands[14].

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[14] PISCO data were not utilized in this report.

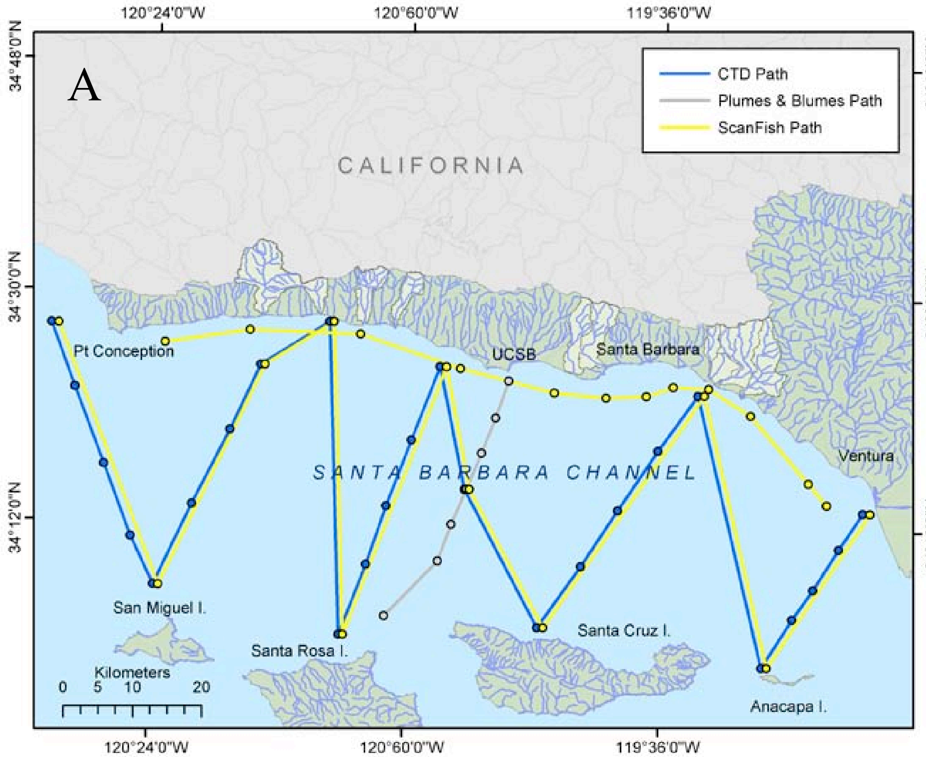
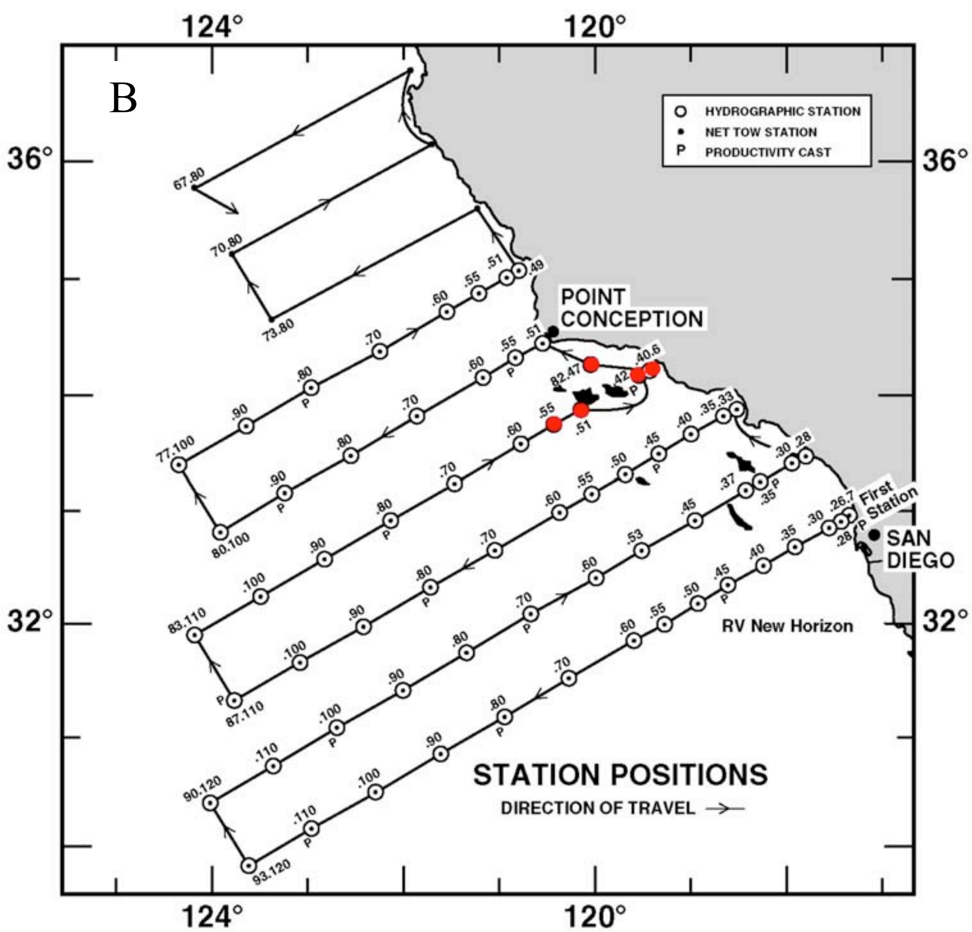


Figure 33. Oceanographic cruise sampling locations in the Santa Barbara Channel.

(A) Location of LTER grid stations(points along the labeled CTD path) and PnB transect stations.



(B) Location of CalCOFI grid stations. Selected CalCOFI salinity data for the stations highlighted in red are examined in this report.

b. What do oceanographic data reveal about the reach of mainland storm plumes in the vicinity of the Park?

Anthropogenic marine water pollution is unstudied at the Park. Measurements of synthetic organic contaminants or inorganic toxicants (metals) are lacking for Park waters. Natural phenomena (such as upwelling, currents, seasons, El Niño/La Niña cycles, and multidecadal climatic shifts) contribute to regional dynamics in SST, nutrient supply, and primary productivity. Consequently, standard oceanographic measurements (such as temperature, salinity, DO, dissolved nutrients, and chlorophyll-a) do not indicate *per se* whether or not water quality at the Park is compromised. However, in some cases, salinity data can be used to examine whether mainland storm plumes (and, presumably, associated contaminants) are advected all the way to the Park after major runoff events. Fine suspended sediments from mainland runoff usually penetrate further offshore than the surface salinity anomalies created by hypopycnal river plumes (Dave Siegel, Professor, Department of Geography, UCSB, pers. comm.). This implies that the dissolved constituents and fine particle-bound constituents of storm plumes are not transported in equivalent fashion away from the mainland. Average ambient coastal salinity in the region is 33.4 ± 0.1 psu, while river plumes produced by storms in the region have salinities in the range of 30.0-33.0 psu (Warrick et al. 2004b). Sea urchin fertility tests indicate that, at least in the Santa Monica Bay, water in storm plumes at sea must contain at least 10% of undiluted river water to be toxic (Section II.A.5). According to Warrick et al. (2005), plume water containing 12% river water corresponds to a decrease in salinity of approx. 4 psu from ambient seawater salinity. This implies that, in this region, the salinity of storm plume water at seas may need to be as low as 30.0 psu before it contains enough terrestrial runoff to represent an immediate threat to sensitive aquatic biota (i.e., acute toxicity). In real time, water quality in the Park is probably not affected by mainland runoff so long as the islands remain outside the zone of decreased salinity produced by major terrestrial runoff events. Below, selected salinity data from the LTER, PnB and CalCOFI research programs are examined to see whether surface salinity anomalies from mainland storm plumes extend far enough into the Santa Barbara Channel to reach Park waters.

Examination of salinity data from LTER and PnB.

Raw bottle sample data from all twelve LTER ocean grid cruises (2001 onward) was obtained in Nov. 2005. Salinity profiles for stations closest to the Park were plotted and inspected for evidence of discharge events of sufficient magnitude to reduce salinity in Park waters. For the dates on which LTER cruises were co-conducted with the more frequent bi-monthly PnB transects, salinity data were also plotted for the two PnB transect stations that lie closest to the Park (PnB7- on shelf waters near Santa Rosa, and PnB6 - nearest Santa Cruz). Combined LTER/PnB cruises coincided twice with stormflow events that influenced water close to the mainland: on 2/26/2004 when a storm plume was observed off of the Ventura coast, and during the Jan. 2005 cruise, after weeks of above-normal rainfall had occurred in the area (monthly rainfall totals with 25 to 50-year return intervals). For this reason, for both of these runoff events, salinity profiles obtained near each of the islands were compared to those obtained nearest the mainland (LTER station called "Ventura Plume" on 2/26/2004 , LTER grid station #25 off Ventura Harbor on 1/25/2005; and PnB transect station #1 off Goleta Point on 2/29/2004 and 1/25/2005). During these two discharge periods, surface salinity was sharply stratified near the mainland coast, and minimum surface values were 32.59 and 30.07 psu (on 2/26/2004 and 1/25/2005, respectively).

San Miguel. Salinity data for San Miguel are from LTER grid station #5. Salinity profiles from this site indicate that surface salinity was never stratified near San Miguel during the twelve LTER cruises, and salinity was not low enough on any of the sampling occasions to indicate dilution of San Miguel waters with terrestrial runoff (Figure 34).

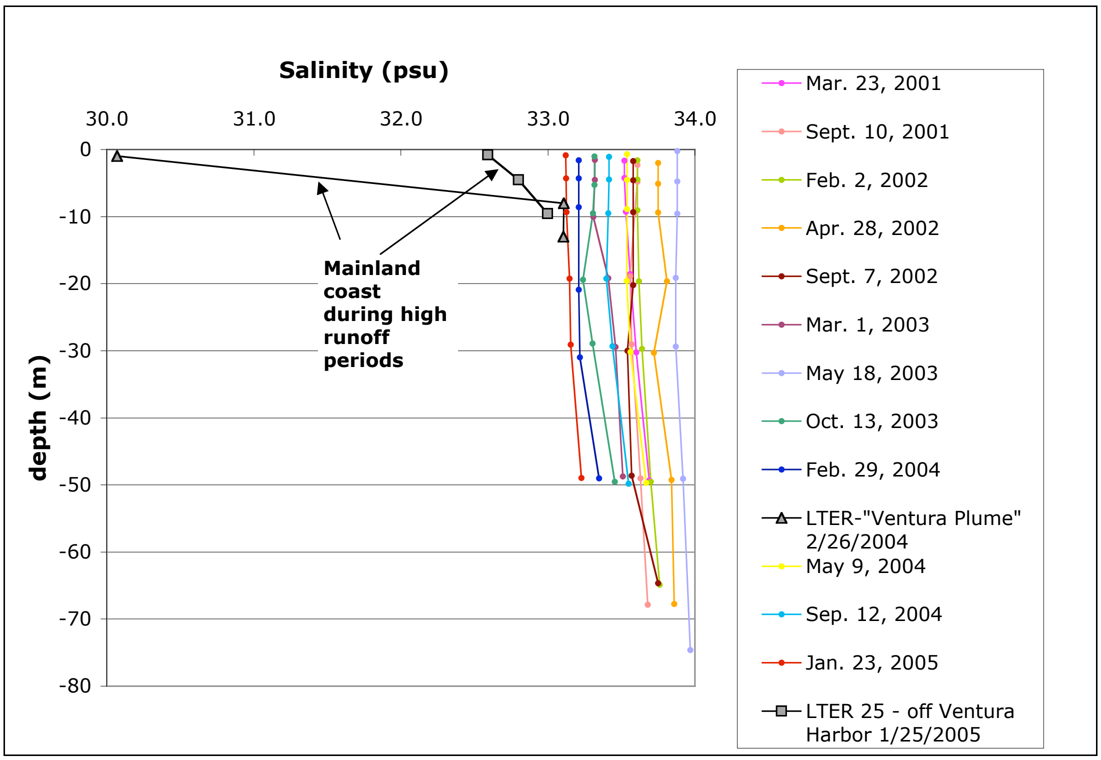


Figure 34. Salinity profiles near San Miguel Island. Data are from bottle samples collected at LTER grid station #5. For comparison, surface salinity at LTER stations nearest the mainland are included from two cruises that coincided with high terrestrial discharge.

Santa Rosa. Salinity data for Santa Rosa are from LTER grid station #10 and PnB transect station #7. Salinity profiles from 1/24/2005 at both stations indicate reduced surface salinity in Park waters near the island (Figure 35). However although a storm plume from the Santa Clara River was present off Ventura on 2/26/2004, surface water near Santa Rosa was not freshened by terrestrial runoff at that time.

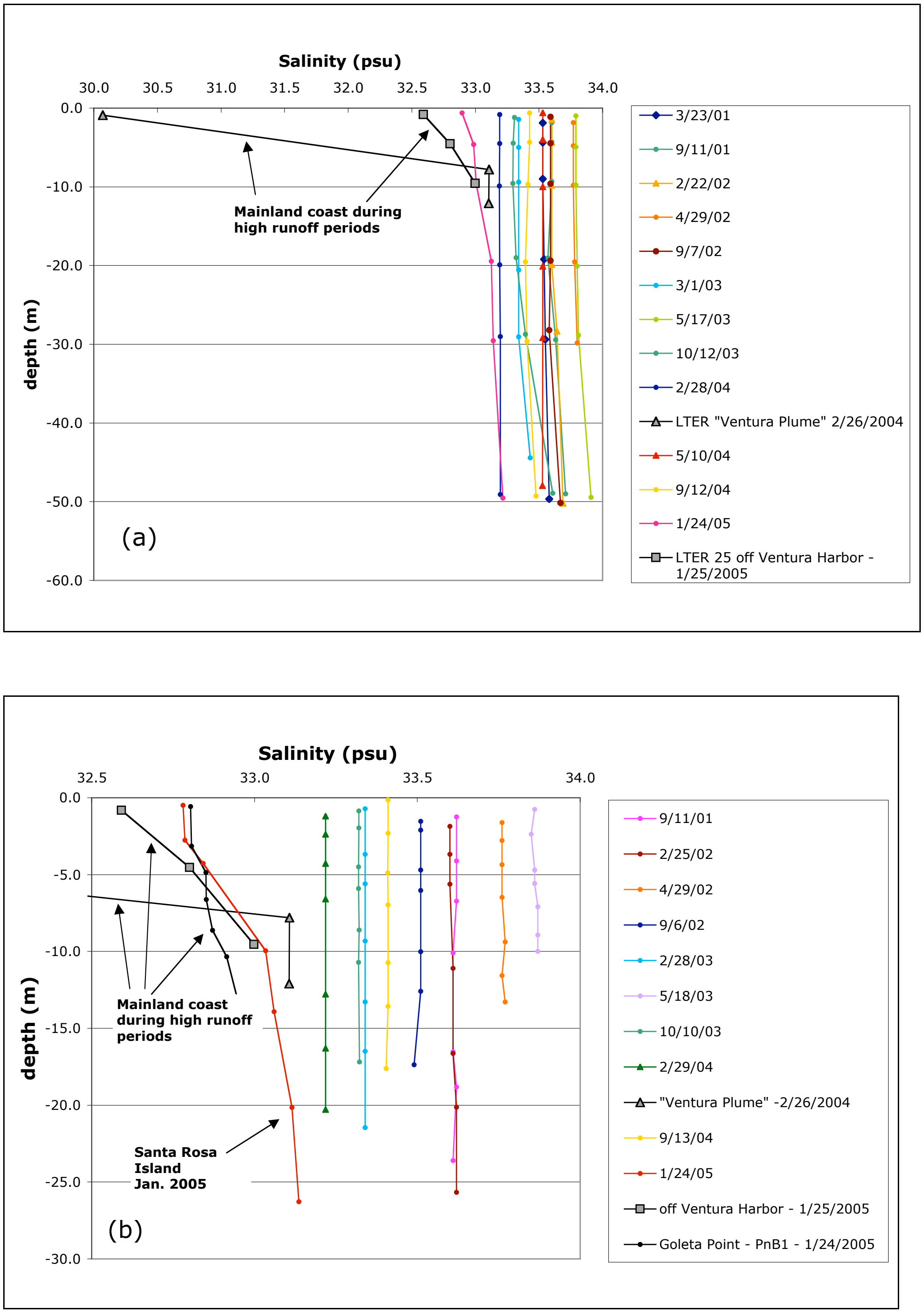


Figure 35. Salinity profiles near Santa Rosa Island. (a) Bottle sample salinity from LTER grid station #10. For comparison, surface salinity at LTER stations nearest the mainland are included from two cruises that coincided with high terrestrial discharge. (b) Bottle sample salinity from PnB station 7. Mainland station data from PnB1 (Goleta Point), and two LTER stations, are included.

Santa Cruz. Salinity data for Santa Cruz are from LTER grid station #16 and PnB transect station #6. As was the case for Santa Rosa, salinity profiles from Jan. 23-26, 2005 indicate reduced surface salinity near the island (Figure 36). However, although a storm plume from the

Santa Clara River was present off Ventura on 2/26/2004, surface water near Santa Cruz was not freshened by terrestrial runoff at that time.

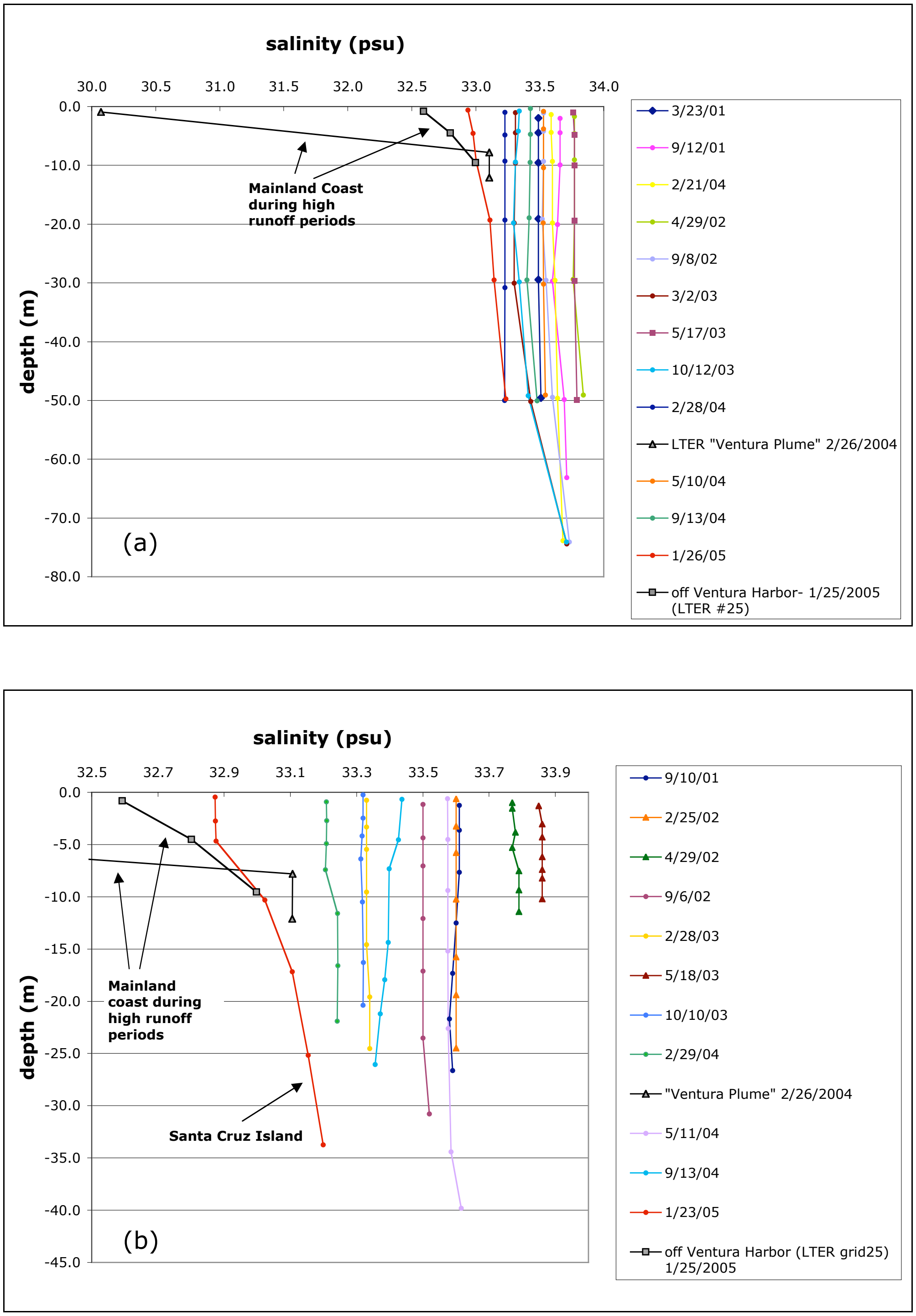
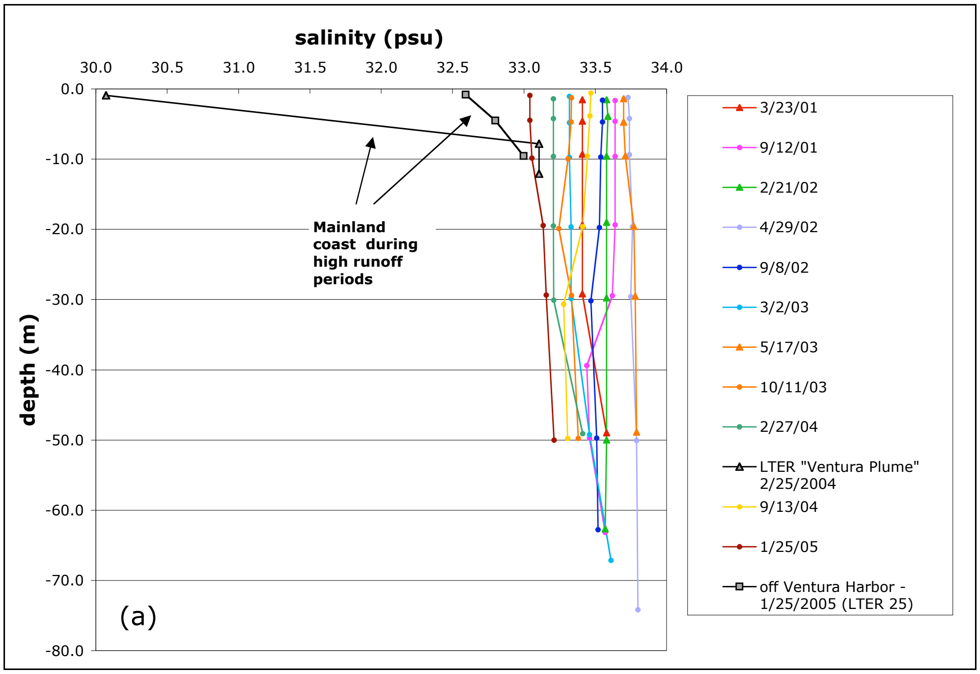


Figure 36. Salinity profiles near Santa Cruz Island. (a) Bottle sample salinity from LTER grid station #16. For comparison, surface salinity at LTER stations nearest the mainland are included from two cruises that coincided with high terrestrial discharge. (b) Bottle sample salinity from PnB station 6. Mainland station data from PnB1 (Goleta Point), and two LTER stations, are included.

Ancacapa. Salinity data for Anacapa are from LTER grid station #21. The salinity profile from 1/25/2005 indicated slightly reduced surface salinity near the island (Figure 37). However, although a storm plume from the Santa Clara River was present off Ventura on 2/26/2004, surface water near Anacapa was not freshened by terrestrial runoff at that time.



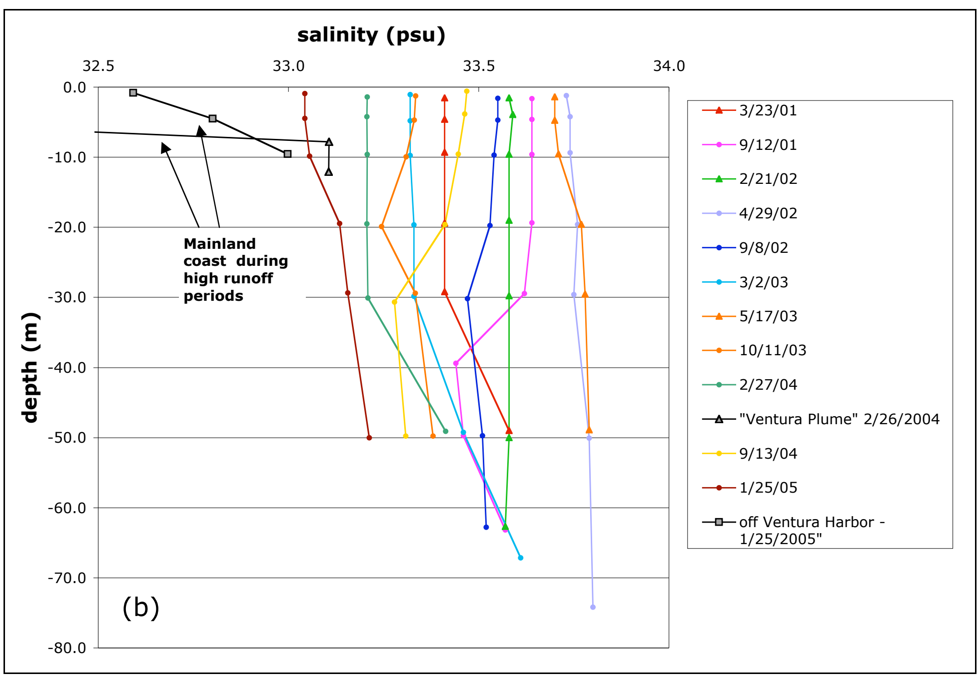
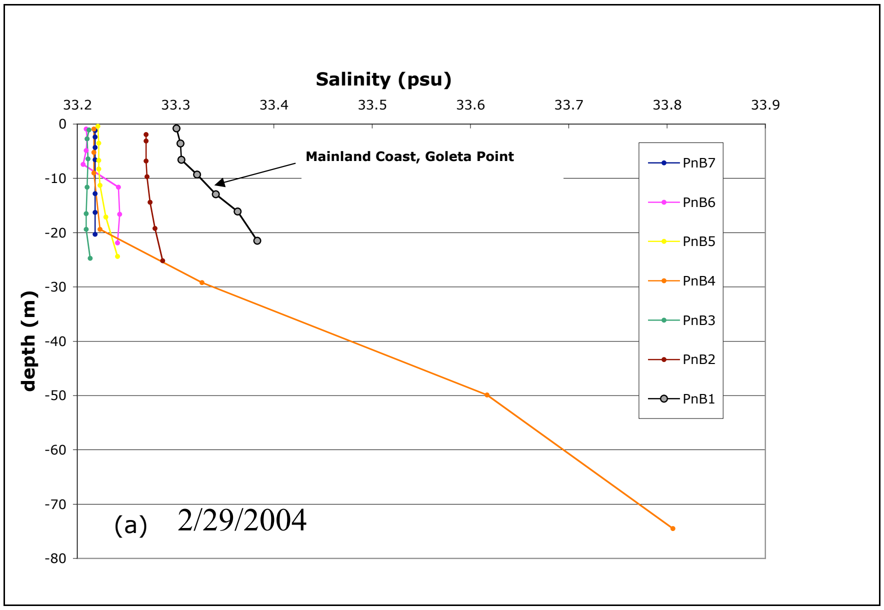


Figure 37. (a) Salinity profiles near Anacapa Island. Data are from bottle samples collected at LTER grid station #21. For comparison, surface salinity at LTER stations nearest the mainland are included from two cruises that coincided with high terrestrial discharge. (b) As in (a), but with truncated X-axis.

Two cross-channel PnB salinity transects examined. The results described above do not indicate whether pronounced surface salinity anomalies near Santa Rosa and Santa Cruz Islands, and slight anomalies near Anacapa, on Jan. 24-25, 2005 were localized phenomena (produced by island runoff) or whether they extended across the whole Channel. In order to address this question, salinity profiles were plotted from bottle data for cross-Channel PnB transects (which extend from the mainland coast at Goleta Point to Santa Rosa - see Figure 40) on Feb. 29, 2004 and Jan. 23, 2005 (Figure 38).



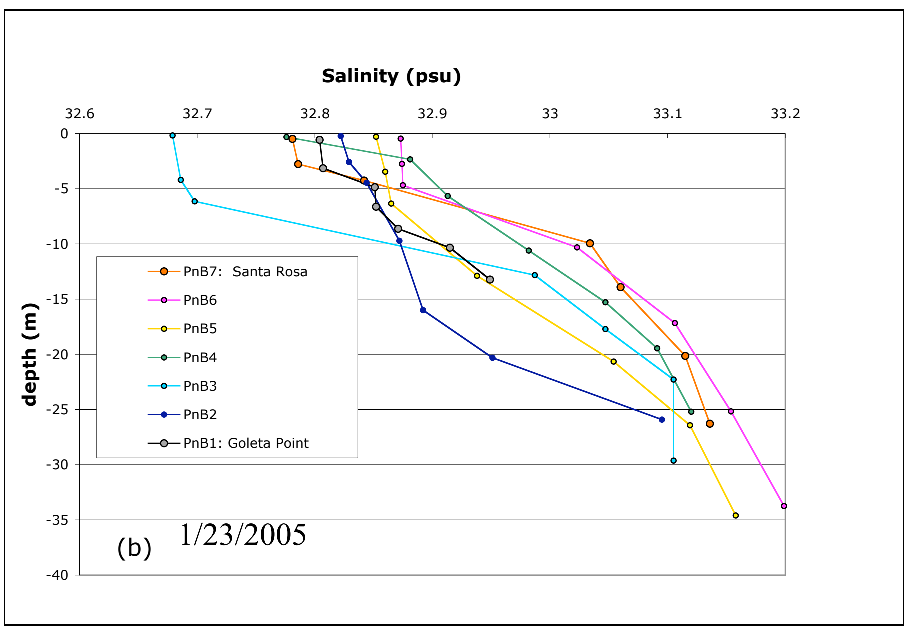


Figure 38. Salinity from bottle samples during PnB cross-Channel transects on 2/29/2004 (a), and 1/23/2005 (b). Note that the y-axes have different scales in (a) and (b).

On 2/29/2004, the surface ocean off of Goleta Point was slightly stratified, however, salinities were not as low (e.g., <33.0 psu) as those observed in hypopycnal plumes from the Santa Clara River. This suggests that the hypopycnal plume observed off the coast at Ventura a few days earlier (on 2/26/2004) did not extend far enough to the west in the Channel to influence stations along the PnB transect. The PnB salinity profile nearest Santa Rosa shows no stratification on 2/29/2004. However, in Jan. 2005 (after monthly rainfall totals with 25 to 50-year return intervals), freshened seawater extended from the mainland all the way out to Santa Rosa and Santa Cruz (Figure 38b). Interestingly, surface salinity at San Miguel did not appear to be influenced by this major event (Figure 34).

Plots of raw data from CTD casts from 103 PnB cross channel transects, covering the period 1996 to 2002, are publically available at: ftp://ftp.icess.ucsb.edu/pub/PnB/plots. Inspection of all of these plots uncovered no cases in which PnB cruises coincided with surface salinity <33.0 psu across the whole Channel, such as was observed on Jan. 23-25, 2005. Apparently, the only time (other than Jan. 2005) when PnB cruises detected freshened water all the way across the Channel was during the 1998/99 El Nino (Figure 39) - however surface salinity in the ocean during these storms was not much less than 33 ppt (Dave Siegel, Professor, Dept. of Geography, UCSB, pers. comm.). Salinity data from a May 5, 1998, PnB cruise (CTD casts, Figure 40) most strongly resemble the Jan. 23, 2005 results, although salinity was lower across the surface of the Channel on the latter date.

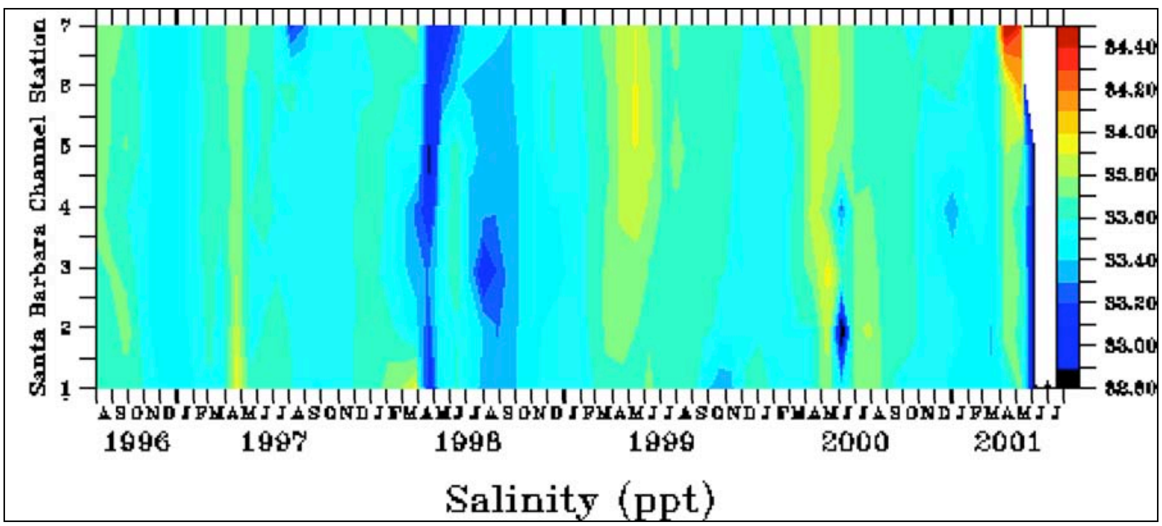


Figure 39. Time series for surface salinity from PnB transects from the mainland (station 1 at bottom) to shelf waters off of Santa Rosa Island (station 7 at top) from August 1996 to July 2001 (figure was provided by D. Siegel, UCSB).

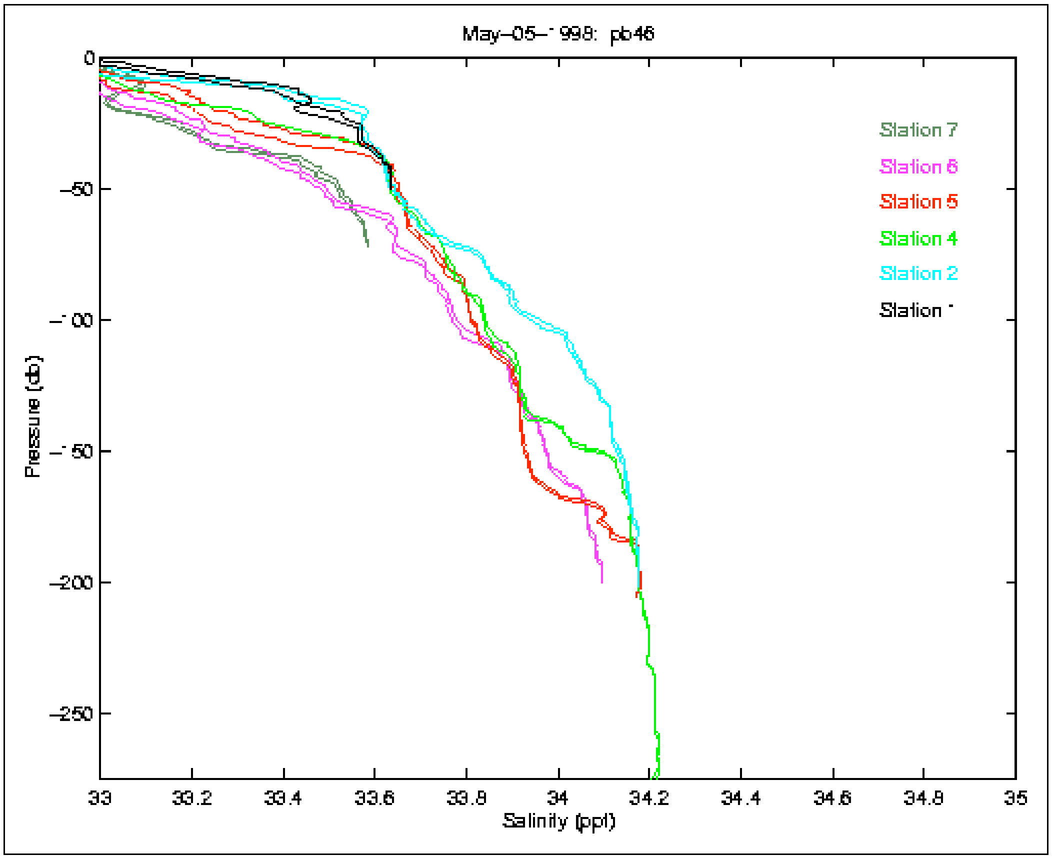


Figure 40. Salinity profiles from a May 5, 1998, PnB Channel transect. Station 1 (black) is at the mainland (Goleta Point) and Station 7 (dark green) is on shelf waters off Santa Rosa Island. Rainfall during April, 1998, was 4.2 cm in the mountains behind Santa Barbara, which represents a monthly total with a 10-year return interval. Figure was obtained at ftp://ftp.icess.ucsb.edu/pub/PnB/plots/seriesplots/

Examination of CalCOFI salinity data. One CalCOFI station (station 83.51) is close to the south shore of Santa Rosa (Figure 33). Because Channel-scale events are less likely to influence water quality on the south shore of Santa Rosa, compared to the shelf waters north of the island, this CalCOFI station provides an opportunity to examine whether runoff from Santa Rosa itself creates a localized hypopcynal plume during periods of high rainfall. For this report, salinity profiles from station 83.51 were inspected for every CalCOFI cruise from the early 1980s to 2005. None of the cruises detected surface salinity <33.0 psu at this station. CalCOFI cruise #0501 took place in mid Jan. 2005, close to when the PnB transect revealed freshened water across the surface of the Channel (as in Figure 38b). In Figure 41, salinity profiles from cruise #0501 from the two CalCOFI stations nearest the south shore of Santa Rosa (stations 83.55, 83.51) are compared to those from four stations *inside* the Channel and near the mainland coast (stations 83.42, 83.40.6, 83.33.9, 82.47).

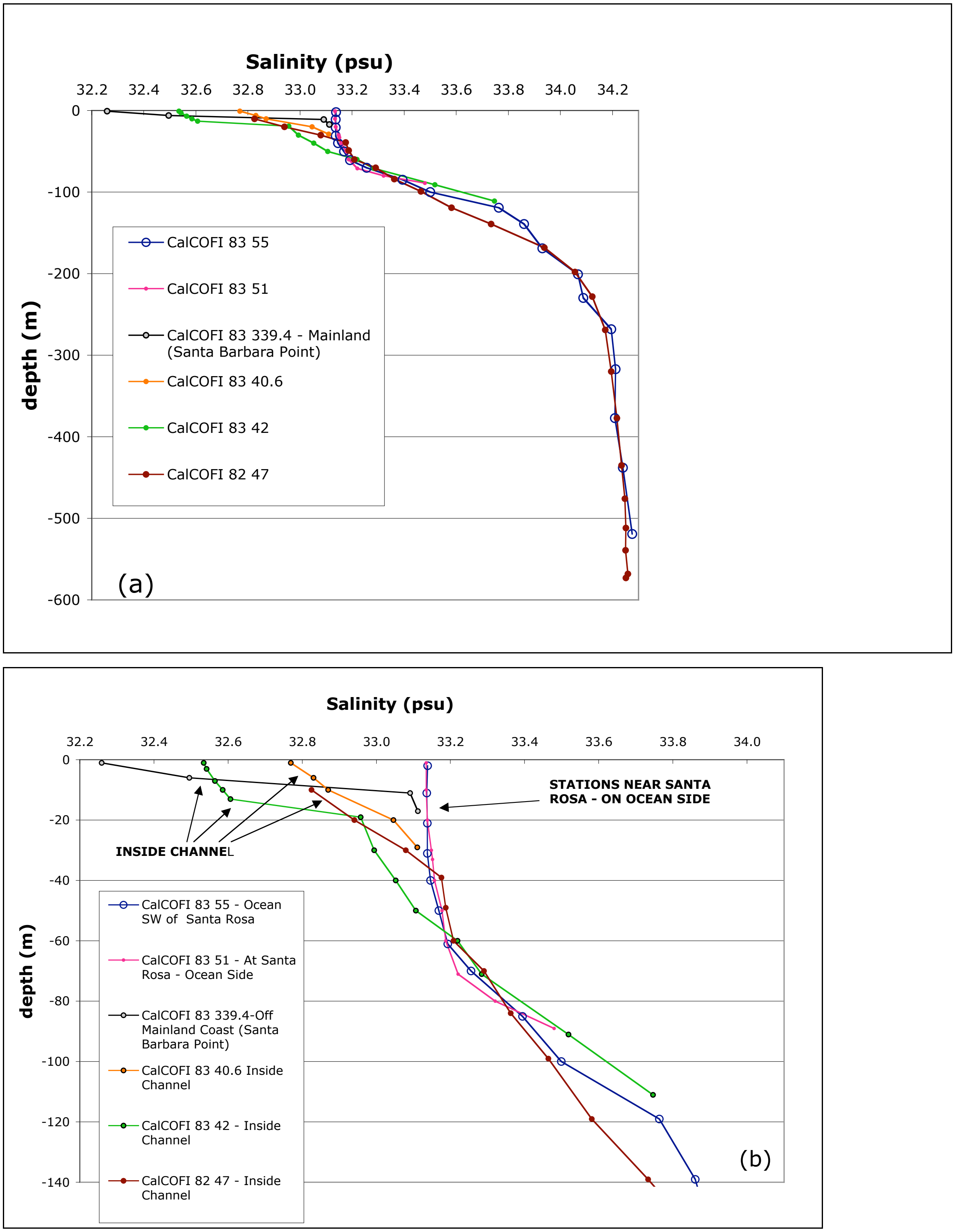


Figure 41. (a) Salinity profiles from CalCOFI cruise #0501. Stations shown were sampled on Jan. 15, 2005; (b) as in (a) for the top 140 m of the water column.

The CalCOFI profiles south of Santa Rosa were obtained to a depth of more than 500 m. Considering this depth range, a pycnocline is evident at ca. 100 m (Figure 41a). This feature is consistent with deep water profiles obtained by PnB from CTD casts across the Channel (data not presented here). However, there is no sign of a hypopycnal surface plume at CalCOFI stations 83.55 and 83.51, such as might occur if stream runoff from Santa Rosa itself (or the islands as a group) was creating a large, localized plume encircling the islands. In contrast to this result, surface salinity was sharply stratified, with surface values below 33.0 psu, at every CalCOFI station *inside* the Channel on that date, including the station in shelf waters north of Santa Rosa (Figure 41). Together with the Jan. 2005 data from LTER and PnB projects discussed above, these CalCOFI data suggest that in January, 2005, mainland runoff could have contributed to decreased salinity near the northern coasts (Channel side) of Santa Rosa, Santa Cruz and Anacapa. These data imply that during periods such as Jan. 2005 (after weeks of rainfall levels with 25- to 50-year return intervals) Park waters might become diluted with discharge from the mainland.

No data were obtained to confirm whether or not a surface sediment plume associated with mainland discharge extended to Park waters in Jan. 2005. The exercise above is intended as an example of how salinity data could be used by the Park to evaluate the likelihood that *dissolved constituents* in mainland runoff reach Park waters during runoff events. The data at hand suggest that extraordinary rainfall (≥25-year events) may be required before Park waters become diluted with mainland runoff. Whether or not detectable quantities of mainland-derived contaminants are present in the water near the islands during these unusual events is unknown. Other evidence, such as remote sensing data of ocean color, may be most useful to determine the reach of fine suspended sediments from the mainland into the Park. Whether the infrequent arrival of mainland-derived suspended sediments in Park waters poses a threat to Park biota is unknown.

c. Remotely sensed observations of water quality in the Park.

Suspended sediment. Sediment export from Park islands was examined using 26 years of remote sensing data, and related to watershed geomorphology and nearshore bathymetry (Mertes et al. 1998). Because the major drainages on Santa Rosa radiate toward the ocean from a central highland, the higher order streams on Santa Rosa have longer streams lengths and greater vertical descents, than same-order streams on Santa Cruz. Consequently, sediment is more efficiently transferred to the ocean by streams on Santa Rosa than on Santa Cruz. During large rain events (such as a 10-year storm on Feb. 15, 1998, Figure 42) suspended sediments can surround much of Santa Rosa, without any influence from mainland storm plumes. However, many of the largest watersheds on Santa Rosa drain into shallow coastal waters, where resuspension of marine sediments also produces surface sediment plumes that can be decoupled from discharge events (Mertes et al. 1998). This complicates efforts to associate sediment concentrations in water around Santa Rosa with terrestrial sediment output.

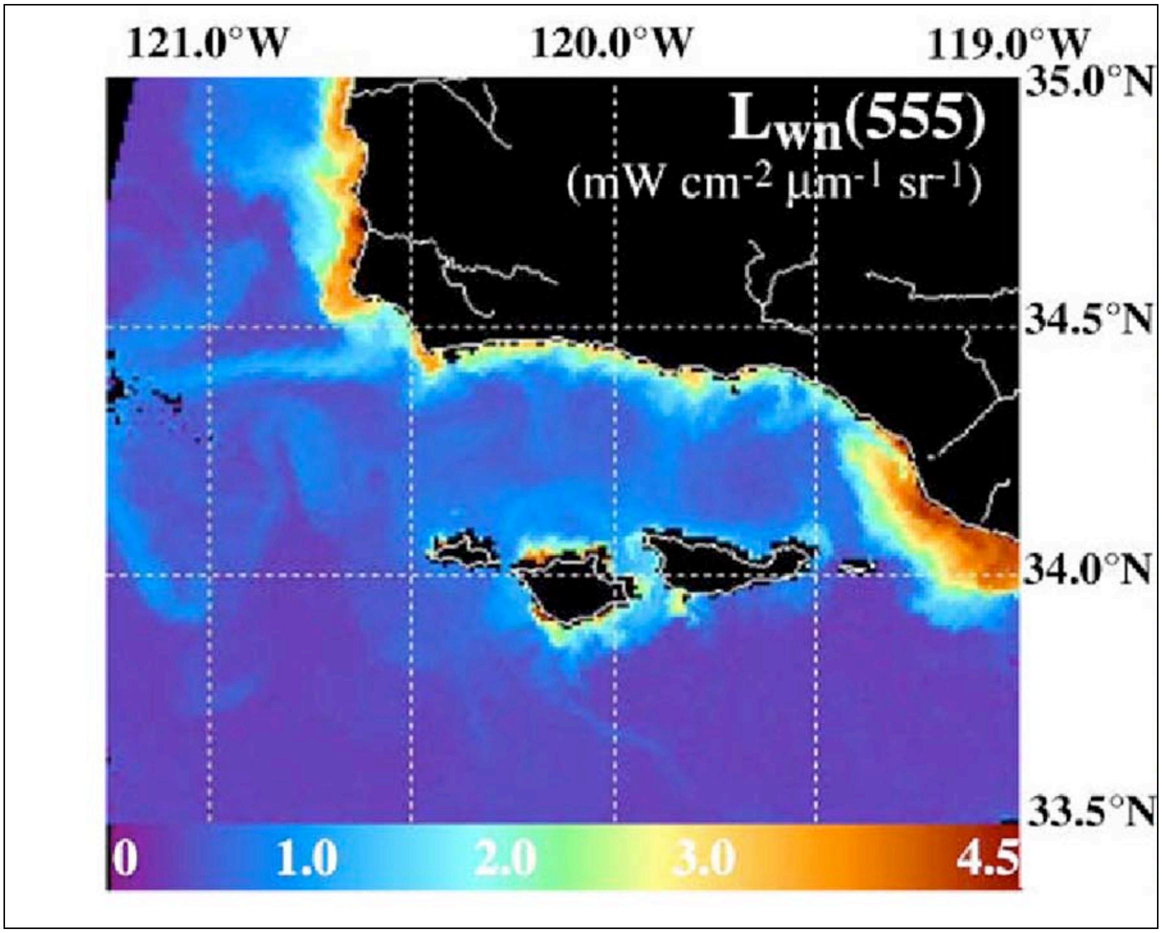


Figure 42. Image of suspended sediment concentrations (based on LwN(555) during a runoff event on February 15, 1998. This was the second largest discharge event from October 1997 to June 2001. Figure is from Otero and Siegel (2004).

The likelihood that a sediment plume will occur at any particular location in the region is illustrated in Figure 43. The northern and eastern shores of Santa Rosa and San Miguel, and the east end of Santa Cruz, are where suspended sediment is most frequently detected in the Park by AVHRR and SeaWiFS data.

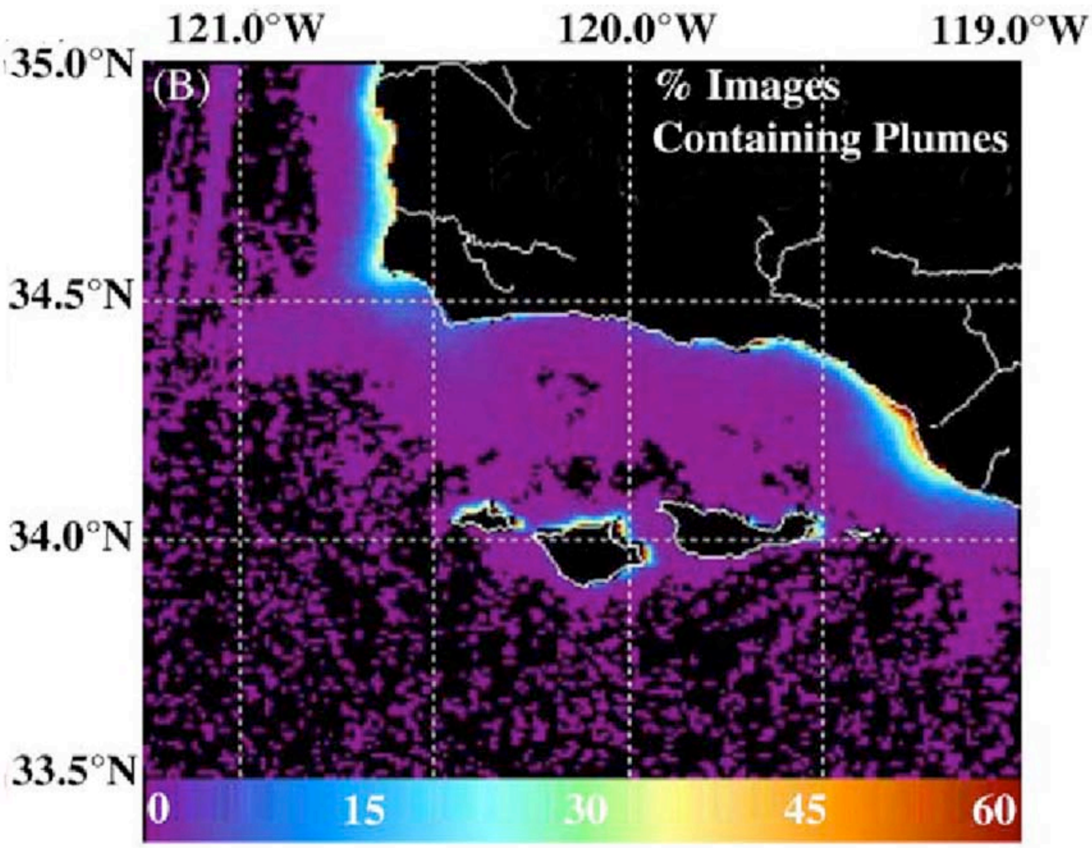


Figure 43. Map showing the frequency of surface sediment plumes by location, based on normalized water-leaving radiance at 555 nm, or LwN(555). Frequency for each pixel is the percentage of AVHRR and SeaWiFS images from October 1997-June 2001 in which LwN(555) > 1.3 mW/cm2/µm/sr. Figure is adapted from Figure 8 in Otero and Siegel (2004).

Regional Chlorophyll Dynamics. Regionally, chlorophyll concentrations in the Channel are controlled by nutrient availability, and are inversely related to SST - which reaches its minima during coastal upwelling events in the western portion of the Channel (Figure 44). The primary nutrient supply is created by coastal upwelling in the western portion of the Channel (Atkinson et al. 1986, Hayward and Venrick 1998). Upwelled waters from near Point Conception typically flow south and often enter the SBC (Jones et al. 1988). The resulting phytoplankton biomass is concentrated in the upper 25m of the water column, and subsurface maxima are rarely observed (Venrick 1998). Temporal fluctuations of mixed-layer chlorophyll within the Channel are well correlated with nearby stations outside of the channel (Hayward and Venrick, 1998), indicating that biological processes within the Channel are regulated, in part, by Bight-scale processes. However, elevated nearshore chlorophyll values along the mainland coast from December to February are poorly related to SST (Otero and Siegel 2004). The *year-round* nature of elevated chlorophyll in the vicinity of the Santa Clara River (see Figure 44) led Warrick et al. (2005) to contend that riverine input of nutrients is insufficient to explain consistently high nearshore phytoplankton biomass in the eastern Channel. Furthermore, nutrient concentrations behave conservatively with respect to salinity in river plumes, resulting in dispersal of dissolved nutrients tens of km away from river mouths during large runoff events (Warrick et al. 2005).

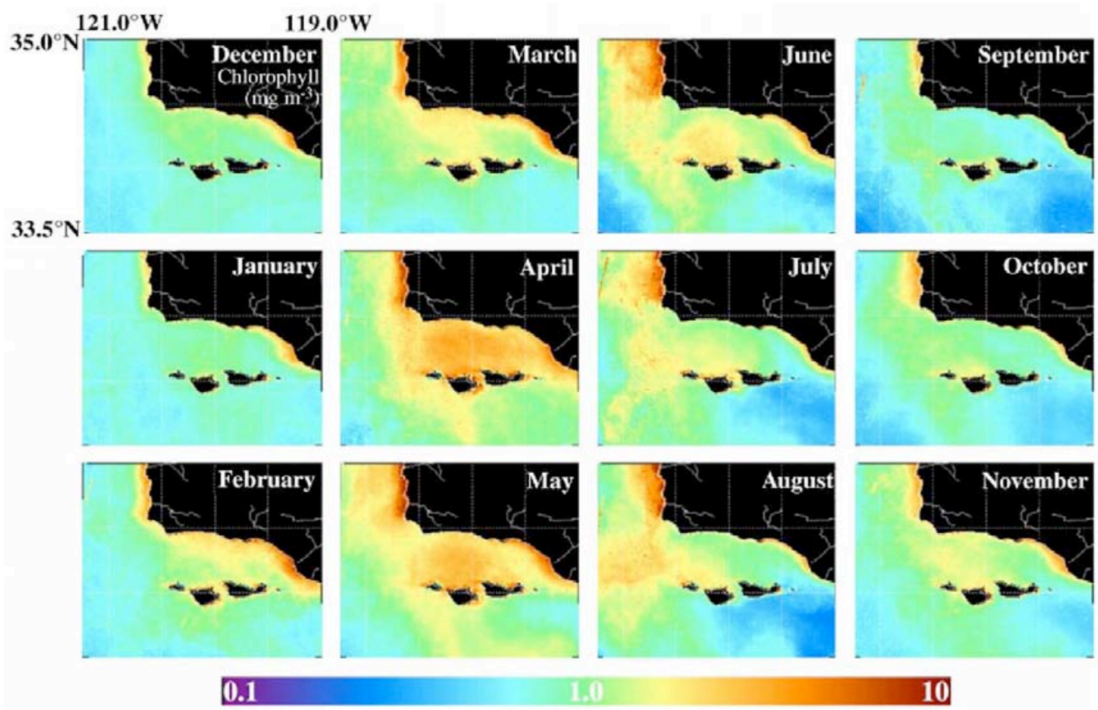


Figure 44. Annual cycle of mean monthly chlorophyll computed from AVHRR and SeaWiFS images from October 1997-June 2001 (Otero and Siegel 2004).

Chlorophyll dynamics at the islands. Satellite data indicate that nearshore bloom conditions are most frequent at Santa Rosa on either side of Brockway Point, in northern Bechers Bay, and around East Point (Figure 45). Determining whether blooms at these sites are related to local fluvial input, or to larger scale phenomena such as upwelling and Channel SST, requires a more sophisticated analysis than this report allows. However, during February, remotely sensed chlorophyll indices are higher on average in close proximity to Santa Rosa than they are further away from the island (Figure 44) - a phenomenon which precedes the March onset of upwelling and SST minima in the Channel (Figure 9). Terrestrial runoff contributes to the sediment plumes that are frequently observed in a narrow zone around the north/northeast shores of Santa Rosa (Figure 17). Based on historical sediment deposition rates in Old Ranch House Lagoon, on Santa Rosa, Cole and Liu (1994) reported that sediment deposition during the most intensive grazing period of 1887 to 1920 was 340 times higher than prior to 1800. Owing to ongoing recovery of riparian corridors on Santa Rosa since the removal of cattle in 1998, island streams are now transporting far less sediment, N, and P (CINP 2002b). Nevertheless, during 1997-2001 (a period which bracketed the removal of cattle) Santa Rosa was still the only island in the Park that frequently produced sediment plumes (Otero and Siegel 2004). As Santa Rosa continues to recover from decades of cattle grazing, it will be interesting to observe whether the frequency of sediment plumes, or bloom conditions, changes in waters surrounding this island. However, owing to the ease with which sediment is resuspended in the shallow bays surrounding Santa Rosa (Mertes et al. 1998), the frequency or persistence of sediment plumes at Santa Rosa may not be the most sensitive indicator of sediment export from streams on that island.

At San Miguel, bloom conditions are most prevalent in Simonton Cove, along the northwest end of the island out to Point Bennett, and off Cardwell Point (Figure 45). During July through August, San Miguel is more frequently encircled by cooler water produced by upwelling events near Pts. Arguello and Conception than are the other islands in the chain (Figure 9). Thus it may be less appropriate to try to link blooms at San Miguel with terrestrial influences from the island itself. Finally, bloom conditions appear to be more common surrounding east Santa Cruz than around west Santa Cruz (Figure 45) - making it tempting to invoke differences in the length of time since sheep removal (and degree of watershed recovery) as a factor contributing to nearshore chlorophyll dynamics.

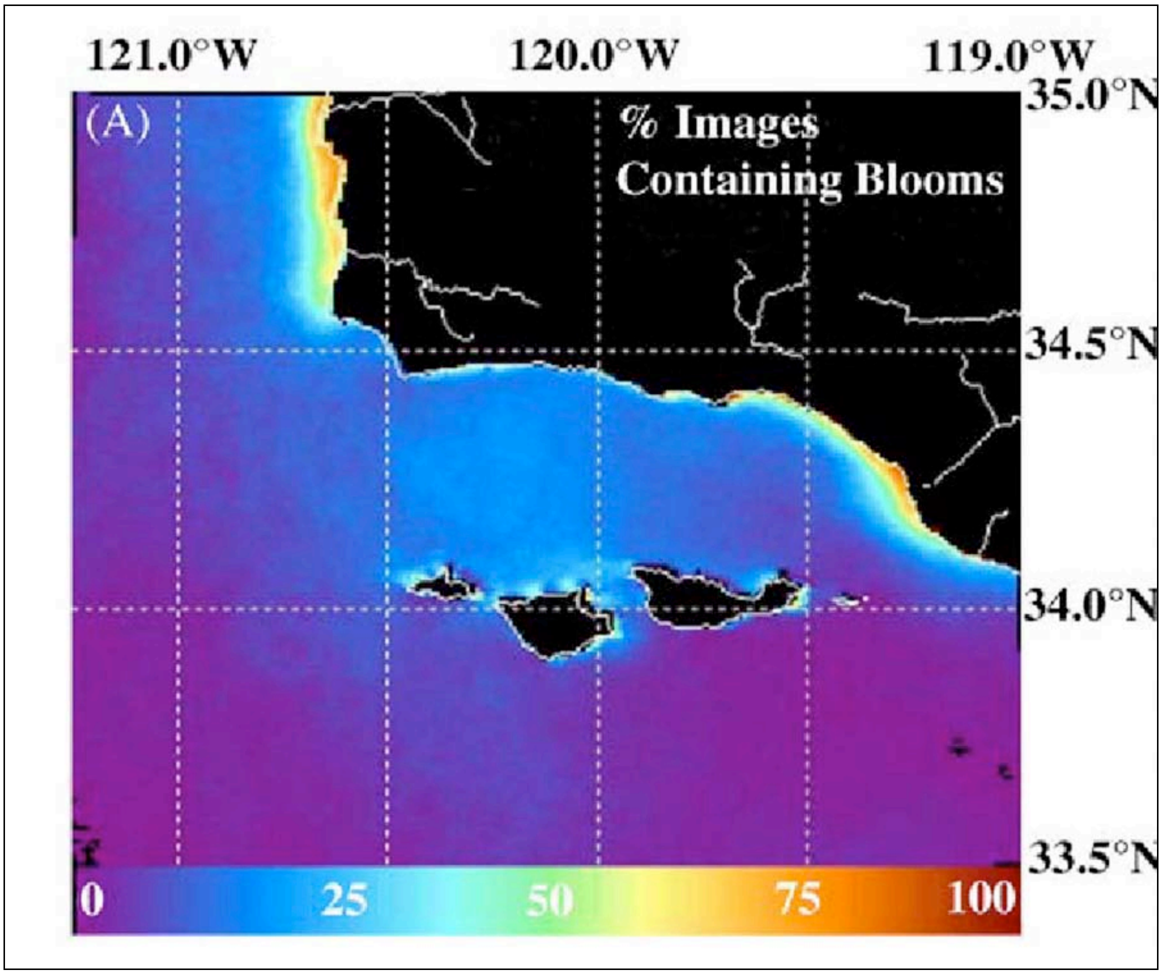


Figure 45. Map showing the frequency of bloom conditions in the region of Channel Islands National Park. Frequency for each pixel is the percentage of AVHRR and SeaWiFS images from October 1997-June 2001 when the chlorophyll index exceeded 2 mg/m3 (Otero and Siegel 2004).

C.9. Mussel Body Burdens in and near the Park

a. Overview of Mussel Watch Programs

Contaminant levels have not been directly measured in sea water in the Park. However, sentinel mussels sampled over the years at Park islands provides indirect evidence for seawater contamination there. Presence of a contaminant in mussel tissue indicates that it resided at least part time in the water column of the Park's marine environment. It does not, however, indicate how the contaminant arrived in the Park, or in which other compartments of the marine habitat contaminants reside (e.g., sediment and other biota).

Figure 46. State and NOAA mussel sampling sites at the Northern Channel Islands.

NOAA's Mussel Watch Project. NOAA created the National Status & Trends (NS&T) Program to assess the influence of human activities on the quality of coastal and estuarine areas. In 1986 the NS&T Mussel Watch Project (NOAA-MWP) began to monitor spatial and temporal trends of chemical contamination by chemically analyzing mussels and oysters collected at fixed sites throughout the coastal United States. Owing to the fact that no single species of mollusc is common to all coasts, NOAA collects different species in different regions of the country: the blue mussel *Mytilus edulis* on the East Coast from Maine to Cape May, NJ; the American oyster *Crassostrea virginica* from Delaware Bay southward and throughout the Gulf of Mexico; the mussels *M. edulis and M. californianus* on the West Coast; the oyster *Ostrea sandvicensis* in Hawaii; the smooth-edged jewel box *Chama sinuosa* at the one site in the Florida Keys; the mangrove oyster *Crassostrea rhizophorae* in Puerto Rico; and the zebra mussel *Dreissena polymorpha* at sites in the Great Lakes. Sampling stations were selected by NOAA to represent large areas rather than the small-scale patches of contamination commonly referred to as ‘‘hot spots’’. *To this end, no sites were knowingly selected near waste discharge points.* NS&T sampling sites are not uniformly distributed along the coast. Within estuaries and embayments, they average about 20 km apart, while along open coastlines the average separation is 70 km. Almost half of the sites were selected in waters near urban areas, within 20 km of population centers in excess of 100,000 people.

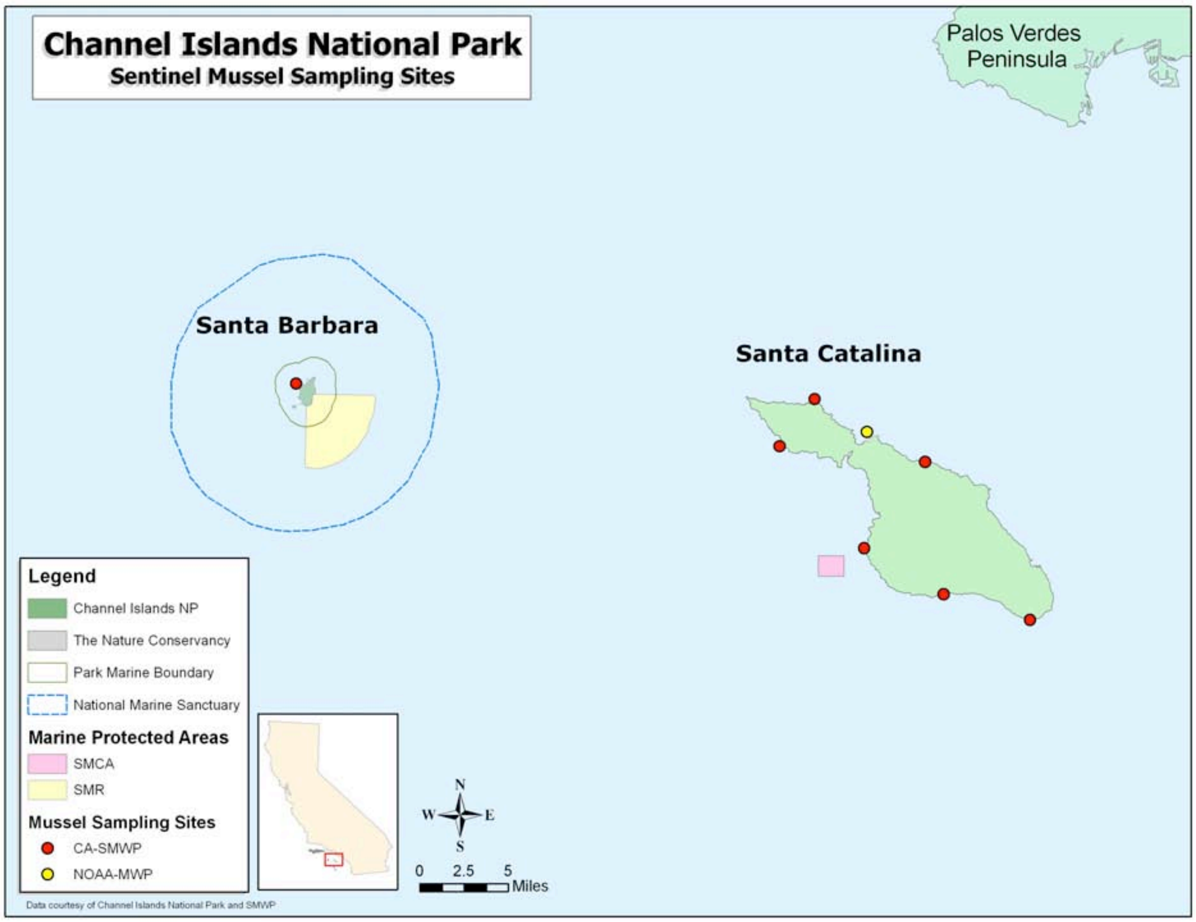


Figure 47. State and NOAA mussel sampling sites at Santa Barbara and Santa Catalina Islands.

Only three of the NS&T sites occur on islands in or near the Park: one each off of San Miguel (Tyler Bight), Santa Cruz (Fraser Point), and Catalina (Bird Rock) (Figures 46-47). Station locations are provided in Table 15. Mussels from San Miguel were sampled by NOAA only once, in 1988. Mussels from Santa Cruz and Catalina were sampled by NOAA from 1986-1988, 1990-1992, 1994, 1996, 1998, 2000, and 2002 (at the time of this writing, 2002 was the most recent year for which NOAA data were available).

Among the analytes measured in the NOAA-MWP are (1) chlorinated pesticides such as DDT (and its metabolites DDE and DDE), aldrin and dieldrin, chlordane (alpha-chlordane, trans-nonachlor, heptachlor, heptachlorepoxide), lindane (gamma-Hexachlorocyclohexane, "HCH") and its metabolites, and mirex; (2) many other pesticides (such as diazinon, ethion, endosulfan, parathion, chlorpyrifos); (3) polychlorinated biphenyls (PCBs); (4) butyltin compounds (mono-, di-, and tri-butyltin); (5) trace metals; and (6) a suite of 23 polycyclic aromatic hydrocarbons (PAHs).

Several of these substances are now banned for use in the U.S. or California. For example, the pesticide lindane is banned in California, but elsewhere in the U.S. it is still widely prescribed for treating head lice and scabies, and is used on pets, livestock, fruits and vegetables, cotton, wool, and tobacco. Lindane is found in air, water and soil samples throughout the world - and is detected in mussels from the Channel Islands (Tables 16-18) - although not in high concentrations. All uses of DDT and dieldrin were banned in the U.S. in the 1970s. Chlordane use on U.S. crops ended in 1983, and its use for termite control effectively ended in 1988. However, residual chlordane persists in soil. Polychlorinated biphenyls (PCBs) are chlorinated compounds first used in the 1920s for a number of industrial purposes especially electrical transformers and capacitors. PCB use in the United States began being phased out in 1971, and a ban on new uses took effect in 1976. The compounds are still found in tissues and sediments because PCB-containing devices are still in use. Organotin (mono-, di-, and tributyltin) is found in molluscs because tributyltin has been used as an antifouling agent in the paint commonly used on boats and some underwater marine facilities. Its use on vessels under 75 feet long was banned in 1988 by the U.S. Organotin Anti-Fouling Paint Act (O'Connor 2002).

Although PAHs and trace metals (Cd, etc.) occur naturally, they can also be indicators of industrial pollution. PAHs are found in fossil fuels such as coal and oil, in creosote and asphalt, and are produced when organic matter burns. Nonetheless, a multitude of human activities, from coal and wood burning to waste incineration, create PAH compounds in excess of those that would exist naturally. In addition, human production, transport, and use of oil release more PAHs to the environment, on a globally averaged basis, than does natural seepage (NRC 1985). However, as discussed in Section II.B.3, prodigious natural oil seepage occurs in the vicinity of the Park, decreasing the likelihood that PAHs in the Park environment result from anthropogenic enrichment. There was a substantial decrease in the use of silver by the U.S. in the late 1970s owing to a decrease of silver use in the photographic industry. Lead concentrations were expected to decline in aquatic organisms following the ban of lead in gasoline. Transportation emissions accounted for over 80% of total lead emissions in 1970, and lead emissions declined by more than 98% from 1970-1980 (USEPA 1990)

California State Mussel Watch Program. For 26 years (1977-2003) the California State Mussel Watch Program (CA-SMWP) collected transplanted and resident mussels and clams from the waters of California's bays, harbors and estuaries. Statewide, samples were analyzed for one of more of the following types of contaminants: trace elements, pesticides, PCBs, and a suite of PAHs (although PAHs were never analyzed by the CA-SMWP in samples from the Channel Islands). In contrast with the NOAA-MWP, the CA-SMWP primarily targeted areas with known, or suspected, degraded water quality.

Over the lifetime of the program, mussels were sampled by the state at least once from 11 sites in or near the Park (Table 15): two on San Miguel , one each on Santa Cruz, Anacapa and Santa Barbara, and six on Catalina (Figure 46-47). Resident mussels from stations inside the Park were sampled only five times: twice in 1977 (several sites), twice in 1978 (several sites), and once in 2001 (Santa Cruz). Mussels transplanted to Anacapa for ca. 5 months were sampled twice in 1980. Outside the Park, at Catalina, resident or transplanted mussels were sampled from six sites during one or more of the years 1977, 1978 and 1980. After a 13 year hiatus, mussels were sampled again at Catalina in 1993 (one site) and 1994 (one site). The only other CA-SMWP data from islands in or near the Park are from Santa Cruz in 2001. The CA-SWMP was discontinued after 2002 owing to budget cuts.

Table 15. Locations of mussel sampling stations for Channel Islands National Park and Santa Catalina Island. Stations from both the California State Mussel Watch Program (CA-SMWP) and NOAA's Mussel Watch Project are included. Coordinates are provided in both sexigesimal and decimal formats (the latter in parentheses).

Station	Latitude	Longitude
CA-SMWP Stations		
San Miguel Island/West (500)	34 01 33	120 25 39
	(34.0258)	(120.4275)
San Miguel Island/East (501)	34 03 36	120 21 19
	(34.0600)	(120.3553)
Santa Cruz Island (502)	34 03 30	119 55 30
	(34.0583)	(119.9250)
Anacapa Island (503)	34 00 20	119 23 10
	(34.0056)	(119.3861)
Santa Barbara Island (504)	33 29 00	119 02 45
	(33.4833)	(119.0458)
Santa Catalina Island/East (680)	33 25 40	118 25 47
	(33.4278)	(118.4297)
Santa Catalina Island/ West (681)	33 28 41	118 32 19
	(33.4781)	(118.5386)
Santa Catalina Island/ Ribbon Rock (682)	33 26 20	118 34 20
	(33.4389)	(118.5722)
Santa Catalina Island/ Ben Weston (683)	33 21 24	118 29 16
	(33.3567)	(118.4878)
Santa Catalina Island/ Silver Canyon (684)	33 19 12	118 24 36
	(33.3200)	(118.4100)
Santa Catalina Island/ Church West (685)	33 17 59	118 19 30
	(33.2997)	(118.3250)
NOAA Mussel Watch Project Stations		
San Miguel Island/ Tyler Bight	34 01 40	120 25 08
	(34.028)	(120.419)
Santa Cruz Island/ Fraser Point	34 03 29	119 55 12
	(34.058)	(119.92)
Santa Catalina Island/ Bird Rock	33 27 06	118 29 13
	(33.45167)	(118.487)

b. Results for Channel Islands

Concentrations of contaminants measured by either the State or NOAA in mussels from sites within the Park are presented in Table 17 (Santa Cruz), and Table 16 (San Miguel, Anacapa and Santa Barbara). Owing to the long time series available, NOAA-MWP data are also presented for Catalina in Table 18. The CA-MWP sampling effort at Catalina was more sporadic. Although CA-MWP data for Catalina mussels were examined for exceedances (see below), concentrations are not presented in this report. Over the years, a wider array of organic contaminants was evaluated in samples from Santa Cruz and Catalina than from the other islands. The most complete time series for organics in mussels at the islands are NOAA's data for aldrin/dieldrin, chlordanes, DDT/DDE/DDD, lindane, hexachlorobenzene, mirex, PAHs, and PCBs at Santa Cruz and Catalina. The same suite of compounds was measured by NOAA in mussels from the Park only one other time - at San Miguel in 1988 (Table 16). Other pesticides were not evaluated by NOAA, nor the State, until 1996, and only every two years hence, providing a very short record for these analytes. Excluding aldrin, the organic compounds above were almost always detected in mussels at Santa Cruz, San Miguel and Catalina (Tables 16-18).

Table 16. Levels of contaminants in mussels from San Miguel, Santa Barbara and Anacapa Islands. All available data are included from California's State Mussel Watch Program (CA-SWMP) and the NOAA National Status & Trends (NS&T) Program's Mussel Watch Project (MWP). Values are based on dry weight. Null values indicate results below the limit of detection. Blanks indicate that the parameter was not analyzed. Values outlined in red exceed the national 85th percentile for that analyte, according to long term data from NOAA's MWP (see text). Shading indicates values that fall between the national 50th and 85th percentiles for that analyte (see text). Station locations provided in Table 15.

Location	San Miguel (Tyler Bight)	San Miguel West (site 500)	San Miguel East (site 501)	Anacapa Island (site 503)	Anacapa Island (site 503)	Santa Barbara Island (site 504)
Program	NOAA	CA-SMWP	CA-SMWP	CA-SMWP	CA-SMWP	CA-SMWP
Year	1988	1977-1978[a]	1977 -1978[a]	1977 -1978[a]	1980	1977 -1978[a]
Type of Mussel	resident	resident	resident	resident	transplanted 5.1-5.9 mo.s	resident
Organics (ppb dry wgt.)						
Total Chlordane[b]	12.18				11.1	
Total DDT[c]	188.33	305	49.7	30.0	43.1	33.6
Total PAH[d]	12.66					
Total PCB[e]	46.07	147.5	29	13.0	18.0	22.0
Aldrin	0.00					
Dieldrin	5.9				2.8	
Hexachlorobenzene	0.28				0.1	
alpha HCH					4.6	
gamma HCH (Lindane)	0.39					
Mirex	0.93					
Trace Elements (ppm dry wgt.)						
Aluminum	130	58.45	17.78	31.14	152.35	91.53
Arsenic	20.33					
Cadmium	4.87	6.53	9.59	5.87	12.65	11.23
Chromium	1.6	1.65	1.50	1.65	1.02	2.01
Copper	6.43	5.15	4.13	4.30	5.100	4.63
Iron	153.33					
Lead	0.79	1.65	2.33	5.09	2.62	3.56
Manganese		2.85	2.28	2.06	6.35	3.90
Mercury	0.57	0.55	0.12	0.15	0.27	0.13
Nickel	2.03	0.70	0.7	1.0	2.0	1.55
Selenium	3.47					
Silver		0.22	0.65	4.27	0.439	0.95
Zinc	146.66	120.65	118.00	119.2	119.2	147.68

[a]Values are means for four sampling dates: 8/1/77, 12/3/77, 8/15/78, 11/18/78.

[b]Total Chlordane = (alphachlordane + transnonachlor + heptachlor + heptachlor-epoxide)

[c]Total DDT = (o,pDDE + p,pDDE + o,pDDD + p,pDDD + o,pDDT + p,pDDT)

[d]Total PAH = (1,6,7-trimethylnaphthalene, 1-methylnaphthalene, 2,6-dimehtylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(k)fluoranthene, benzanthracene, benzo(g,h,I)perylene, benzo-a-pyrene, benzo-b-pyrene, benzo-e-pyrene, benzo-k-flouranthene, biphenyl, chrysene, bibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, perylene, phenanthrene, pyrene)

[e]For Tyler Bight (NOAA site): Total PCB = (2) ∑(pcb8+pcb18+pcb28+ pcb52+pcb44+ pcb66 +pcb101+pcb105 +pcb138 +pcb118+pcb128+pcb153+pcb170+pcb180+pcb187+pcb195+pcb206+pcb209)

Table 17. Levels of contaminants in mussels from Santa Cruz Island. All available data are included from California's State Mussel Watch Program (CA-SWMP) and the NOAA National Status & Trends (NS&T) Program's Mussel Watch Project (MWP). Values are based on dry weight. Null values indicate results below the limit of detection. Blanks indicate that the parameter was not analyzed. Values outlined in red exceed the national 85th percentile; shading indicates values that fall between the national 50th and 85th percentiles (see text). All samples were from resident mussels. Station locations are provided in Table 15.

	CA-SMWP site 502	NOAA Fraser Point										CA-SMWP site 502	NOAA Fraser Point
Analyte	**1977-78[a]**	**1986**	**1987**	**1988**	**1990**	**1991**	**1992**	**1994**	**1996**	**1998**	**2000**	**2001**	**2002**
Organics (ppb dry weight)													
Aldrin		0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
Organotins (DBT, TBT, MBT)					0.00	14.60	10.21	17.26	8.66	8.12	5.97		11.74
Chlorpyrifos									0.00	0.00	3.80	0.00	0.00
cis-Nonachlor									0.62	0.47	0.11	0.00	0.13
Total Chlordanes[b]		5.32	5.33	4.13	5.16	0.77	2.27	7.46	4.96	1.67	3.46	1.3	3.38
gamma-Chlordane									1.65	0.55	0.53	0.00	0.50
Chrysenes (C1,C2,C3,C4)								0.00	0.00	7.60	0.00		0.00
Total DDT[c]	30.9	16.57	62.9	34.67	29.81	10.18	23.45	69.35	35.07	25.07	14.06	9.1	10.44
Dacthal												0.00	
Diazinon												0.00	
Dibenzothiophenes (C1,C2,C3)								0.00	6.00	7.70	0.30		0.10
Dieldrin		2.27	2.67	2.37	0.00	0.32	2.18	2.06	2.34	2.55	2.31	2.9	2.02
Endosulfan I											0.26	0.00	0.00
Endosulfan II									1.84	0.00	0.11	0.00	0.05
Endosulfan sulfate											0.00	0.00	0.30
Endrin						0.00	0.00	1.24	0.77	0.41	0.32	0.00	0.41
Ethion												0.00	
Ethylparathion												0.00	
Fluorenes (C1,C2,C3)								0.00	0.00	11.90	0.00		0.00
alpha HCH									1.21	0.63	1.26	1.0	0.94
beta HCH									0.78	0.38	0.63	0.00	0.61

Analyte	CA-SMWP site 502 1977-78[a]	NOAA Fraser Point 1986	1987	1988	1990	1991	1992	1994	1996	1998	2000	CA-SMWP site 502 2001	NOAA Fraser Point 2002
delta HCH									0.19	0.06	0.00	0.00	0.00
gamma HCH (lindane)		0.47	0.00	0.00	4.13	0.15	0.00	0.98	0.70	0.16	0.42	0.00	0.30
Hexachlorobenzene		0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.13	0.32	0.00	0.13
C1-Fluoranthenes/pyrenes								0.00	0.00	3.80	0.00		0.00
Methylparathion												0.00	
Methoxychlor												0.00	
Mirex		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.22	0.00		0.00
Naphthalene (C1, C2, C3, C4)								7.42	0.00	24.60	7.10		9.00
Oxychlordane									0.43	0.02	0.11	0.00	0.00
Oxydiazon												0.00	
Total PAH[d]		2026.67	0.00	0.00	9.05	41.75	118.75	36.31	34.60	58.30	23.20		24.90
Total PCB[e]	16.0	5.60	3.85	11.20	7.69	1.00	17.74	50.82	40.36	33.64	22.88	14.0	8.70
Phenanthrenes/anthracenes								0.00	0.00	13.70	4.20		0.00
Pentachloroanisole									0.50	0.34	0.42		0.53
Pentachlorobenzene										0.00	0.00		0.00
1,2,3,4-tetrachlorobenzene										0.19	0.11		0.00
1,2,4,5-tetrachlorobenzene										0.00	0.00		0.00
Tetratributyltin									0.00	0.00	0.00		0.00
Tetradifion												0.00	
Toxaphene												0.00	
Trace Elements (ppm-dry weight)													
Aluminum	49.85	116.67	163.33	326.67	85.60	150.00	12.00	170.00	333.00	639.00	131.00	23.0	70.20
Arsenic		19.67	39.67	40.00	32.17	28.00	27.80	23.30	25.40	19.00	19.50		14.10
Cadmium	6.833	5.37	4.67	4.63	5.08	9.67	0.07	3.15	3.03	4.52	3.16	20.23	14.40
Chromium	1.515	1.93	1.73	1.50	1.63	2.73	2.75	2.09	4.60	4.39	1.69	2.24	1.79

Analyte	CA-SMWP site 502	NOAA Fraser Point										CA-SMWP site 502	NOAA Fraser Point
	1977-78[a]	1986	1987	1988	1990	1991	1992	1994	1996	1998	2000	2001	2002
Copper	4.375	6.50	7.63	6.23	6.04	6.37	7.72	7.75	6.40	6.84	5.80	5.3	5.52
Iron		453.33	310.00	313.33	163.40	533.33	250.00	210.00	765.00	1010.00	282.00		122.00
Lead	1.583	1.09	0.85	0.70	0.99	0.92	0.02	0.80	0.30	0.84	0.48	1.10	1.94
Manganese	3.200	6.43	7.43		2.93	8.93	8.90	7.20	5.90	14.90	11.20	2.6	2.90
Mercury	0.115	0.11	0.08	0.08	0.02	0.12	0.11	0.07	0.07	0.08	0.07	0.00	0.13
Nickel	1.150	2.63	3.30	2.97	2.03	2.47	0.65	1.37	1.50	2.93	1.78		1.62
Selenium		2.97	4.10	3.70	1.44	1.53	1.72	1.73	2.60	2.19	2.62		1.34
Silver	1.017				0.28	0.19	0.51	0.42	0.70	0.10	0.46	0.013	0.34
Zinc	121.225	153.33	193.33	180.00	160.00	166.67	190.00	180.00	151.00	175.00	158.00	131.3	223.00

[a]Values are means for four sampling dates: 8/1/77, 12/3/77, 8/15/78, 11/18/78.

[b]Total Chlordane = (alphachlordane + transnonachlor + heptachlor + heptachlor-epoxide)

[c]Total DDT = (o,pDDE + p,pDDE + o,pDDD + p,pDDD + o,pDDT + p,pDDT)

[d]Total PAH = (1,6,7-trimethylnaphthalene, 1-methylnaphthalene, 2,6-dimehtylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(k)fluoranthene, benzanthracene, benzo(g,h,I)perylene, benzo-a-pyrene, benzo-b-pyrene, benzo-e-pyrene, benzo-k-flouranthene, biphenyl, chrysene, bibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, perylene, phenanthrene, pyrene)

[e]For Frazer Point (NOAA site): during 1986-1987, Total PCB = ∑congeners: di-, tri-, tet-, pen-, hex-, hep- , oct-, non-. From 1988 onward, Total PCB = (2) ∑(pcb8+pcb18+pcb28+ pcb52+pcb44+ pcb66 +pcb101+pcb105 +pcb138 +pcb118+pcb128+pcb153+pcb170+pcb180+pcb187+pcb195+pcb206+pcb209)

Table 18. Levels of contaminants in mussels from Santa Catalina Island. Data are from the Bird Rock station in NOAA's National Status & Trends (NS&T) Mussel Watch Project (MWP). Values are based on dry weight. Null values indicate results below the limit of detection. Blanks indicate that the parameter was not analyzed. Values outlined in red exceed the national 85th percentile (see text). Shading indicates values that fall between the national 50th and 85th percentiles (see text). All samples were from resident mussels. Station location is provided in Table 15.

	1986	1987	1988	1990	1991	1992	1994	1996	1998	2000	2002
Organics (ppb dry weight)											
aldrin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.00	0.00
Butyltin (DBT, TBT, MBT)				19.84	0.00	17.67	22.6	10.8	7.02	5.604	11.735
chlorpyrifos								0.46	0.00	0.203	0
cis-nonachlor								0.6	1.06	0.203	0.649
Total Chlordane[a]	2.90	5.50	8.00	5.39	0.13	0.00	2.54	3.52	1.41	1.62	1.91
gamma-chlordane								1.23	0.71	0.61	0.65
Chrysene (C1,C2,C3,C4)							0.00	4.40	3.80	0.00	0.00
Total DDT[b]	21.10	77.43	37.87	144.24	28.77	47.58	27.87	36.24	32.71	19.45	30.56
Dibenzothiophene (C1,C2,C3)							0.00	0.00	2.00	0.00	0.00
Dieldrin	2.13	3.67	2.27	0.47	0.07	1.57	1.25	2.04	0.97	1.22	1.14
endosulfan I								0.00		0.27	0.00
endosulfan II								0.51	0.04	0.00	0.00
endosulfan sulfate										0.00	0.20
endrin					0.00	0.00	0.32	0.33	0.00	0.10	0.27
Fluorene (C1,C2,C3)							0.00	29.70	5.60	0.00	0.00
alpha HCH								0.96	0.90	1.12	0.00
beta HCH								1.20	0.68	0.41	0.42
delta HCH								0.30	0.01	0.00	0.03
gamma HCH (lindane)	1.23	1.10	0.40	3.30	0.94	1.47	0.77	0.38	0.36	0.30	0.44
Hexachlorobenzene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.15	0.20	0.34
C1-fluoranthenes/pyrenes							0.00	9.60	2.00	0.00	0.00
Mirex	0.00	0.00	0.00	0.00	0.00	3.12	0.00	0.00	0.00	0.00	0.00
Naphthalene (C1,C2,C3,C4)							5.70	97.30	14.50	5.90	15.40

	1986	1987	1988	1990	1991	1992	1994	1996	1998	2000	2002
oxychlordane								0.32	0.49	0.10	0.00
Total PAH[c]	1824.00	0.00	4.67	32.99	31.27	121.06	20.92	159.40	24.50	27.20	35.60
Total PCB[d]	115.30	73.47	1.53	1.29	0.09	3.50	1.55	1.82	2.20	1.00	1.32
phenanthrenes/anthracenes							0.00	27.60	6.10	2.40	0.00
pentachloroanisole								0.51	0.33	0.30	0.37
pentachlorobenzene									0.13	0.00	0.00
1,2,3,4-tetrachlorobenzene									0.00	0.00	0.25
1,2,4,5-tetrachlorobenzene									1.55	0.00	0.00
tetratributyltin								0.00	0.00	0.00	0.00
Trace Elements (ppm-dry weight)											
Aluminum	22.67	65.67	153.33	75.10	42.67	240.00	36.30	194.00	645.00	36.40	8.82
Arsenic	16.00	22.67	18.33	12.41	19.33	13.92	16.50	13.20	14.10	12.50	10.30
Cadmium	3.40	4.63	6.63	4.38	2.83	1.20	2.44	2.74	4.47	5.96	4.10
Chromium	1.23	1.97	1.57	1.49	1.77	1.79	1.79	1.40	4.71	1.37	0.99
Copper	7.03	5.43	4.73	5.52	7.37	6.14	5.25	5.70	6.71	4.83	5.19
Iron	65.00	110.00	133.33	152.50	133.33	99.70	76.00	179.00	635.00	96.10	56.30
Lead	2.00	2.87	1.73	1.47	1.57	3.53	1.12	0.80	1.41	1.14	1.36
Manganese	4.17	6.23		1.70	6.50	7.50	0.00	5.90	11.90	4.52	3.34
Mercury	0.14	0.18	0.14	0.02	0.11	0.10	0.08	0.15	0.12	0.07	0.10
Nickel	2.27	1.93	6.57	0.94	2.00	1.43	1.07	1.60	4.26	1.78	1.13
Selenium	3.87	5.47	3.80	3.31	3.13	2.52	2.17	3.70	2.64	2.72	2.84
Silver				0.20	0.24	0.19	0.35	0.74	1.12	0.38	0.31
Zinc	133.33	166.67	130.00	126.67	126.67	130.00	120.00	121.0	91.40	118.00	116.00

[a]Total Chlordane = (alphachlordane + transnonachlor + heptachlor + heptachlor-epoxide)

[b]Total DDT = (o,pDDE + p,pDDE + o,pDDD + p,pDDD + o,pDDT + p,pDDT)

[c]Total PAH = (1,6,7-trimethylnaphthalene, 1-methylnaphthalene, 2,6-dimehtylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(k)fluoranthene, benzanthracene, benzo(g,h,I)perylene, benzo-a-pyrene, benzo-b-pyrene, benzo-e-pyrene, benzo-k-flouranthene, biphenyl, chrysene, bibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, perylene, phenanthrene, pyrene)

[d] Total PCB = (2) ∑(pcb8+pcb18+pcb28+ pcb52+pcb44+ pcb66 +pcb101+pcb105 +pcb138 +pcb118+pcb128+pcb153+pcb170+pcb180+pcb187+pcb195+pcb206+pcb209)

Statistical analyses were not performed on time series data from the NOAA-MWP. However, based on visual inspection, PCBs appear to be declining in mussels at both Santa Cruz and Catalina Islands from peak levels observed in 1986. (PCBs in Santa Cruz mussels temporarily rose in 1994, but have declined since then) (Figure 52). Also, lindane appears to be declining in mussels at both islands from peak values obtained in 1990 (Figure 49). Temporal trends in DDT levels in mussels are not evident (Figure 50). Much higher levels of PAHs were observed in mussels at both islands in 1986, than at any subsequent time (Figure 53).

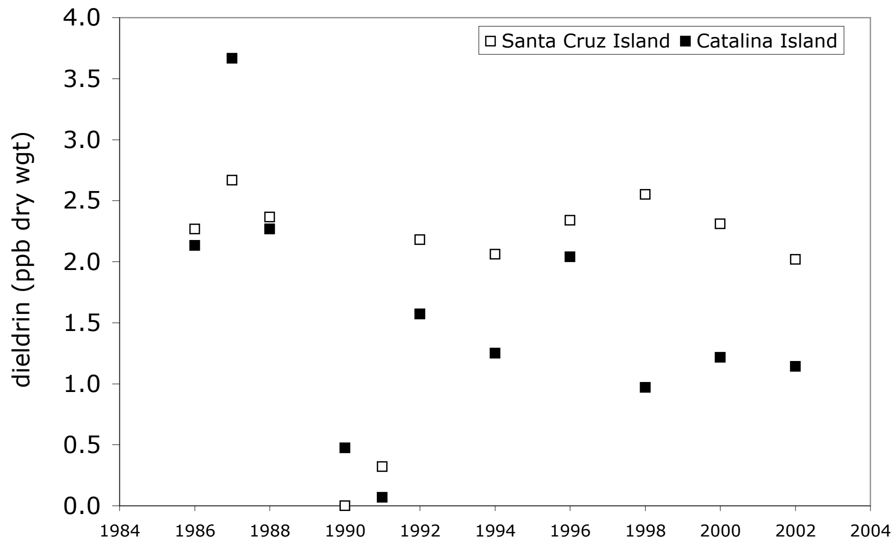


Figure 48. Dieldrin in mussels from Santa Cruz and Catalina Islands from 1986 to 2002. Data are from the NOAA-MWP.

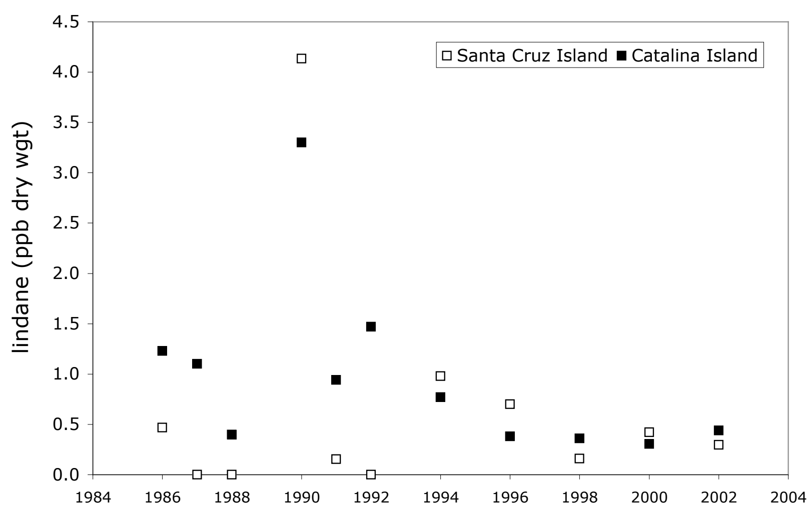


Figure 49. Lindane in mussels from Santa Cruz and Catalina Islands from 1986 to 2002. Data are from the NOAA-MWP.

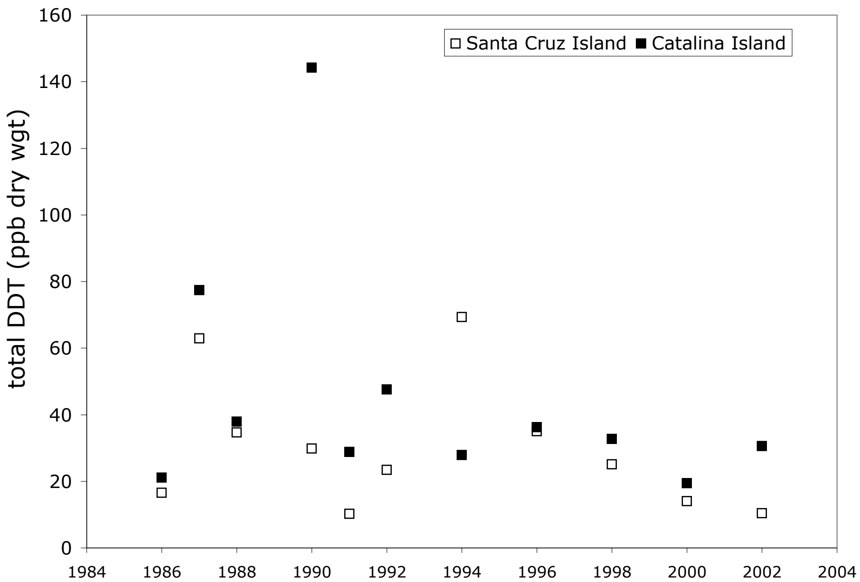


Figure 50. Total DDT in mussels from Santa Cruz and Catalina Islands from 1986 to 2002. Total DDT equalled 31 ppb in a 1978 sample of Santa Cruz mussels. Data are from the NOAA-MWP.

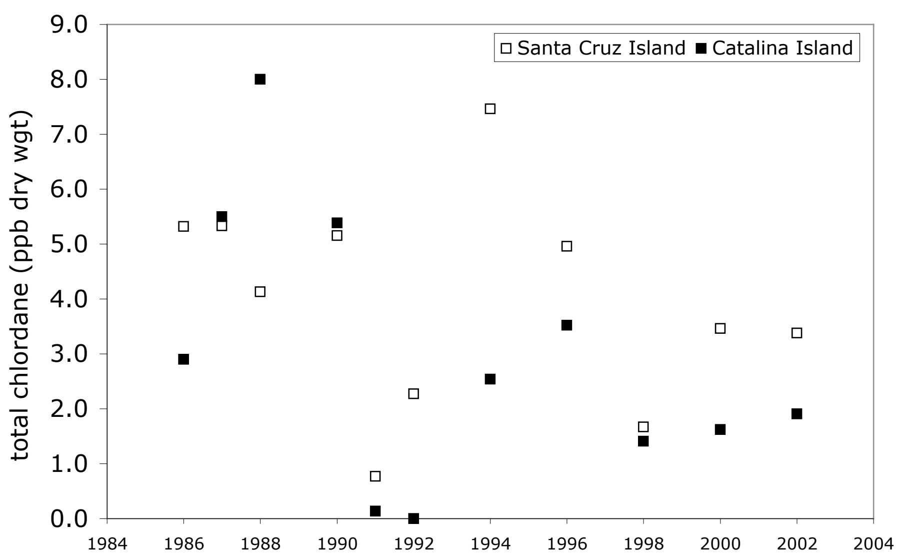


Figure 51. Total chlordane (alphachlordane + transnonachlor + heptachlor + heptachlor-epoxide) in mussels from Santa Cruz and Catalina Islands from 1986 to 2002. Data are from the NOAA-MWP.

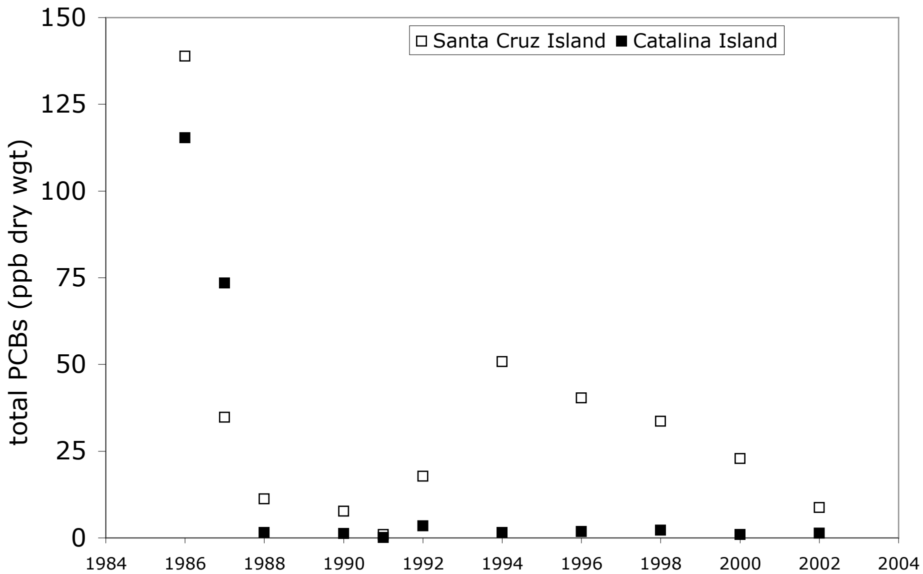


Figure 52. Total PCBs in mussels from Santa Cruz and Catalina Islands from 1986 to 2002. Data are from the NOAA-MWP.

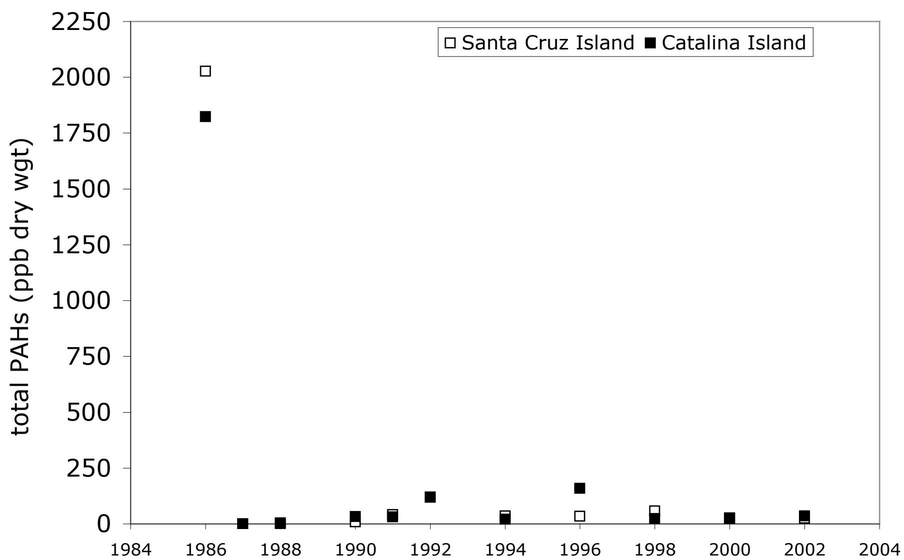


Figure 53. Total PAHs in mussels from Santa Cruz and Catalina Islands from 1986 to 2002. Data are from the NOAA-MWP.

In order to put the available results into perspective, the organic compounds and trace metal concentrations from all of the islands were compared to several criteria: (1) national 50th and 85th percentiles (from NOAA), (2) Maximum Tissue Residue Levels (from the SWRCB), and (3) California-wide Elevated Data Levels.

National 50th and 85th percentiles. O'Connor (2002) evaluated national trends in a long-term data set from the NOAA-MWP. Rather than force a mathematical distribution function on the data, central tendencies and variations were characterized by the 15th, 50th, and 85th percentiles among 214 site means measured in 1990 at marine sites. Contaminant concentrations based on dry weight were used in his analysis. The year 1990 was chosen as the basis for comparison because it was the year in which the most sites were sampled nationwide. Among the 238 marine sites included nationwide in NOAA-MWP, 24 of the sites were not sampled until 1991 or later and, according to O'Connor (2002), the percentiles calculated for 1990 data would change little if they were percentiles of site means calculated over all years. Following O'Connor (2002), both state and NOAA data from the islands were inspected for exceedances of the national 85th percentile concentrations in order to identify sites with "high" (terminology used below) concentrations of contaminants. For the purposes of this report, values falling between the national 50th and 85th percentiles reported by O'Connor (2002) are referred to in the following discussion as "above the national median".

Using this basis, three islands had high concentrations of total DDT in their mussels: San Miguel (in 1977, 1978, and 1988), Santa Cruz (in 1987, 1988, 1994, and 1996), and Catalina (1990). In addition, every island except Santa Cruz yielded mussel samples in which total DDT was above the national median. Total PAHs were especially high in mussels at Fraser Point on Santa Cruz in 1986. Levels of total PCBs and dieldrin were above the national median in mussels at San Miguel in 1977-78. Arsenic was above the national median, or high, in every sample from every island. Cadmium, chromium and lead were above the national median, or high, in 83%, 86% and 87% of island samples, respectively. Mercury, nickel, selenium, silver and zinc were frequently high or above the national median in island samples, although less consistently over time than the other elements above.

Maximum Tissue Residue Levels (MTRLs). The MTRLs were developed by SWRCB staff using human health water quality "objectives" from the 1997 *California Ocean Plan* and from the California Toxic Rule (40 CFR Part 131, May 18, 2000) as established in the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (SWRCB 2000). The "objectives" are target concentrations of contaminants in ocean water, in ug/L, intended to that protect people from consumption of fish, shellfish, and water (the latter, freshwater only) that contain substances at levels which could result in significant human health problems. MTRLs (ppb wet weight) were calculated by multiplying these target ocean water concentrations with bioconcentration factors (L/kg) taken from the USEPA Draft Assessment and Control of Bioconcentratable Contaminants in Surface Waters (USEPA 1991). Rasmussen (2000) presents MTRLs for aldrin, total chlordane, total DDT, dieldrin, heptachlor, hexachlorobenzene, total PAHs, total PCBs, toxaphene. *Application of MTRLs for this report required tissue concentrations based on wet weight, which were obtained from the CA-SMWP, but not from the NOAA-MWP.* All available CA-SMWP data for Park islands and Catalina were inspected for MTRL exceedances for the organic contaminants and trace elements listed above; exceedances are indicated in Tables 19 and 20, respectively. Exceedances for total PCBs were widespread at the islands during 1977, 1978, and 1980. In addition, exceedances for total chlordane were observed at Anacapa (at one site), and Catalina (at two sites) in 1980. The MTRL for dieldrin was exceeded at Anacapa in 1980. The MTRL for total DDT was exceeded at San Miguel (at one site) every time mussels were sampled during 1977 and 1978.

Elevated Data Levels (EDLs). The EDL was introduced by SWRCB staff in 1983 as an internal comparative measure which ranks a given concentration of a particular substance with previous SMWP data. The EDL is calculated by ranking all of the results for a species and exposure condition (resident or transplant) and a given chemical from the highest concentration measured down to and including those records where the chemical was not detected. From this, a cumulative distribution is constructed and percentile rankings are calculated. The 85th percentile (EDL85) was chosen by the SWRCB as an indication that a chemical is "markedly elevated" from the median (Rasmussen 2000). The 85th percentile corresponds to measures used by the U.S. Fish and Wildlife Service in its National Contaminant Biomonitoring Program and would represent approximately one and one-half standard deviations from the mean, if the data were normally distributed. The 95th percentile (EDL 95) was chosen to indicate values that are "highly elevated" above the median. The 95th percentile would represent two standard deviations from the mean, if the data were normally distributed. *As with the MTRLs, EDLs were derived from wet weight concentrations, thus only CA-SMWP data were evaluated using EDLs.* For this report, island data were compared to the EDLs for organic contaminants and trace elements that were derived from combined statewide results from 1977-97, and which are reported in Rasmussen (2000). EDLs were available for the following organic contaminants: cis-chlordane cis-nonachlor, oxychlordane, trans-chlordane, total chlordane, total DDT, dieldrin, endosulfan I, total endosulfan, alpha HCH, gamma HCH (lindane), phenol, pentachlorophenol, and total PCBs. EDLs were available for all of the trace elements listed in Tables 16-18.

None of the available CA-SWMP results from the Channel Islands exceeded the EDL95 for any organic contaminant (Table 19). Total DDT and total PCB exceeded the EDL85 at San Miguel during 1977-78. Alpha-HCH and gamma-HCH (lindane) were each above the EDL85 in 1980 (at Anacapa and Catalina, respectively). Levels of cis-chlordane exceeded the EDL85 three times at Catalina, most recently in 1993. Highly elevated concentrations (>EDL95) of cadmium (Cd), lead (Pb) and chromium (Cr) were observed; in particular, Pb was consistently >EDL95 at one site on Catalina (Table 20). Elevated concentrations (>EDL85) of mercury, cadmium, and silver were observed sporadically at the islands.

Table 19. Exceedances for organic contaminant concentrations measured by the State Mussel Watch Program in mussels from Channel Islands National Park and Santa Catalina Island. Data for all available sample dates were evaluated. Exceedance criteria are based on wet weight (ppb), and were different for resident and transplanted mussels (see text). Values for DDT (ppb wet wgt) are given in parentheses. Total DDT in resident mussels from White's Point (station 617) was 170.8 ppb on 1/82, which exceeded the EDL95[c] for total DDT. Station locations are provided in Table 15 and shown in Figures 46-47.

CA-SMWP station	Station #	Sample Date	Type	Exceedance Criteria EDL85[a]	EDL95[b]
San Miguel/West	500	8/1977	resident	Total DDT (65.8)	Total DDT (65.8)
		12/1977	resident	Total DDT (31.6)	Total PCB
		8/1978	resident	Total DDT (55.4)	Total DDT (55.4)
		11/78	resident	Total DDT (22.9)	Total PCB
San Miguel/East	501	7/77	resident	Total PCB	------
		12/77	resident	Total PCB	------
		8/78	resident	Total PCB	------
		11/78	resident	Total PCB	------
Santa Cruz Island	502	8/77	resident	Total PCB	------
		12/77	resident	Total PCB	------
		8/78	resident	Total PCB	------
		12/78	resident	Total PCB	------
		3/01	resident	------	------
Anacapa Island	503	8/77	resident	Total PCB	------
		12/77	resident	Total PCB	------
		8/78	resident	Total PCB	------
		11/78	resident	Total PCB	------
		5/80	transplant	total chlordane	------
		11/80	transplant	total PCB	alpha-HCH
Santa Barbara Island	504	7/77	resident	total PCB	------
		12/77	resident	total PCB	------
		8/78	resident	total PCB	------
		12/78	resident	total PCB	------
Santa Catalina Island/East	680	8/78	resident	total PCB	------
		12/78	resident	total PCB	------
		12/80	resident	total PCB,	gamma-HCH,
Santa Catalina Island/West	681	7/77	resident	total PCB	------
		12/77	resident	total PCB	------
		8/78	resident	total PCB	------
		12/78	resident	total PCB	------
		3/94	resident	------	------
Santa Catalina Island/ Ribbon Rock	682	2/93	resident	total chlordane, dieldrin	cis-chlordane
Santa Catalina Island/ Ben Weston	683	12/80	resident	total PCB, total chlordane	cis-chlordane

[a]MTDL: Maximum Tissue Residue Level for Ocean Waters (see text)

[b]EDL85: 85th percentile for statewide CA-SMWP samples from 1977-1997.

[c]EDL95: 95th percentile for statewide CA-SMWP samples from 1977-1997.

Table 20. Exceedances for trace element concentrations measured by the State Mussel Watch Program in mussels from Channel Islands National Park and Santa Catalina Island. Data from all available sample dates was evaluated. Exceedance criteria are based on wet weight (ppb), and were different for resident and transplanted mussels (see text). Station locations are provided in Table 15 and Figures 46-47.

CA-SMWP station	Station #	Sample Date	Mussel Type	Exceedance Criteria EDL85[a]	EDL95[b]
San Miguel/West	500	8/1977	resident	Hg	------
		12/1977	resident	Hg	------
		8/1978	resident	Cd	------
		11/1978	resident	Hg	------
San Miguel/East	501	7/1977	resident	Cd	------
		12/1977	resident	Cd	------
		8/1978	resident	------	------
		11/1978	resident	------	------
Santa Cruz Island	502	8/1977	resident	------	------
		12/1977	resident	------	------
		8/1978	resident	------	------
		12/1978	resident	------	------
		3/2001	resident	Cd	Cd
Anacapa Island	503	8/1977	resident	Ag	------
		12/1977	resident	------	------
		8/1978	resident	Ag, Pb	------
		11/1978	resident	Ag	------
		12/1979	resident	------	------
		5/1980	transplant	Cd	Cd
		11/1980	transplant	Cd	Cd
Santa Barbara Island	504	7/1977	resident	Cd	------
		12/1977	resident	------	------
		8/1978	resident	------	------
		12/1978	resident	Cd	Cd
Santa Catalina Island/East	680	8/1978	resident	------	------
		12/1978	resident	------	------
		12/1980	resident	------	------
		12/1980	transplant	------	------
Santa Catalina Island/West	681	7/1977	resident	Pb	Pb
		12/1977	resident	Pb	Pb
		8/1978	resident	Pb	Pb
		12/1978	resident	Pb	Pb
		12/1979	resident	Pb	Pb
		5/1980	transplant	Al, Mn, Ni, Ag, Cr, Pb	Ag, Cr, Pb
		12/1980	resident	Pb	Pb
		12/1980	transplant	------	------
		9/1991	resident	Pb	Pb
		3/1994	resident	Pb	Pb

CA-SMWP station	Station #	Sample Date	Mussel Type	Exceedance Criteria EDL85[a]	EDL95[b]
Santa Catalina Island/Ribbon Rock	682	12/1980	resident	------	------
		9/1990	resident	Zn	Zn
		2/1993	resident	Pb, Cr	Cr
Santa Catalina Island/Ben Weston	683	12/1980	resident	Cr	Cr
Santa Catalina Island/Silver Canyon	684	12/1980	resident	Cr	------
Santa Catalina Island/Church Rock	685	12/1980	resident	------	------

[a]EDL85: 85th percentile for statewide CA-SMWP samples from 1977-1997.

[b]EDL95: 95th percentile for statewide CA-SMWP samples from 1977-1997.

Summary of sentinel mussel results for the Channel Islands

Trace elements. *Based on California distributions*, mussels in and near the Park have contained elevated levels of several metals in recent years (most frequently, Cd, Pb, Ag, and Cr). In addition, *compared to national distributions*, arsenic (As) has consistently been above the national median, and also "high", in mussels in or near the Park. High concentrations of some trace elements may represent entirely natural conditions (O'Connor 2002). When *groups* of sites in particular regions, rather than individual sites, show high concentrations of particular trace elements, a natural source is more likely. Some natural sources for Cd, Pb, Ag, and Cr have been identified in U.S. surveys. For example, the high As concentrations in southeast U.S. molluscs are probably due to phosphate deposits in that region (Vallette-Silver et al. 1999). The serpentine rocks of the Northwest are a source of both the Cr and Ni that are found at high levels in molluscs along that coast, and serpentine outcrops may be the source for the high Ni in oysters in the Mid-Atlantic (O'Connor 2002). Goldberg et al. (1983) and Farrington et al. (1983) suggested that the high Cd concentrations in mussels of Northern California may reflect the fact that the coastal water in that region upwells from the deep Pacific and that deep ocean waters are naturally enriched in Cd relative to surface waters. Whether or not the high levels of Cd, Pb, Ag and Cr in Park mussels are explained by upwelling, minerals in exposed bedrock, or some form of anthropogenic contamination, has not been investigated. Trace element concentrations evaluated by Lauenstein and Daskalakis (1998) indicated that between 1965 and 1993, more sites on the west coast of the U.S. experienced declines than increases in Ag, Cd and Pb in sentinel mussels. However, from 1986-2002, Ag, Cd and Pb in sentinel mussels at Santa Cruz have not shown decreasing trends (Table 17). In fact, the maximum levels of Cd and Pb measured by the NOAA-MWP in Santa Cruz mussels were obtained in 2001 and 2002, respectively. Interestingly, nationwide, high concentrations of As, Ni, Se and Cd in sentinel bivalves are inversely correlated with human population (O'Connor 2002), suggesting that hot spots for these trace elements are less likely being caused by anthropogenic pollution than are hot spots for other trace elements, such as Pb and Ag. This phenomenon suggests that natural explanations for high levels of As and Cd in Park mussels may be appropriate.

Organic contaminants. Among the islands, the highest DDT levels in the available record were found at San Miguel in 1977-78 - more recent data for the island are unavailable to indicate whether or not San Miguel remains a DDT hot spot. The above was true despite the fact that, among all the islands, San Miguel is the furthest from the most significant source of DDT contamination in the region: sediments near the White's Point outfall on the Palos Verde Shelf.

In 1977, the most contaminated mussels sampled by the CA-SMWP at San Miguel (65.8 ppb DDT based on wet wgt) contained 39% as much total DDT as was contained in mussels at White's Point in 1982 (170.8 ppb DDT based on wet wgt). Although lower than at San Miguel, DDT was also "high" in mussels from Santa Cruz and Catalina as recently as 1996 and 1990, respectively, at the national level. Nationwide, and along the west coast, total DDT, dieldrin and total PCBs are declining in sentinel bivalves (Lauenstein and Daskalakis 1998). Compared to the national distribution, PCB levels have not been notably high in mussels at the islands. However, at the state level, PCB contamination was notable (>EDL85) in mussels from San Miguel in the late 1970s. Consistent with regional trends, the NOAA-MWP time series for Santa Cruz and Catalina suggest that PCBs have declined in mussels at these two islands (Figure 52). MTRLs for PCBs were exceeded in almost every mussel sample taken from every island, indicating that PCB levels in water and mussels around the islands may still be a concern from a human health perspective, and presumably from the perspective of marine mammal health.

Interestingly, total PAH was highly elevated in NOAA samples at both Santa Cruz and Catalina in 1986, but not at any other time sampled. PAHs were analyzed by NOAA at San Miguel in 1988, but were not high at that time. Given that PAH residue in bottom fish taken from the Park (Pacific sanddabs) has a petrogenic, rather than a pyrogenic, signature (Brown and Steinert 2003), it may be appropriate to assume that PAHs in sentinel mussels at the Park also have a petrogenic origin. It would be interesting to know whether events related to the extraction of oil led to transient high levels of PAHs in mussels at these two sites - although the distance between Catalina and Santa Cruz makes a single event a less likely explanation. Given that Hostetler et al. (2004) identified natural seeps near the Park, and one seep in particular off of Fraser Point on Santa Cruz, as the source of the majority of tar that washes up on the beaches in the Park, it seems logical to assume that some fraction of the PAH in Park mussels has a local origin.

III. OTHER CONCERNS

A. EXOTIC SPECIES THAT DIRECTLY AFFECT AQUATIC RESOURCES

A.1. Non-native plants in riparian zones and wetlands

Eucalyptus was brought to the islands during the ranching era, and stands of *Eucalyptus* occur in several locations in the Park, especially in valleys and at harbors on Santa Cruz where ranchers resided. *Eucalyptus* is colonizing the riparian terraces of a number of streams on Santa Cruz (Noon 2003). There have been reports from Australia of decreases in water yield from catchments where *Eucalyptus* plantations have been established (Whitehead & Beadle 2004, Ruprecht & Stoneman 1993), or where *Eucalyptus* forest has replaced native vegetation of shorter stature in South Africa (Dye 1996) and in southern India (Calder 1986). It is tempting to speculate that *Eucalyptus* may have altered the water economy in portions of some drainages in the Park, perhaps reducing water levels in streams or coastal wetlands at some sites. Non-native plants that are displacing native wetland vegetation at some sites include Kikuyu grass (*Pennisetum clandestinum*), smilo grass (*Piptatherum miliaceum*), black mustard (*Brassica nigra*), fennel (*Foeniculatum vulgare*) and milk thistle (*Silybum marinum*) (Noon 2003).

A.2. Feral Pigs

Domestic pigs were introduced to Santa Cruz in 1852 during the occupation of the island by European sheep and cattle ranchers (Schuyler 1988). By 1857, pigs had escaped and become feral on Santa Cruz. Recent annual estimates of the island's pig population have ranged from 1,500 to over 4,000 (CINP 2002a). The environmental consequences of the feral pig population on Santa Cruz has been well described elsewhere (Coonan et al. 2005, Roemer & Wayne 2003, Roemer et al. 2002, CINP 2002a). Feral pigs were implicated in the colonization of Santa Cruz by non-native golden eagles (and the consequent near-eradication of the endemic Channel Island fox), and in the spread of invasive weeds (notably fennel). In addition, feral pigs feed directly on intertidal animals. It is a common contention that the rooting activities of feral pigs has increased erosion and sediment delivery to streams on Santa Cruz. Because feral pigs occur throughout Santa Cruz, the observed differences in the frequency of slope failures (Pinter & Vestal 2005) and nearshore sediment plumes (Otero & Siegel 2004) between the TNC- and NPS-owned portions of the island are probably related to the different lengths of time that sheep have been absent from the two parts of the island. At any rate, a lack of stream studies on Santa Cruz, and the presence of feral pigs throughout the island, makes it difficult to ascertain whether feral pigs actually increase turbidity or sediment transport in island streams. A program to eradicate the feral pigs on Santa Cruz began in March, 2005, and was still in progress at the time of this writing. Feral pigs were also present on Santa Rosa, but were eliminated by 1993.

A.3. Elk and Deer

Vail & Vickers Co. continue to operate a commercial hunting operation for trophy elk and mule deer on Santa Rosa (http://mumwildlife.com/index.php?pg=santarosa). Currently, 425 deer and 740 elk are allowed, although as recently as Dec., 2005, the numbers were a little lower than that (Kate Faulkner, Chief of Natural Resources, Channel Islands National Park, pers. comm.). As discussed in Sections I.C.1 and II.C.3, riparian corridors on Santa Rosa have recovered substantially, and stream water quality has improved, following the complete removal of cattle from the island in 1998. However, according to Park staff, preferential browsing of seedlings by elk and deer is one of the major factors preventing the reestablishment of woody riparian species such as arroyo willow and black cottonwood (the other postulated factor being a shortage of seed sources). Barring future legal maneuvering[15], or changes in the agreement between Vail & Vickers and the federal government, negative impacts caused by elk and deer should diminish in the near future as the hunting operation is phased out, and as the animals are destroyed or removed from the island. Annual reductions in herd size are scheduled for every year beginning in 2008, and complete removal of the elk and deer is scheduled for 2011 (Kate Faulkner, Chief of Natural Resources, Channel Islands National Park, pers. comm.).

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[15] For example, on May 3, 2006, the House Armed Services Committee passed a measure by committee Chairman Duncan Hunter (R-Alpine) that would void the court-ordered settlement requiring the elk and deer removal by 2011. The measure is designed to preserve the herds with the a goal of making Santa Rosa Island a hunting destination for disabled veterans. The ultimate fate of this legislation was unknown at the time of this writing.

A.4. Arundo donax

One of the greatest threats to the dwindling riparian resources of coastal southern California is the alien grass species known as *Arundo donax* (Arundo). Arundo (referred to as giant reed, bamboo reed, giant reed grass, arundo grass, donax cane, giant cane, river cane, bamboo cane, and canne de Provence) is among the largest of the grasses, growing to a height of 8 m. It is believed to be native to eastern Asia, but has been cultivated throughout Asia, southern Europe, north Africa, and the Middle East for thousands of years and has been planted widely in North and South America and Australasia in the past century. It was intentionally introduced to California from the Mediterranean in the 1820s in Los Angeles area as an erosion control agent in drainage canals, and was also used as thatching for roofs of sheds, barns, and other buildings. Arundo is also grown to make reeds for musical instruments.

Over the last 25 years the riparian corridors of coastal southern California have become infested with Arundo[16]. Arundo is a hydrophyte, growing along lakes, streams, drains and other wet sites. It uses prodigious amounts of water, as much as 2,000 L/m2. Under optimal conditions it can grow more than 5 cm per day. Arundo dramatically alters the ecological and successional processes in riparian systems and ultimately moves most riparian habitats towards pure stands of this alien grass. By current estimates there are tens of thousands of acres of Arundo along the major coastal drainage systems of southern California, including the Santa Ana, Santa Margarita, Ventura, Santa Clara, San Diego, and San Luis Rey rivers. In addition, Arundo has invaded many of the low order streams that enter the Channel. Arundo is classified by the California Invasive Plant Council as among the top 5 invasive species degrading natural ecosystems in the state, and is listed as an 'A-1' invader (Most Invasive & Widespread Wildland Pest Plants). It was recently declared a Noxious Weed by the California Department of Food and Agriculture.

Among the serious environmental and socio-economic impacts of Arundo are:

- displacing native riparian plants and providing poor quality habitat to wildlife, including numerous officially protected species in Southern California
- reducing water availability in dry regions by transpiring large quantities of water (approx. double the loss rates of native woody plants)
- choking watercourses, exacerbating flooding, and promoting channel erosion
- providing fuel for wildfire, especially near urban areas
- contributing massive debris to riverbanks and beach areas
- interfering with recreational use of river corridors by the public

During large winter storms in Southern California, viable Arundo stems are washed into the ocean in prodigious quantities and are later washed up on beaches. Stands of Arundo are commonly viewed above the high tide line at beaches in the area. Vegetative propagation from drift Arundo at stream mouths allows the invasive plant to gain a foothold in previously unaffected drainages. Arundo stems wash up on Park beaches (Richards and Rich 2006), and are

[16] The discussion of Arundo derives in part from from personal communication with T. Dudley, Marine Science Institute, UCSB, who conducts research on biological control of Arundo in southern California.

removed whenever encountered during beach monitoring or other field work. To date, Arundo has not gained a foothold in riparian zones in the Park, but it remains a serious potential threat.

A.5. Invasive seaweed

Undaria pinnatifida is an edible brown kelp ("wakame") cultured off the coasts of Korea, China and Japan. Within the past thirty years, this species has spread from its native range off the coasts of Japan, Korea, and China to locations worldwide, including the coasts of Great Britain, France, Italy, Argentina, New Zealand, and Australia. The invasive kelp was first discovered in California in the Los Angeles/Long Beach Harbor in 2000 where it was probably introduced on the hulls of commercial ships. It is possible that a piece of a macroscopic sporophyte broke loose and started a new population, or that the gametophyte stage was transported in ballast water. It was found in Santa Barbara Harbor in 2001. *Undaria* is primarily found in sheltered areas, including harbors, but can survive on the open coast as well. Populations in California already occur in Monterey Bay, Santa Barbara Harbor, Catalina Island, and at San Pedro (Thornber et al. 2004). Juvenile *Undaria* plants were seen on a boat that traveled to the islands from Santa Barbara Harbor, and Park staff suspect it is only a matter of time before a population becomes established in the Park (Dan Richards, Marine Biologist, Channel Islands National Park, pers. comm.).

Another invasive algae, *Caulocanthus ustulatus*, was tentatively sighted at Anacapa in November, 2005, and Park staff are still waiting for confirmation. *C. ustulatus* is becoming common on the mainland, especially in Orange County. If confirmed, this will be its first sighting at the Northern Channel Islands (Dan Richards, Marine Biologist, Channel Islands National Park, pers. comm.).

B. COMMERCIAL AND RECREATIONAL FISHING

B.1. Marine protected areas at the Park

In 2003, the State designated 12 areas surrounding the Park islands as Marine Protected Areas (MPAs); ten are State Marine Reserves (SMRs) and two are State Marine Conservation Areas (SMCAs) (Figure 54). The SMRs are no fishing zones. The SMCA at Santa Cruz allows limited recreational fishing, and the SMCA at Anacapa allows limited recreational and commercial catch (Table 21). The establishment of the reserves, combined with two decades of data from the Park's intertidal and kelp forest monitoring programs, has created an opportunity to evaluate whether fishing is responsible for some of the recent changes in nearshore communities at the Channel Islands (as opposed to natural phenomena, such as El Niños, La Niñas and longer-scale regime shift). So far, comparison of monitoring data from inside versus outside fishing refugia at the Park provides the following evidence for fishing impacts on Park biota:

(1) owing to the following trophic cascade:

spiny lobster[17] -» urchins -» kelp,

and the presence of larger and more abundant lobsters inside protected areas, rocky reefs inside protected areas are more likely to support kelp forest than rocky reefs in fished areas (Behrens & Lafferty 2004);

(2) harvest of lobsters indirectly increases epidemics in sea urchins (Lafferty 2004); and

(3) harvest is responsible for 33-83% of the decline in warty sea cucumber numbers that occurred within 3 to 6 years of the rapid expansion of the commercial dive fishery at the Channel Islands (Schroeter et al. 2001).[18]

A review of the anticipated ecological consequences of establishing the MPAs is not provided here. Instead, an overview of commercial and recreational fishing in the Park is provided to address three questions concerning Park habitat where fishing still takes place: (1) which Park species are harvested, (2) where, within the Park, is fishing effort concentrated, and (3) which regulations pertain to particular target species? Detailed descriptions of the pertinent fisheries are available outside this report; links to these sources are provided below, and in Appendix C.

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[17]And probably other predators that are fished, such as California sheephead.

[18]In this case, reserve data came from a protected area at Anacapa that pre-dated the establishment of the Anacapa SMR and SMCA.

Table 21. Summary of fishing restrictions for the MPAs, and other closures, at Channel Islands National Park.

MPA or other closure	Recreational Fishing	Commercial Fishing
Richardson Rock State Marine Reserve (San Miguel Island)	All species prohibited	All species prohibited
Special Closure: San Miguel Island	Boating prohibited within 300 yards from shore between Castle Rock and Judith Rock except as noted: Boats may approach no nearer than 100 yards from shore during the period(s) from March 15 through April 30, and October 1 through December 15	Boating prohibited within 300 yards from shore between Castle Rock and Judith Rock except as noted: Boats may approach no nearer than 100 yards from shore during the period(s) from March 15 through April 30, and October 1 through December 15. Commercial Sea Urchin Permittees may enter the portion of the closed area between the western boundary of the Judith Rock SMR and Castle Rock for the purpose of taking urchins.
Judith Rock State Marine Reserve (San Miguel Island)	All species prohibited	All species prohibited
Harris Point State Marine Reserve (San Miguel Island)	All species prohibited	All species prohibited
South Point State Marine Reserve (Santa Rosa Island)	All species prohibited	All species prohibited
Carrington Point State Marine Reserve (Santa Rosa Island)	All species prohibited	All species prohibited
Skunk Point State Marine Reserve (Santa Rosa Island)	All species prohibited	All species prohibited
Gull Island State Marine Reserve (Santa Cruz Island)	All species prohibited	All species prohibited
Scorpion State Marine Reserve (Santa Cruz Island)	All species prohibited	All species prohibited
Santa Barbara Island State Marine Reserve	All species prohibited	All species prohibited
Painted Cave State Marine Conservation Area (Santa Cruz Island)	Lobster and Pelagic Finfish[a] allowed. All other invertebrates, other finfish, and all marine aquatic plants prohibited.	All species prohibited
Anacapa State Marine Reserve	All species prohibited	All species prohibited
Anacapa Special Closure	No nets or traps shallower than 20 feet around entire island.	No nets or traps shallower than 20 feet around entire island.
Anacapa State Marine Conservation Area	Lobster and Pelagic Finfish[a] allowed. All other invertebrates, other finfish, and all marine aquatic plants prohibited.	Lobster allowed. All other invertebrates, all finfish, and all marine aquatic plants prohibited.
Anacapa Pelican Fledgling Area (contained within the Anacapa SMCA)	No entry January 1 to October 31	No entry January 1 to October 31.

[a]Pelagic finfish, for the purpose of MPAs, are defined as: northern anchovy (Engraulis mordax), barracudas (Sphyraena spp.), billfishes* (family Istiophoridae), dolphinfish (Coryphaena hippurus), Pacific herring (Clupea pallasi), jack mackerel (Trachurus symmetricus), Pacific mackerel (Scomber japonicus), salmon (Oncorhynchus spp.), Pacific sardine (Sardinops sagax), blue shark (Prionace glauca), salmon shark (Lamna ditropis), shortfin mako shark (Isurus oxyrinchus), thresher sharks (Alopias spp.), swordfish (Xiphias gladius), tunas (family Scombridae), and yellowtail (Seriola lalandi). *Marlin is not allowed for commercial take.

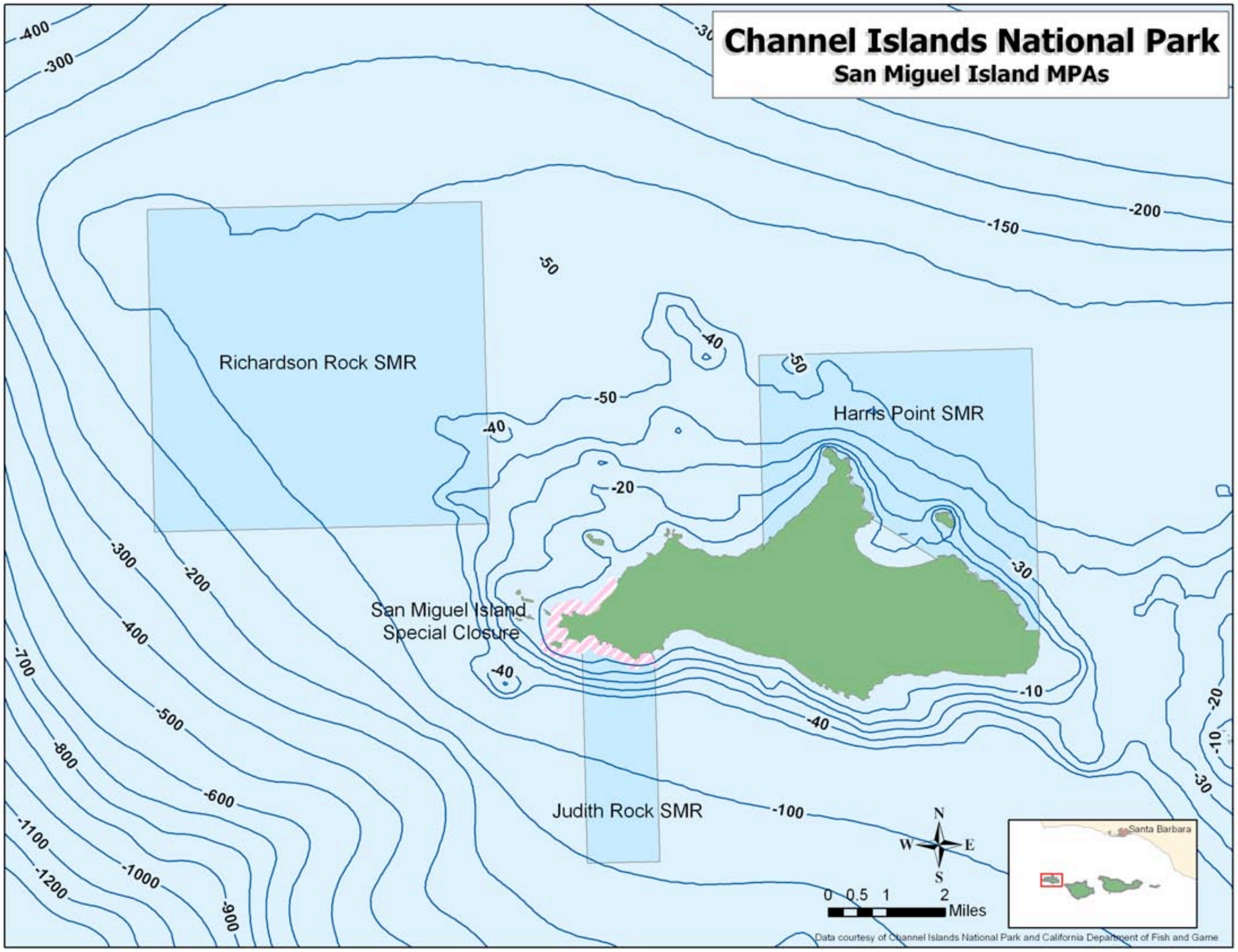

Figure 54. Marine Protected Areas at Channel Islands National Park. Isobaths are in meters. Restrictions and prohibitions are explained in Table 21.

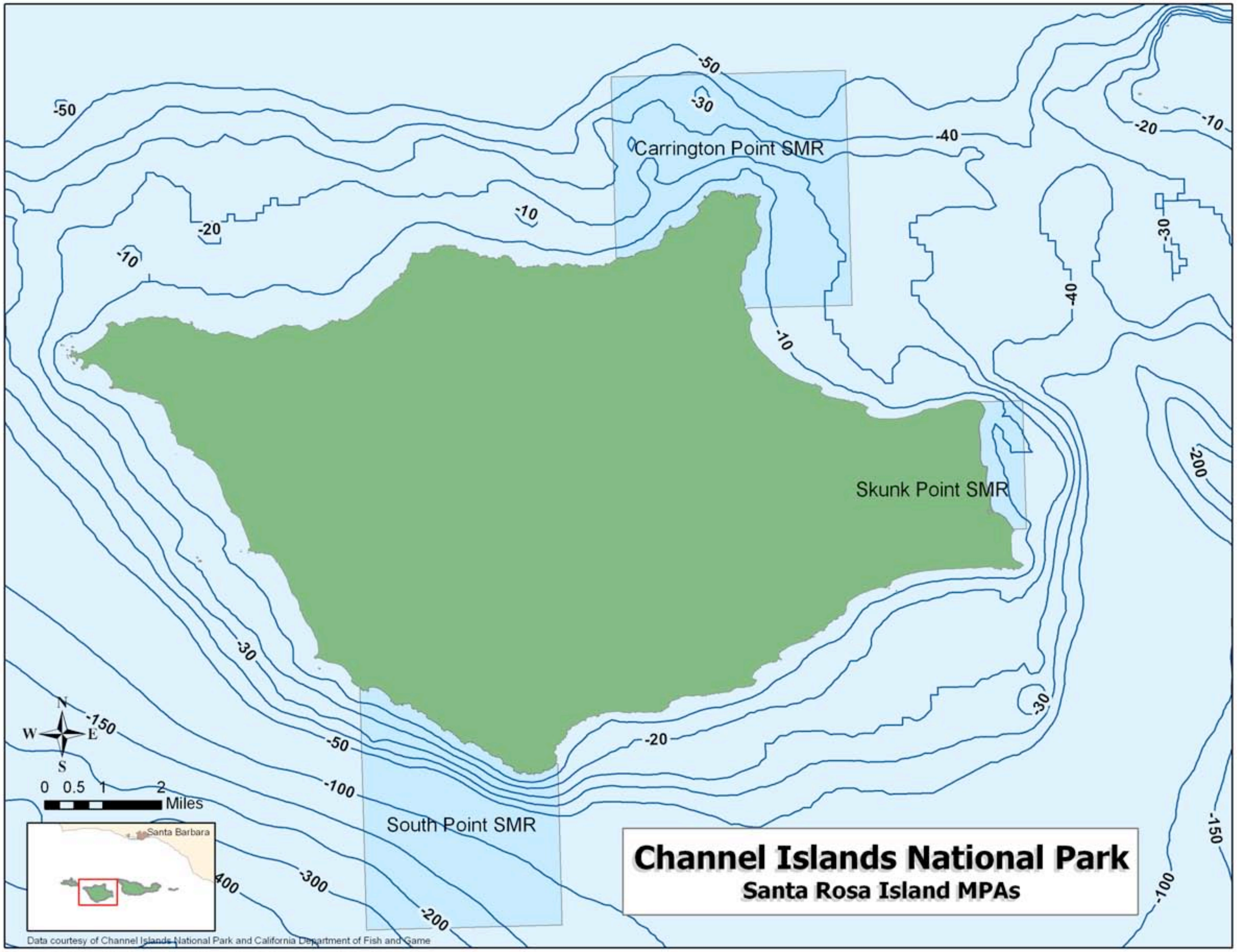

Figure 54. (continued).

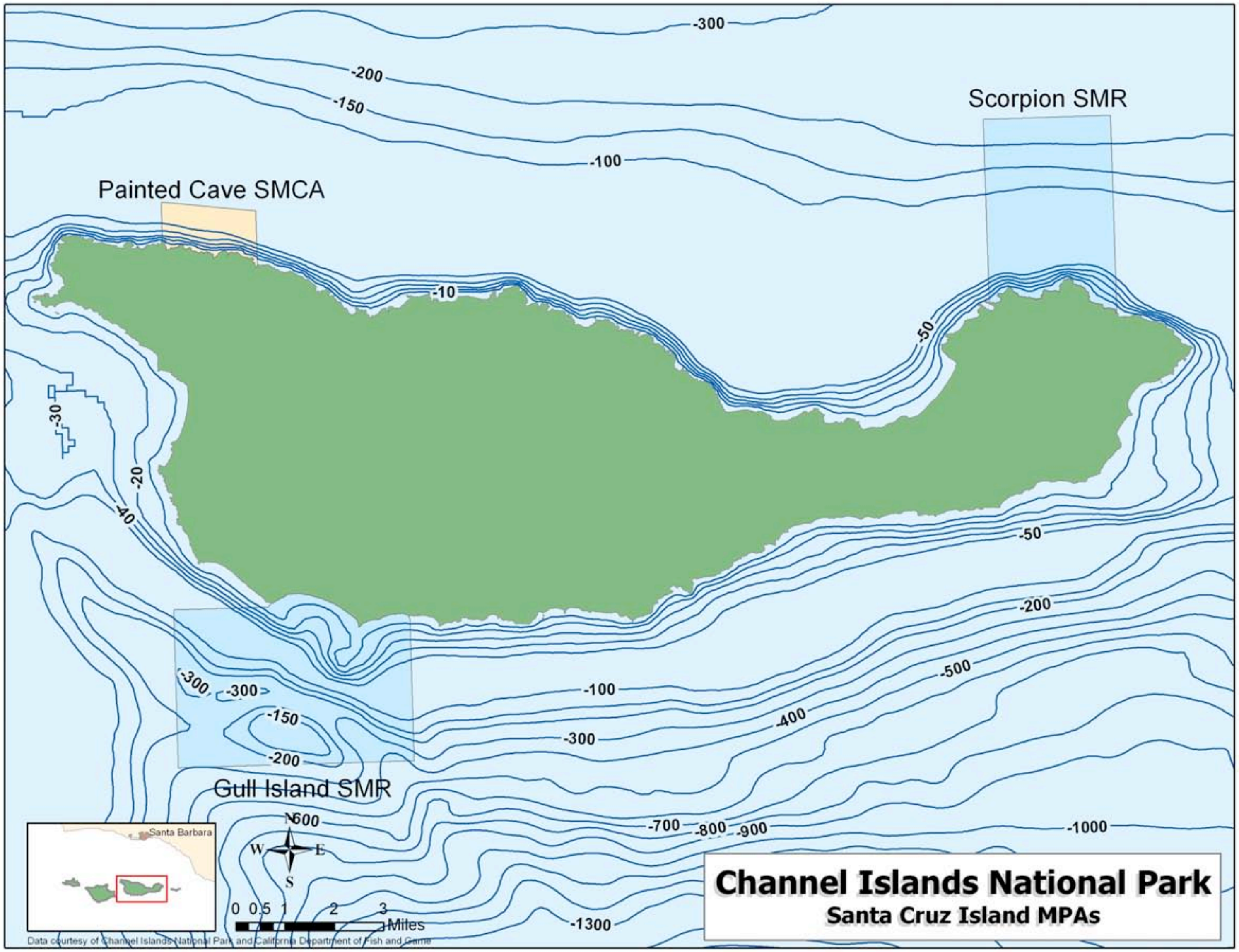

Figure 54. (continued).

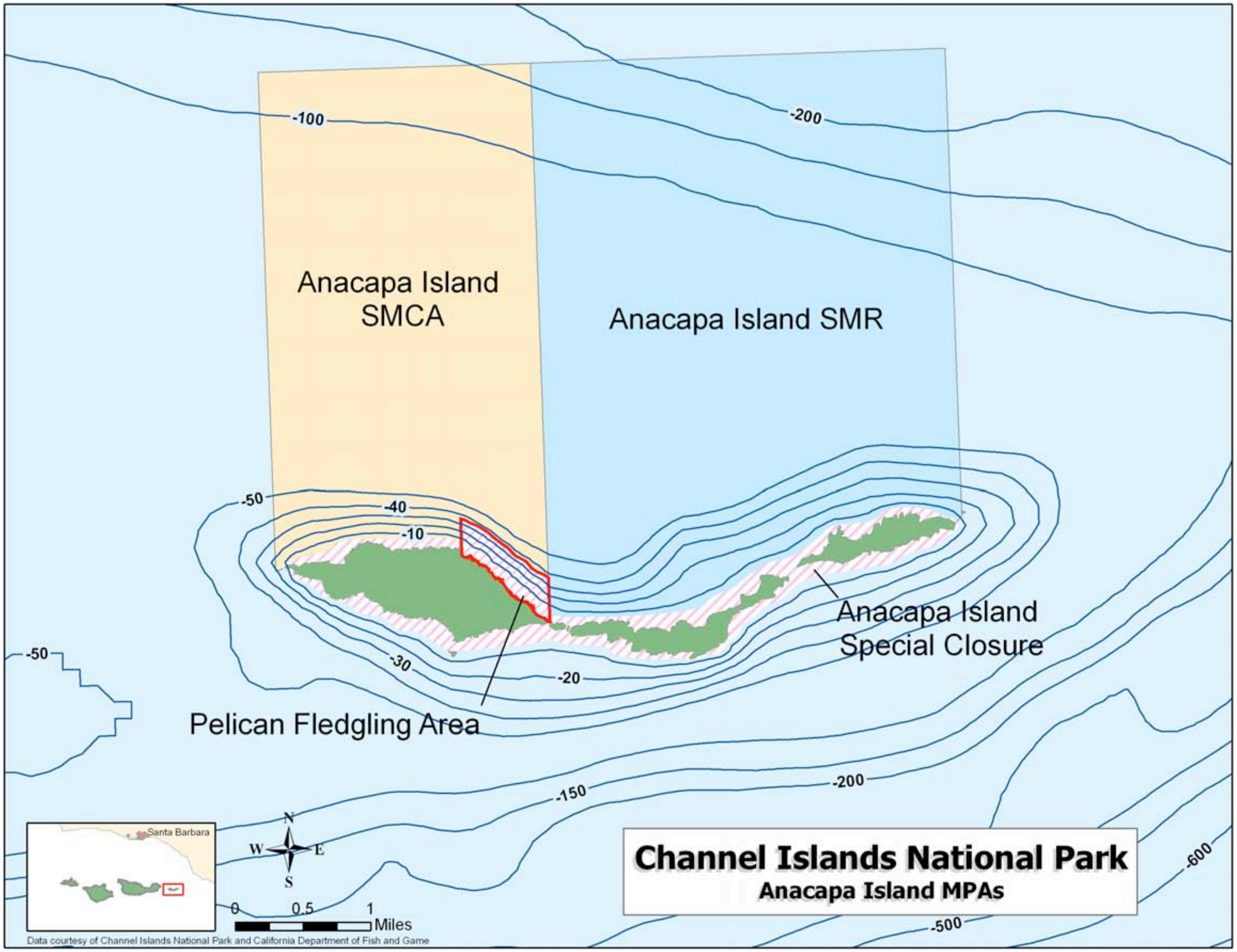

Figure 54. (continued).

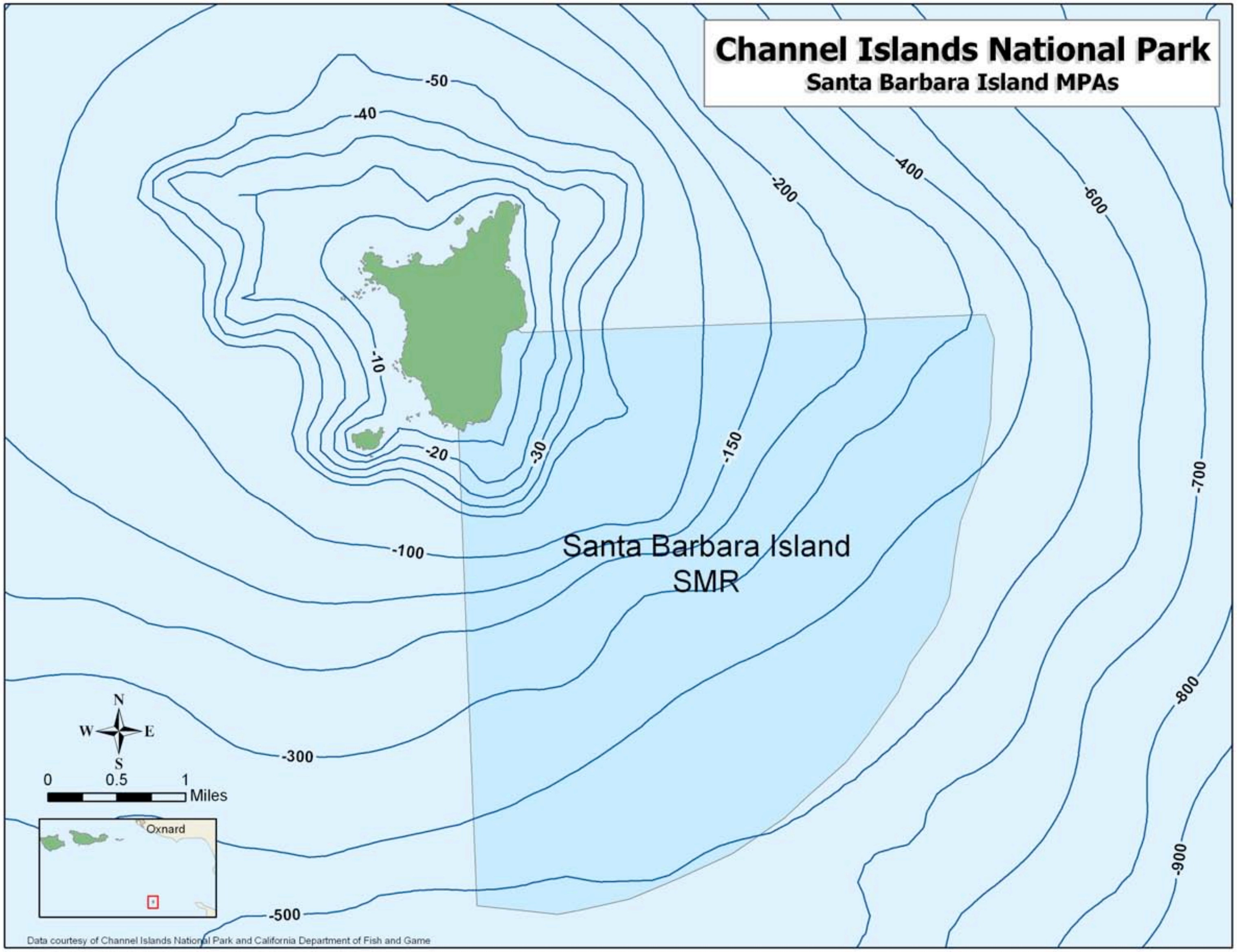

Figure 54. (continued).

B.2. Which Park species are Harvested?

The Sanctuary and the Park have extremely productive commercial fishing grounds. The majority of fish are caught in nearshore waters that contain kelp beds. Key targeted species include: squid, sea urchin, spiny lobster, sea cucumber, prawn, nearshore finfish (e.g., rockfishes and California sheephead), coastal pelagic species (e.g., anchovy, sardine, and mackerel), flatfishes (e.g., California halibut, starry flounder, and sanddabs), rock crab, tuna, and kelp. Trawling for ridgeback prawn occurs in the Sanctuary outside of state waters. However, trawling for any species (except for California halibut, in the designated trawling grounds) is prohibited in state waters in District 19, consequently, trawling for shrimp or prawn is prohibited within Park boundaries. (Note: *all trawling* for spot prawns in California was halted by CF&G in 2002). Live fish trapping for rockfish, California sheephead, California scorpionfish and other shallow water species occurs primarily near the coastlines of the Channel Islands. This particular fishery has expanded recently owing to demand for live fish in the Asian market. Limited entry Nearshore Fishery Permits, and Deeper Nearshore Species Permits, are now required by the State, and a limited number of live-fish trap endorsements (39 in the South Coast Region) are issued. Without a live-fish trap endorsement, the 19 species regulated as Nearshore Finfish (most are rockfish, see Appendix C) may only be taken by line. It is unlawful to use more than 150 hooks on a vessel, or to use more than 15 hooks per line, to take nearshore fish stocks for commercial purposes in ocean waters within one mile of shore in District 19. Traps are also used to take shrimp and prawns, California spiny lobster, and three types of rock crab (red, brown and yellow). However, south of Pt. Conception, the use of traps to catch shrimp is prohibited in waters <50 fathoms deep (300 ft), which rules out shrimp trapping in the Park, except for a small area of sufficient depth south of Anacapa. The use of gill nets and trammel nets to catch *any* species is prohibited within 1 mile of offshore islands south of Pt. Conception. Consequently, fishing using this gear is prohibited in Park waters. Other fisheries in the Sanctuary include shark and swordfish drift netting, squid seining using purse seines and light boats, urchin diving, and diving or trawling for sea cucumbers (although within 3 miles of shore, sea cucumbers can only be taken by diving). Much of the Sanctuary harvest of market squid, urchins, rockfish, spiny lobster, crab, and sea cucumber takes place close to shore within Park boundaries. The dive fishery for sea cucumber emerged at Park islands in the 1990s. Abalone, once one of the most valuable fisheries in the Sanctuary (over $2.5 million harvested between 1988 and 1997 according to Leeworthy & Wiley 2003), was closed to commercial harvest by the state legislature in 1997. Other Park species for which commercial harvest is closed in California are uncultivated rock scallops, Pismo clams, giant sea bass, California corbina, spotfin croaker, yellowfin croaker, kelp bass, barred sand bass, spotted sand bass, garibaldi, wolf eel, blacktip poacher, pygmy poacher, bluespotted poacher, ocean sunfish, great white shark, basking shark, and striped marlin. There is a small but increasing fishery for turban snails and whelks, which is not currently regulated. The Draft Market Squid Management Plan, submitted to the Commission by CF&G in early 2006, recommends the establishment of area closures (one nautical mile wide areas around the islands) and time closures (1 February through 30 November) prohibiting squid fishing around Anacapa, Santa Barbara and San Miguel Islands. Many of the other commercially important species, such as tuna, flatfish, wetfish (anchovies, mackerel and sardines), shrimp, swordfish, and shark, tend to be caught mostly outside of Park boundaries, in deeper waters than contained within the Park, or using gear that is disallowed by the State within Park waters.

Ranking of Sanctuary fisheries. Twenty-five species, or species groups, that are commercially harvested within the Sanctuary are ranked according to average annual revenue derived from Sanctuary fishing effort in Table 22. Of the Sanctuary's commercially caught species, market squid, sea urchin, spiny lobster, and rockfish are some of the most economically valuable, with urchin and squid exceeding the market value of all other species. Commercial fishermen that use Sanctuary waters also fish outside the Sanctuary. However, high percentages (over 50%) of the revenue obtained by area fishermen from urchin, spiny lobster, sea cucumbers, and market squid result from effort within the Sanctuary (Table 23).

Table 22. Average annual revenue from fish and invertebrates harvested inside Channel Islands National Marine Sanctuary. Data were included from fishing effort within the CF&G 22 Block definition of the Sanctuary (see text). Species/species groups are listed in descending order of importance. Data are from Leeworthy & Wiley (2002).

Species/Species Group	Average 1996-1999 Ex-Vessel Value $
Market squid	13,046,664
Urchins	5,265,233
Spiny Lobster	922,098
Prawn*	703,186
Rockfishes	549,319
Crab	343,664
Tuna	305,665
CA Sheephead	235,928
Anchovy & Sardines	234,367
Flatfish	183,871
Abalone**	178,027
Sea Cucumbers	167,700
Mackerel	67,119
Sculpin & Bass	60,327
Swordfish	39,090
Shark	34,751
Roundfish	33,262
Yellowtail	6,891
Shrimp	5,813
Mussels & Snails	4,694
Salmon	1,411
Rays & Skates	1,164
Surf Perch	695
Grenadiers	211
Octopus	196

* In 2002, the California Fish and Game Commission voted to close the spot prawn trawl fishery.
**The commercial harvest of abalone was prohibited starting in 1997.

Table 23. Proportion of total 1999 revenue for Sanctuary fishermen that resulted from effort inside the Sanctuary, as opposed to outside of it. Data are from Leeworthy & Wiley (2002).

Target Fishery	Percent of 1999 Fishing Revenue that came from the Channel Islands National Sanctuary
Urchin	73.76
Spiny Lobster	58.39
Sea Cucumbers	71.88
Rockfish	20.42
Crab	35.85
Flatfish	10.47
CA Sheephead	49.27
Sculpin and Bass	10.02
Shark	4.72
Squid, using Purse Seine	70.34
Squid, using Light Boats	86.90
Wet Fish by Purse Seine*	22.10

*Wet fish are anchovies, sardines and mackerel. For wetfish, percent is average for 1996-1999.

State and national importance of Sanctuary fisheries.

Although the Sanctuary makes up only about 5% of California's coastal waters, it provides a disproportionate percentage of the total state catch for many species. A large percentage of the Sanctuary catch is landed at ports in the Santa Barbara area (primarily at Santa Barbara, Ventura and Oxnard Harbors, and at Port Hueneme). In Table 24, the 2004 total California landings of commercial species is compared to the combined total 2004 landings of species at four major, plus three minor, Santa Barbara area ports. Among rockfish species, Santa Barbara area landings of bocaccio and Mexican, aurora, copper/whitebelley, copper, grass, rosy, starry, and vermillion rockfishes, make up sizable percentages (~20% or more) of total California landings for those species. With regards to the *more important* state fisheries (>500,000 lbs, based on 2004 landings), Santa Barbara area ports accounted for the following percentages of total state landings:

74 % shrimp

67% of red sea urchin

57% of market squid

51% red rock crab

43% California spiny lobster

20% of California halibut

18% of pacific bonito

16% of spot prawn (after 2002, no longer caught by trawl in state waters)

10% of pacific sardine

Only small percentages (less than 5%) of state landings for other important state fisheries, such as mackerel, sablefish, chinook salmon, sanddab, swordfish, thornyhead spp., tuna, pacific whiting, Dover/English/petrale sole, and dungeness crab, are landed in the Santa Barbara area. Although sea cucumber is not a major California fishery, 95% and 65% of state landings of giant red sea cucumbers and warty sea cucumbers, respectively, are landed in Santa Barbara area ports, and approximately two-thirds of the sea cucumber harvest in California takes place at the five islands of the Park, plus San Nicolas Island, to the south (Schroeter et al. 2001). From the national perspective, Sanctuary harvest of market squid and urchins is significant. Squid and urchins harvested from the Sanctuary constituted 62% and 72% of U.S. landings (lbs) in 1999 (Leeworthy & Wiley 2002).

Stocks of many species found at the Channel Islands have declined regionally (Leet et al. 2001). The PFMC considers several groundfish species that occur in the Park to be overfished including shelf rockfish spp. (canary, yelloweye, and widow rockfishes, cowcod, and bocaccio), lingcod, and Pacific whiting. California populations of lingcod appear to be less than 25% of their pre-1970s levels (Leet et al. 2001). Rockfishes (*Sebastes*) are particularly vulnerable to commercial and recreational fishing because they are long-lived (approximately 13-100 years), grow slowly, mature late (4-12 years), and have unpredictable recruitment. Declines of up to 50% have been observed in recent decades in the length and weight of some rockfish spp. taken in California. Recreational fishing dominates the take of many nearshore species (such as California scorpionfish, kelp greenlings, treefish, and calico, blue, olive, and kelp rockfishes). As far back as the 1970s, recreational angling was suspected to be responsible for the complete lack of mature olive rockfish in heavily fished offshore reefs (Love 1978). Recreational landings of nearshore finfish species declined by at least 65% from the 1980s to the 1990s (Schroeder and Love 2002, Love et al. 1998). Giant seabass have been in decline for several decades, and commercial catch is now prohibited. Catches of pelagic sharks have been in sharp decline since the 1970s (Leet et al. 2001). Fishing has altered the abundance and size structure of California spiny lobster populations at the Channel Islands (Behrens and Lafferty 2004), and populations of warty sea cucumber are also in decline in fished areas (Schroeter et al. 2001).

Table 24. Comparison of 2004 California landings (lbs) with combined landings from Port Hueneme, Ventura Harbor, Santa Barbara Harbor, and Gaviota, Guadalupe and Surf Beaches (the latter three are minor contributors). All species are included for which commercial landings were reported by CF&G for the Santa Barbara area. Landings are from the 2004 Annual Report of Statewide Fish Landings, Department of Fish & Game, Marine Region.

Species	Total State Landings (2004)	Total Landings in Santa Barbara area Ports (2004)	Percent of State Landings from Santa Barbara area Ports
ROCKFISH			
Mexican	156	48	30.8%
Aurora	920	275	29.9%
Bank	199,370	22	0.0%
Black and yellow	23,086	92	0.4%
Black	145,855	870	0.6%
Blackgill	249,678	34,807	13.9%
Blue	20,993	275	1.3%
Bocaccio	19,293	4,253	22.0%

Species	Total State Landings (2004)	Total Landings in Santa Barbara area Ports (2004)	Percent of State Landings from Santa Barbara area Ports
Brown	53,357	933	1.7%
Chillipepper	139,623	162	0.1%
Copper/whitebelley	330	328	99.4%
Copper	10,794	4,167	38.6%
Flag	541	14	2.6%
Gopher	34,766	385	1.1%
Grass	30,090	5,173	17.2%
Greenspotted	641	58	9.0%
group *Bolina*	6,832	29	0.4%
group *Gopher*	3,037	39	1.3%
group *Red*	21,630	4,807	22.2%
group *SHELF*	5,491	173	3.2%
group *SLOPE*	329,627	38	0.0%
Kelp	2,088	110	5.3%
Olive	2,209	66	3.0%
Redbanded	221	2	0.9%
Rosy	419	85	20.3%
Speckled	53	2	3.8%
Splitnose	22,668	3	0.0%
Starry	274	91	33.2%
Treefish	1,536	198	12.9%
Unspecified	6,131	1,677	27.4%
Vermillion	30,704	5,569	18.1%
Widow	19,085	167	0.9%
Yellowtail	20,805	236	1.1%
OTHER FISH			
Northern Anchovy	14,974,777	6,072,683	40.6%
Barracuda, California	57,976	4,128	7.1%
Bass, Giant Sea	8,656	2,594	30.0%
Blacksmith	130	1	0.8%
Bonito, Pacific	780,209	139,095	17.8%
Butterfish	13,136	876	6.7%
Cabezon	108,540	11,663	10.7%
Croaker, unspecified	48,567	58	0.1%
Croaker, white	67,261	5,156	7.7%
Eel, California moray	2,077	1,363	65.6%
Escolar	2,998	54	1.8%
Flounder, unspecified	74,234	55	0.1%
Flyingfish	10	10	100.0%
Greenling, kelp	4,486	1	0.0%
Guitarfish, shovelnose	17,306	9,977	57.7%
Hagfishes	4,466	3,974	89.0%
Halfmoon	145	2	1.4%
Halibut, California	1,000,946	200,168	20.0%

Species	Total State Landings (2004)	Total Landings in Santa Barbara area Ports (2004)	Percent of State Landings from Santa Barbara area Ports
Kelpfishes	4,673	1	0.0%
Lingcod	137,636	4,438	3.2%
Lizardfish, California	86	63	73.3%
Louvar	1,624	445	27.4%
Mackerel, Pacific	7,869,466	154,190	2.0%
Mackerel, Jack	2,264,375	39	0.0%
Opah	41,462	1,375	3.3%
opaleye	18,085	71	0.4%
Pomfret, Pacific	745	12	1.6%
Ray, Pacific electric	1,028	965	93.9%
Ray, Bat	1,688	209	12.4%
Sablefish	3,107,490	47,312	1.5%
Salmon, Chinook	6,186,036	9,440	0.2%
Salmon	3,932	2,997	76.2%
Sanddab, Pacific	3,180	23	0.7%
Sanddab	785,590	5,605	0.7%
Sardine, Pacific	97,649,122	10,436,747	10.7%
Sargo	36	2	5.6%
Scorpionfish, California	11,034	1,646	14.9%
Seabass, white	297,207	173,463	58.4%
Shark, Pacific angel	14,325	13,841	96.6%
Shark, basking	77	77	100.0%
Shark, brown smoothhound	3,129	3,014	96.3%
Shark, leopard	21,864	2,918	13.3%
Shark, shortfin mako	82,385	14,729	17.9%
Shark, soupfin	42,252	9,027	21.4%
Shark, spiny dogfish	58,122	16	0.0%
Shark, swell	159	100	62.9%
Shark, thresher	147,985	54,571	36.9%
shark, unspecified	12,053	100	0.8%
Sheephead, California	87,213	35,695	40.9%
Skate, unspecified	251,845	567	0.2%
Sole, Dover	5,337,785	598	0.0%
Sole, English	677,381	5,498	0.8%
Sole, Petrale	1,080,285	3,202	0.3%
Sole, rex	463,782	42	0.0%
Sole, rock	28,977	6,216	21.5%
Surfperch, barred	27,976	9,359	33.5%
Surfperch, black	54	37	68.5%
Surfperch, rubberlip	326	13	4.0%
Surfperch, unspecified	36,342	1,784	4.9%
Swordfish	1,802,414	24,644	1.4%
Thornyhead, longspine	1,197,918	6,730	0.6%
Thornyhead, shortspine	694,548	29,552	4.3%

Species	Total State Landings (2004)	Total Landings in Santa Barbara area Ports (2004)	Percent of State Landings from Santa Barbara area Ports
Thornyhead	91,313	7,951	8.7%
Tuna, albacore	2,976,800	14,554	0.5%
Tuna, bluefin	20,628	6,884	33.4%
Tuna, skipjack	670,892	117	0.0%
Tuna, yellowfin	1,053,339	139	0.0%
Whitefish, ocean	3,711	1,984	53.5%
Whiting, Pacific	10,454,767	64	0.0%
Wrasse, rock	3	3	100.0%
Yellowtail	47,019	3,213	6.8%
CRUSTACEANS			
crab, dungeness	24,870,614	834	0.0%
crab, box	4,761	1,442	30.3%
crab, claws	3,526	2,235	63.4%
crab, king	343	80	23.3%
crab, red rock	135	69	51.1%
crab, rock, unspecified	808,594	490,752	60.7%
crab, sand	427	341	79.9%
crab, spider	95,251	46,648	49.0%
crab, yellow rock	21	21	100.0%
lobster, California spiny	928,302	396,350	42.7%
prawn, spot	223,628	36,280	16.2%
shrimp, mantis	10,097	571	5.7%
shrimp, unspecified	196	145	74.0%
ECHINODERMS			
Sea cucumber, giant red	288,796	275,101	95.3%
sea cucumber, warty	285,749	174,947	61.2%
sea stars	15,600	5	0.0%
sea urchin, purple	2,839	76	2.7%
sea urchin, red	12,228,501	8,130,828	66.5%
MOLLUSCS			
clam, unspecified	3	3	100.0%
mussel	3,510	109	3.1%
octopus, unspecified	3,602	162	4.5%
sea snail	2,061	1,079	52.4%
snail, top	8,902	150	1.7%
snail, moon	1,091	1,091	100.0%
squid, jumbo	1,528	60	3.9%
squid, market	88,334,632	50,567,042	57.2%
whelk, Kellet's	70,371	24,578	34.9%

During the process leading up to the creation of the State MPAs in 2003, detailed analyses of pertinent fisheries, temporal trends in those fisheries, and spatial analyses of Sanctuary use by commercial and recreational fishermen were conducted by consultants and staff of NOAA's

National Marine Sanctuary Program and the CF&G. Much of this information is contained in the following documents, which are available on-line:

1) Ugoretz J (2002) Final Environmental Document. Marine Protected Areas in the National Oceanic and Atmospheric Administration's Channel Islands National Marine Sanctuary. Volume I.-II. California Department of Fish and Game, Marine Region. State Clearing House Number 2001121116, October 2002. http://www.dfg.ca.gov/mrd/ci_ceqa/index.html#vol2

2) Leeworthy VR & PC Wiley (2002) Socioeconomic Impact Analysis of Marine Reserve Alternatives for the CINMS. U.S. Department of Commerce, National Oceanic and Atmospheric Adminstration, National Ocean Service, Special Projects, Silver Spring, MD, April 29, 2002. http://www.cinms.nos.noaa.gov/marineres/sec4.html

   and as revised:

3) Leeworthy VR and PC Wiley (2003) Socioeconomic Impact Analysis of Marine Reserve Alternatives for the Channel Islands National Marine Sanctuary. Silver Spring, MD: NOAA, NOS, Special Projects. 375 pp. http://marineeconomics.noaa.gov/reserves/analysis/analysis.pdf

In 2003, the Sanctuary and CF&G initiated a joint state and federal process to consider enlarging several of the State MPAs into federal waters within the Sanctuary (sometimes referred to as "Phase II" of the Marine Reserves process) (Figure 55). Concise summaries of Sanctuary fisheries (including condition of the stocks, history of the fisheries, gear and methods used, and selected regulatory actions) are contained in the following document:

> Staff Preliminary Working Draft Document for Consideration of a Network of Marine Reserves and Marine Conservation Areas within the Channel Islands National Marine Sanctuary: http://www.cinms.nos.noaa.gov/marineres/main.html

Owing to its preliminary nature, material from this document is not presented here, however the reader is encouraged to view the draft document, or subsequent versions that are made public.

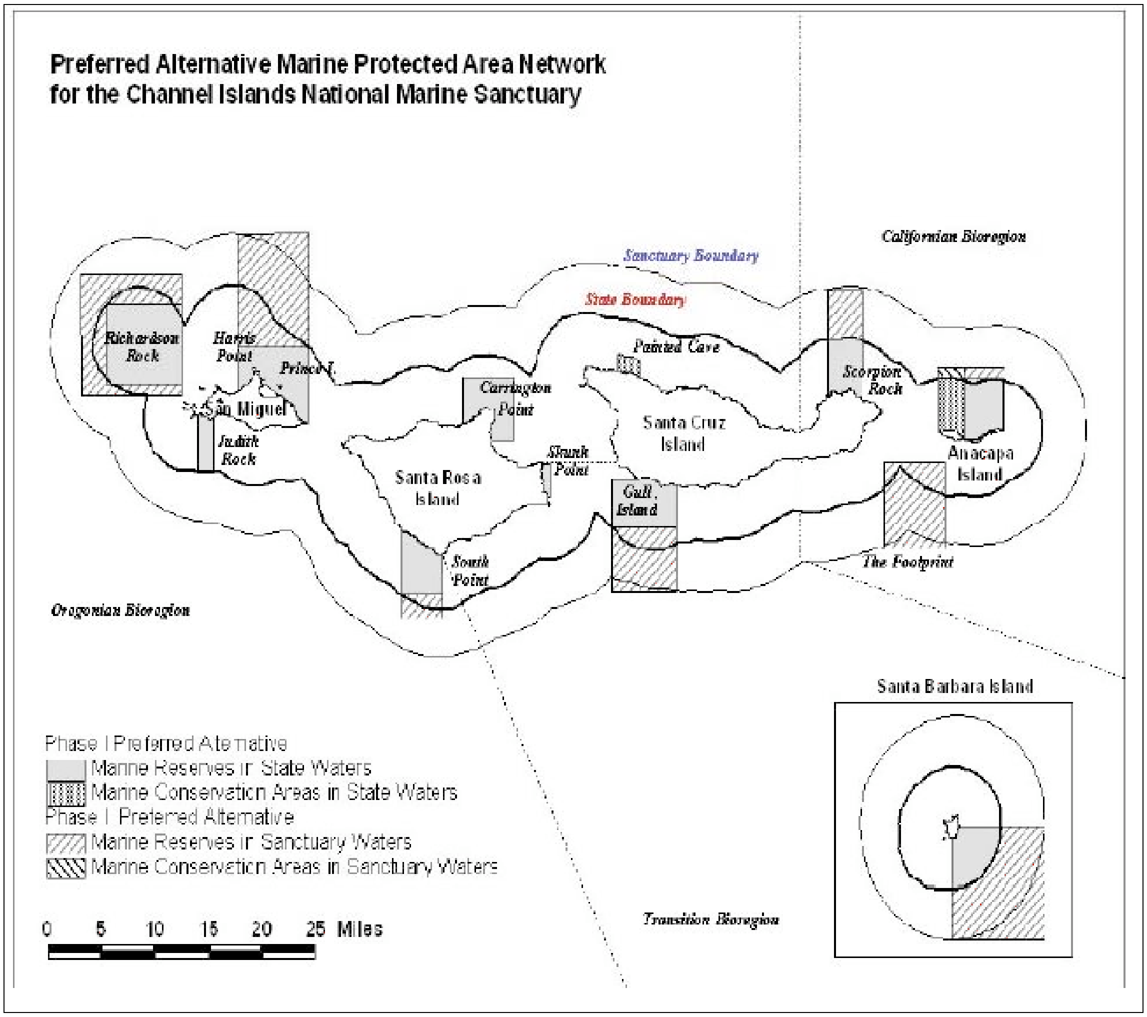

Figure 55. One version of the areas under consideration for the extension of no-fishing zones into federal waters contained within the Sanctuary (downloaded from website of CF&G).

B.3. Where in the Park is Fishing Effort Concentrated?

As part of NOAA's socioeconomic analysis of marine reserves in the Sanctuary (Leeworthy & Wiley 2002, 2003), maps were created showing (1) the spatial distribution (1x1 km grid) of fishing revenue from the Sanctuary (ex vessel values) for kelp, squid, tuna and wetfish, and (2) maps showing the areas most valued by Sanctuary fishermen (termed "exclusion zones" in the reports, because in surveys the fishermen identified sites in the Sanctuary which they wished excluded from the reserves). Although these maps were created using data from 1996-1999, they reveal spatial patterns of use that should still be valid for locations outside of the MPAs that were created in 2003, subsequent to the surveys. Based on visual inpection, the establishment of the MPAs interfered with preferred locations for commercial fishing in the Park in the following ways:

market squid: In general, the siting of the MPAs did not coincide with the most desirable locations for squid fishing, with the exception of the Anacapa SMR and SMCA (compare Figures 54 and 56).

urchin: The SMRs off San Miguel and Santa Rosa, and the Gull Island Reserve off Santa Cruz, eliminated sites well-used by urchin fishermen (compare Figures 54 and 57). Holders of commercial sea urchin permits are exempt from restrictions in part of the Special Closure Area at San Miguel that lies outside the Judith Rock SMR (Table 21).

spiny lobster: Large percentages of preferred lobster trapping grounds at the islands remain outside of the reserves. Some preferred lobster trapping areas were impacted by the SMR at Anacapa, the Gull Island Reserve at Santa Cruz, and the Carrington Point Reserve on Santa Rosa (compare Figures 54 and 58). Both commercial and recreational lobster fishing is allowed in the Anacapa SMCA.

rockfish: All of the reserves except for two (Scorpion Reserve at Santa Cruz, and Harris Point Reserve at San Miguel) impacted stretches of island coastline preferred for rockfish trapping and fishing (compare Figures 54 and 59).

crab: The preferred crabbing areas south of Santa Cruz, at Skunk Point and in Becher's Bay at Santa Rosa, and along the north shore of San Miguel were impacted by reserves. Much of the crabbing area between Santa Cruz and Santa Rosa, and to the south of both Santa Rosa and San Miguel, remains open (compare Figures 54 and 60).

sea cucumber: Almost all of the preferred sea cucumber grounds in the Park were eliminated by the reserves except for the stretches of coastline between Potato Harbor and Painted Cave and from Kinton Point to Morse Point on Santa Cruz, at Crook Point on San Miguel, and at the west end of Santa Rosa (compare Figures 54 and 61).

prawn and tuna: For the most part tuna and prawn are harvested outside of Park boundaries (Figures 62 and 63).

wetfish: anchovies, sardines, and (to a lesser extent in the Sanctuary) mackerel: Most of the commercial effort for wetfish occurs just outside of Park boundaries, although some activity occurs close to the Park south of Santa Cruz and Anacapa (Figure 64). Recreational fishing for these taxa is allowed in the Anacapa and Painted Cave SMCAs (Table 21).

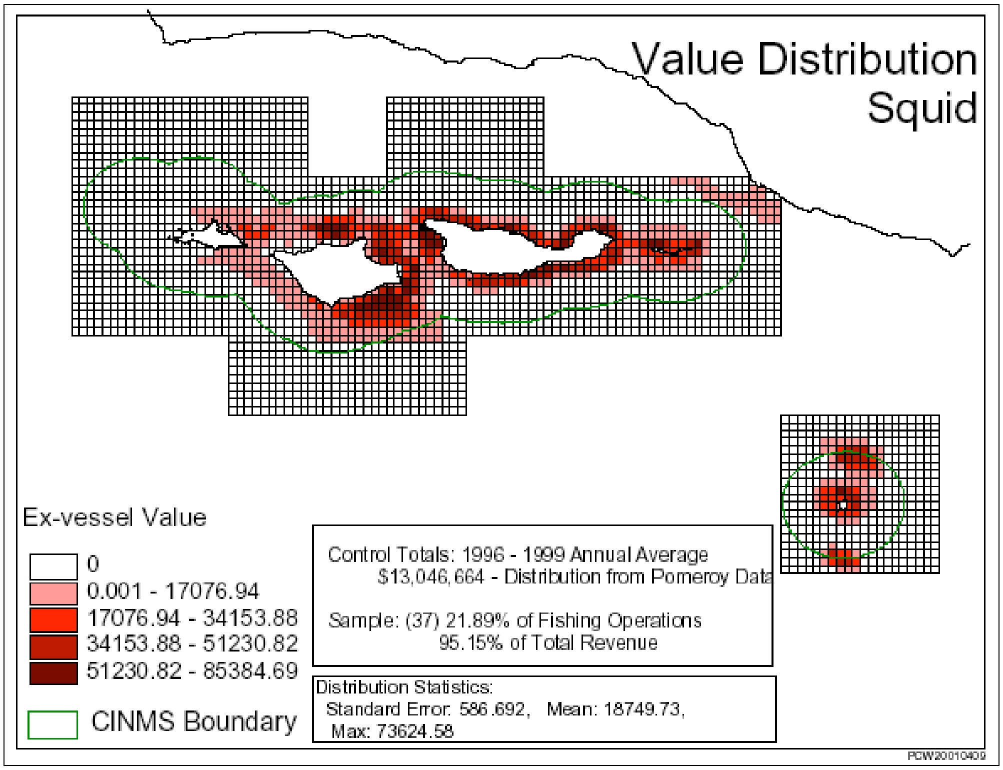

Figure 56. Average annual ex-vessel values for market squid (Leeworthy & Wiley 2002).

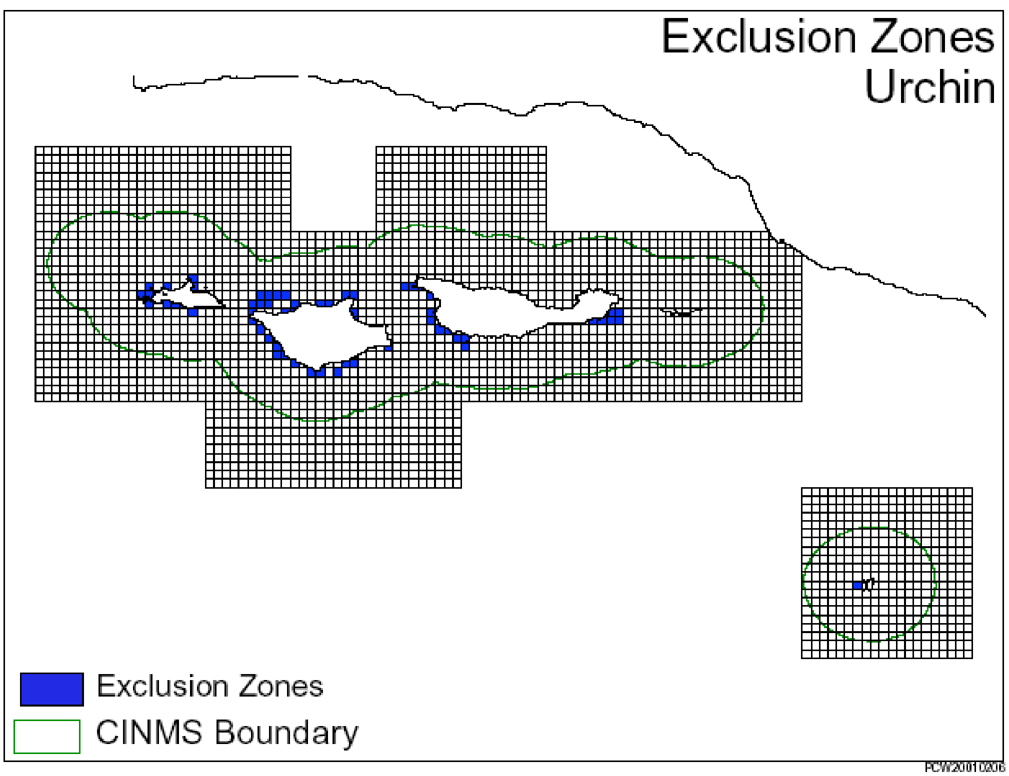

Figure 57. Areas in the Sanctuary preferred by urchin fishermen (Leeworthy & Wiley 2002).

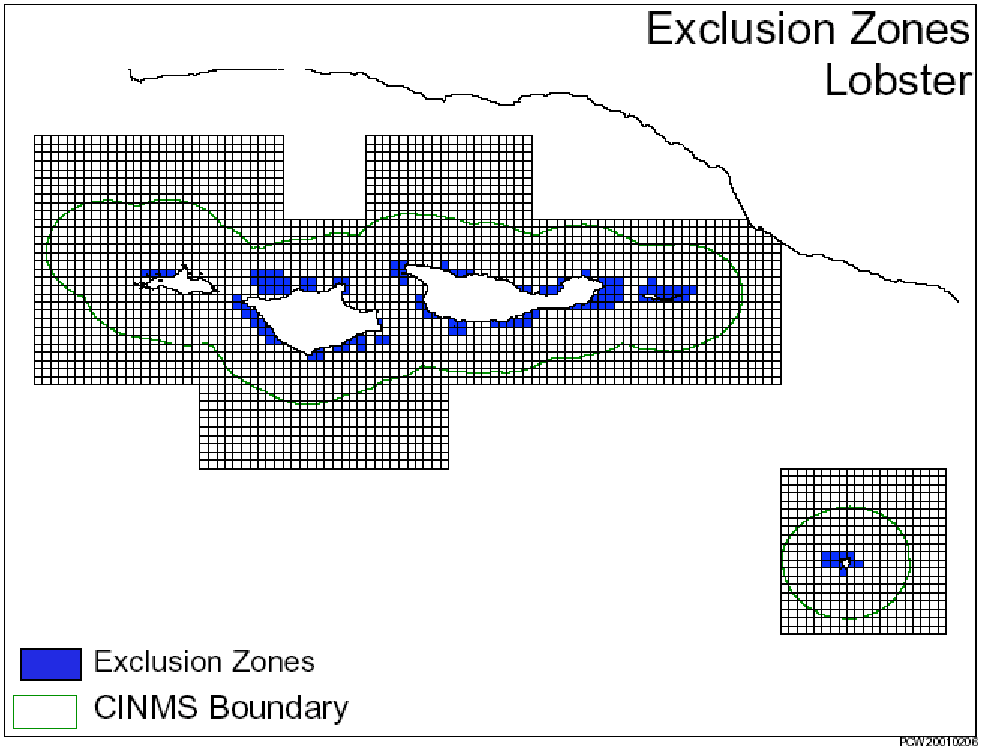

Figure 58. Areas in the Sanctuary preferred by lobster fishermen (Leeworthy & Wiley 2002).

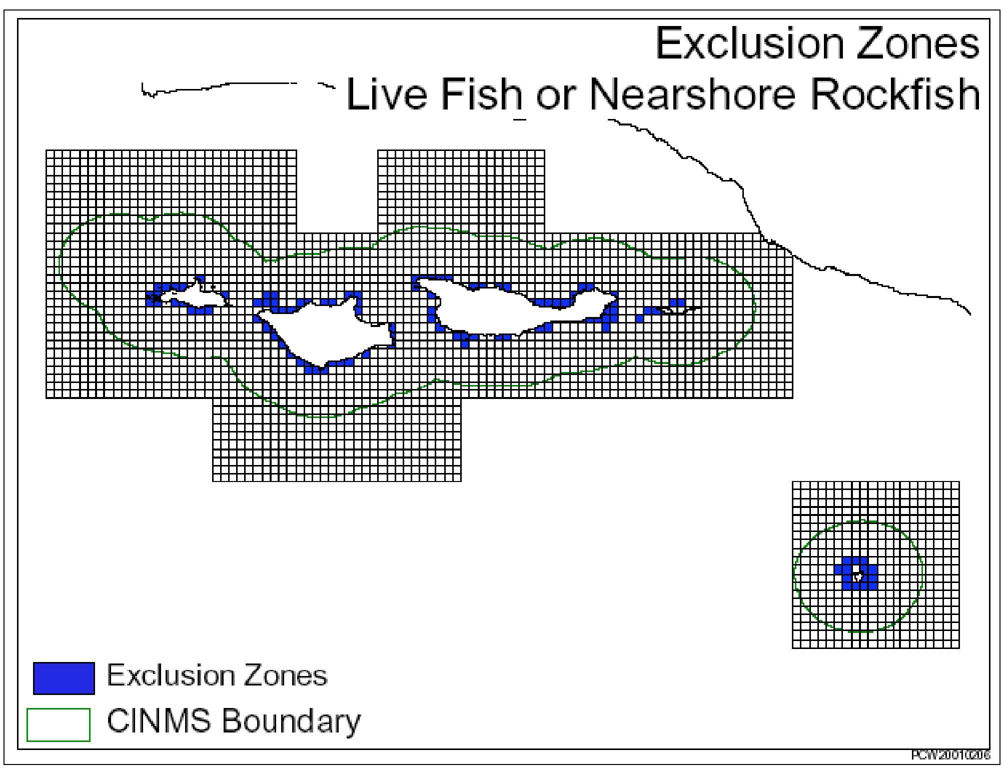

Figure 59. Areas in the Sanctuary preferred in the live fish and nearshore rockfish fishery (Leeworthy & Wiley 2002).

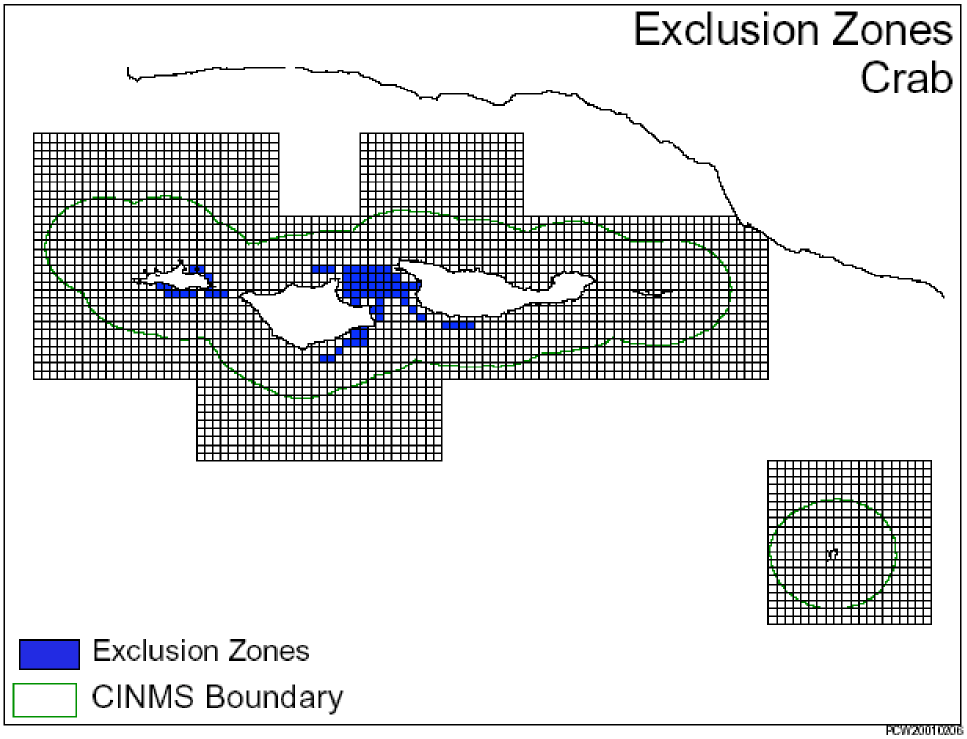

Figure 60. Areas in the Sanctuary preferred by crab fishermen (Leeworthy & Wiley 2002).

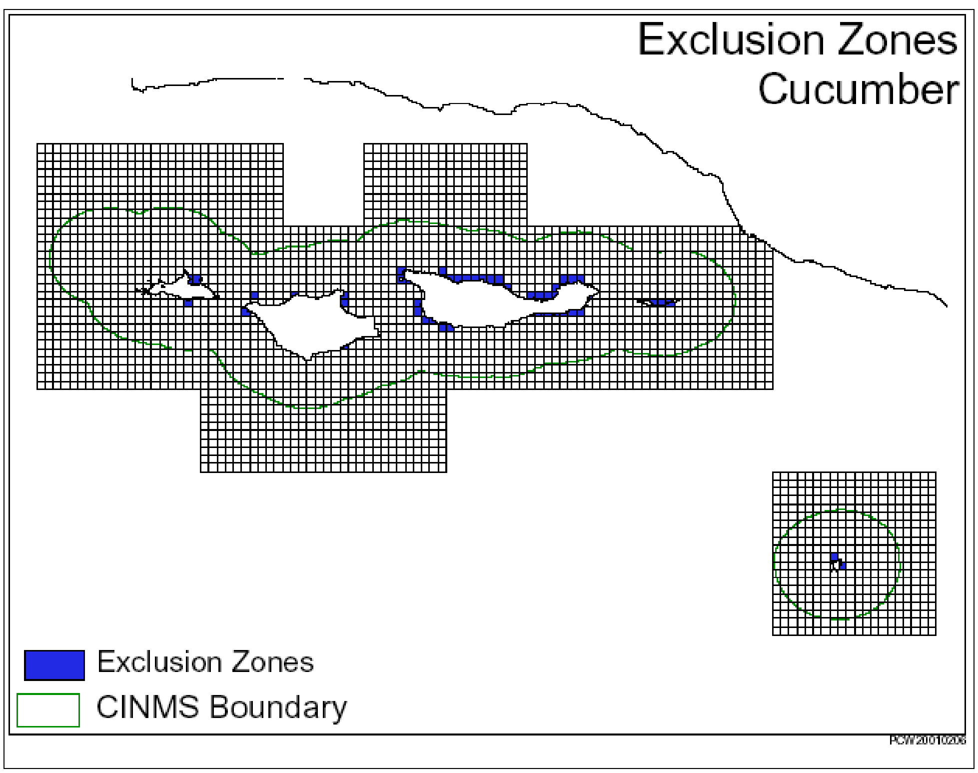

Figure 61. Areas in the Sanctuary preferred by cucumber fishermen (Leeworthy & Wiley 2002).

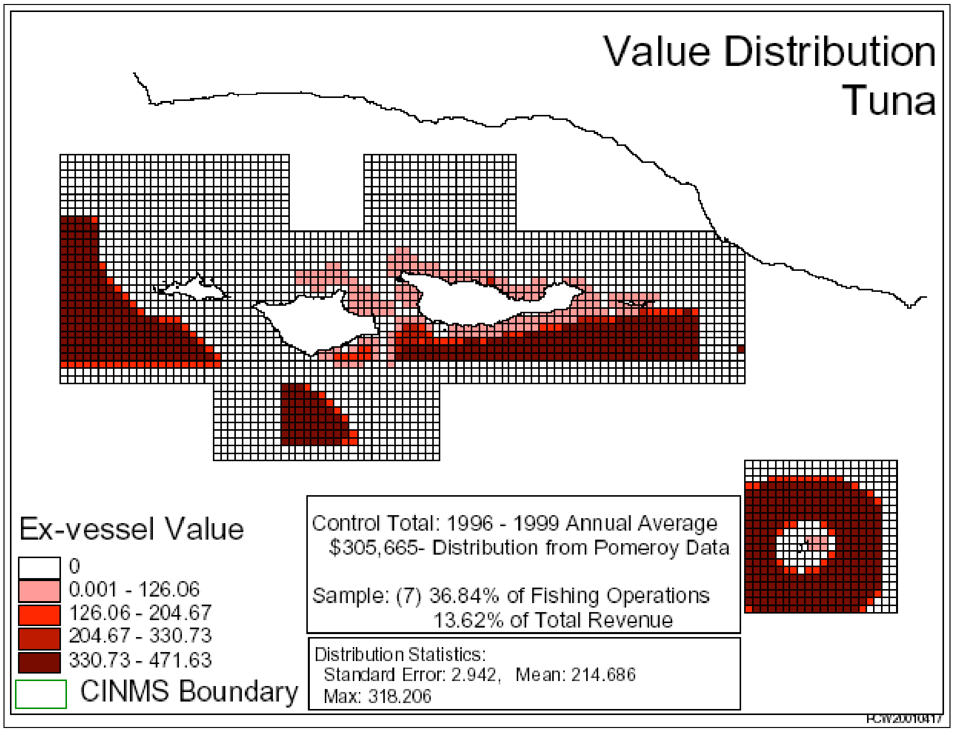

Figure 62. Average annual ex-vessel values for tuna (Leeworthy & Wiley 2002).

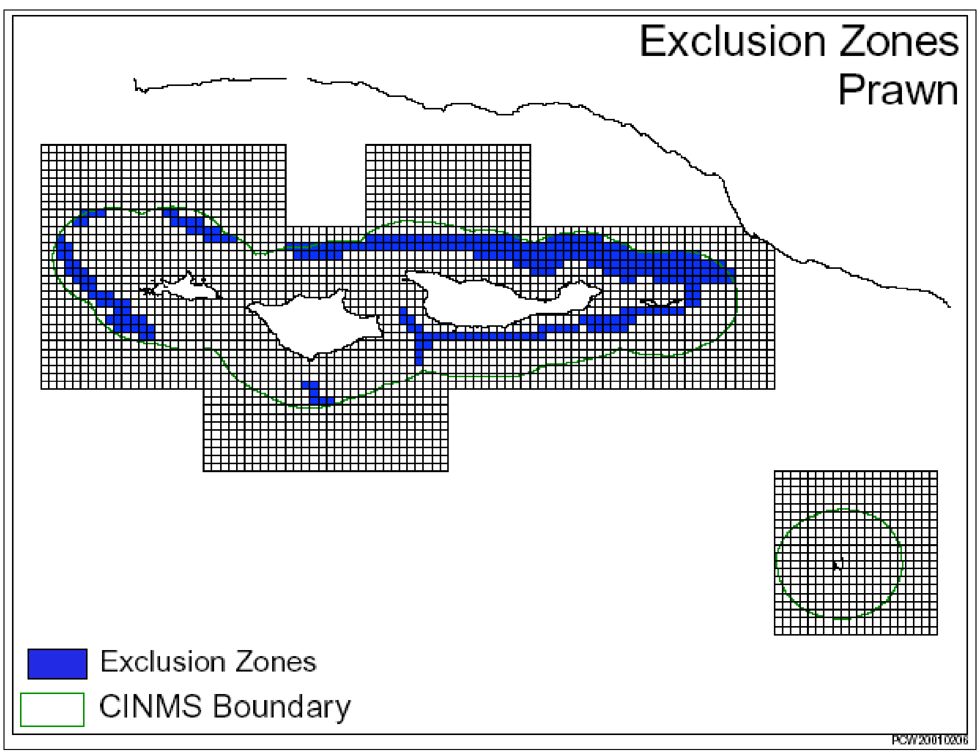

Figure 63. Areas in the Sanctuary preferred by prawn fishermen (Leeworthy & Wiley 2002).

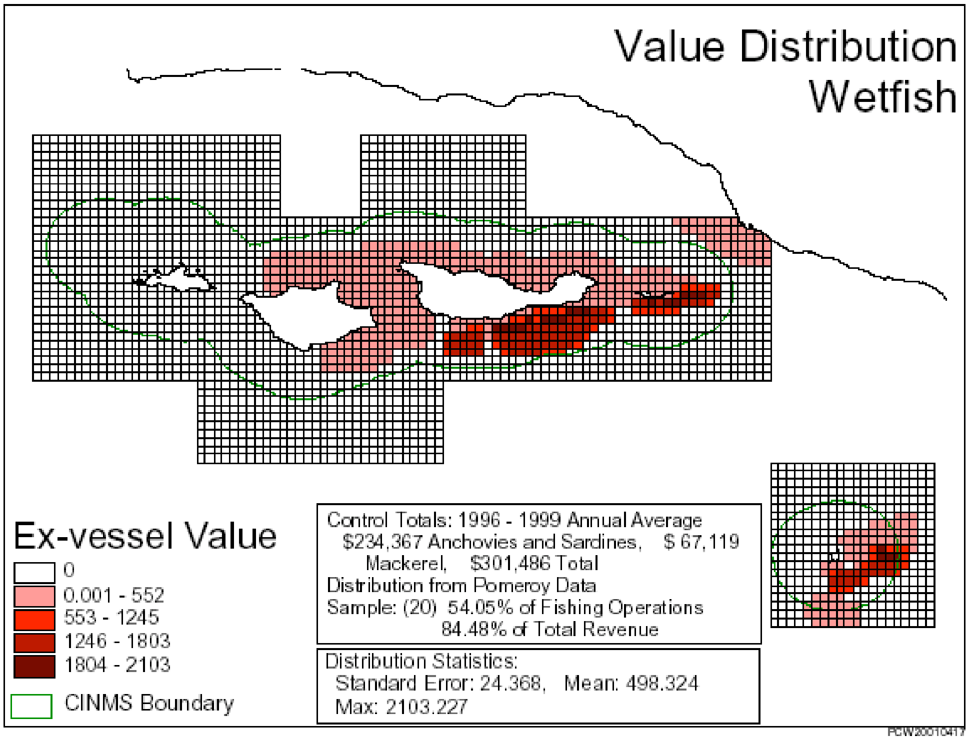

Figure 64. Average annual ex-vessel values for wetfish (Leeworthy & Wiley 2002).

Sport Fishing

Sport fishing and consumptive diving occurs from commercial passenger fishing vessels (CPFVs), charter boats (party boats), and private boats. Table 25 ranks the top 16 species/species groups according to the 2004 CPFV landings at the four Santa Barbara area ports combined (Point Hueneme, Oxnard, Ventura and Santa Barbara). As a group, rockfishes are taken in the largest numbers by the recreational fleet, followed distantly by barred sand bass, calico kelp bass, and ocean whitefish.

In the recent past, charter boat fishing and consumptive diving were especially concentrated around Anacapa and the Park-owned east end of Santa Cruz. The creation of the MPAs, and in particular the reserves at Anacapa and the Scorpion Reserve at Santa Cruz, excluded sport fishermen and consumptive divers from some of the areas most highly valued by them in recent years. Patterns of Park use by private fishing boats is distinct from that of the charter boats. The waters off San Miguel and Santa Rosa are more frequently visited by private fishing boats than by CPFVs.

Table 25. 2004 landings by CPFVs at Port Hueneme, Oxnard, Ventura, and Santa Barbara Harbors. Data are from the Annual Report of Statewide Fish Landings, Department of Fish & Game, Marine Region.

Species	Landings (numbers)
Rockfishes, unspecified	176,839
Rockfish, blue	21,446
Rockfish, copper	15,016
Rockfish, gopher	1,611
Rockfish, yelloweye	481
Rockfish, canary	194
Barred sand bass	51,327
Calico kelp bass	23,855
Ocean whitefish	23,195
California barracuda	6,352
Sanddab	3,239
Pacific bonito	3,132
Pacific mackerel	2,890
California sheephead	2,434
White sea bass	2,049
Yellowtail	390

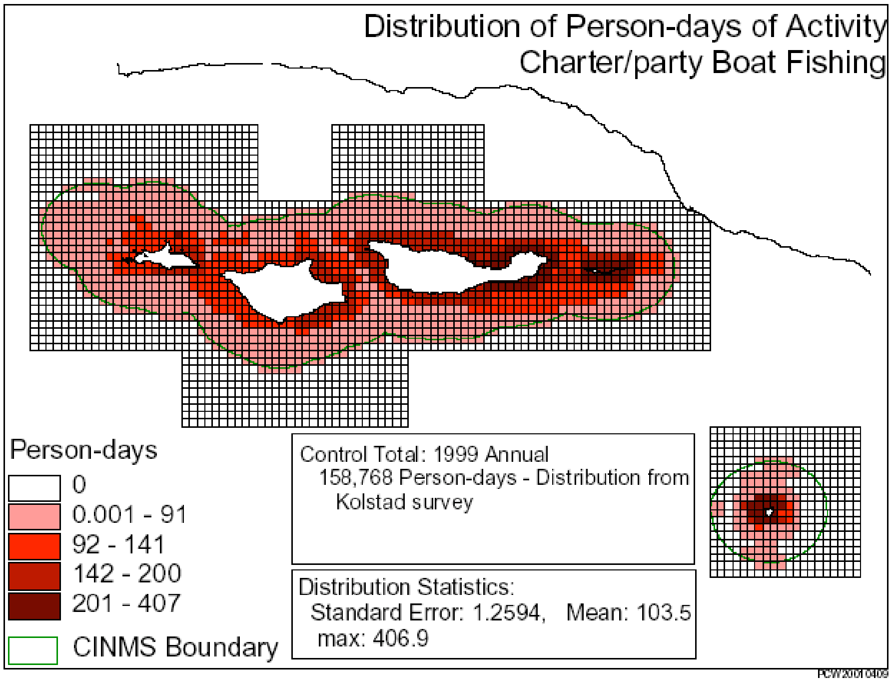

Figure 65. Spatial distribution of person-days of charter/party boat fishing in 1999 (Leeworthy & Wiley 2002).

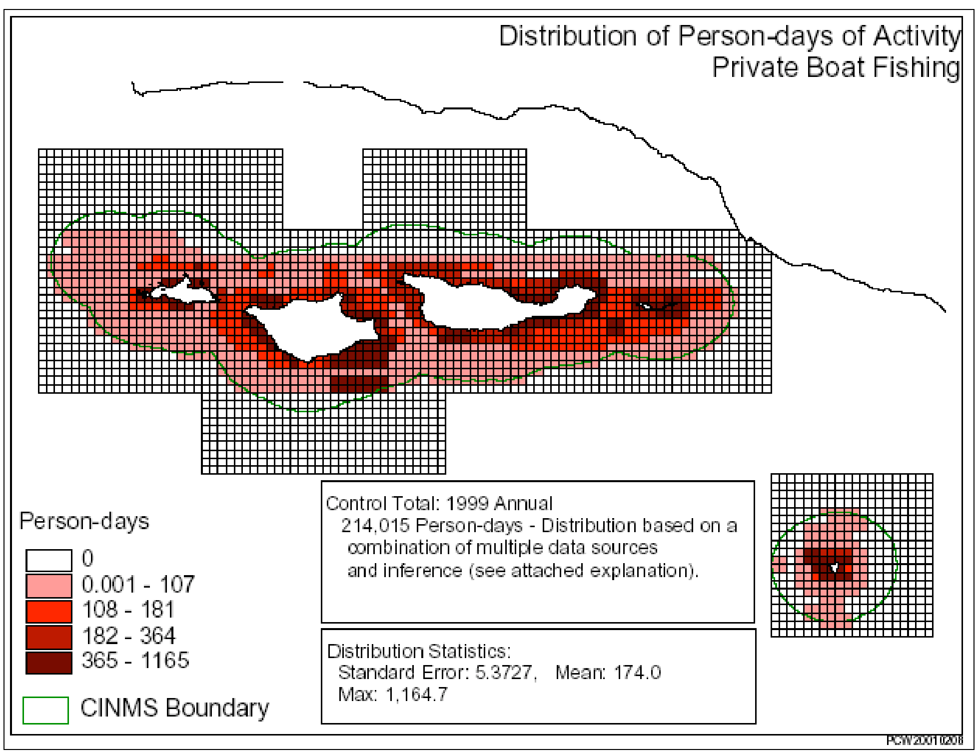

Figure 66 Spatial distribution of person-days of private boat fishing in 1999 (Leeworthy & Wiley 2002).

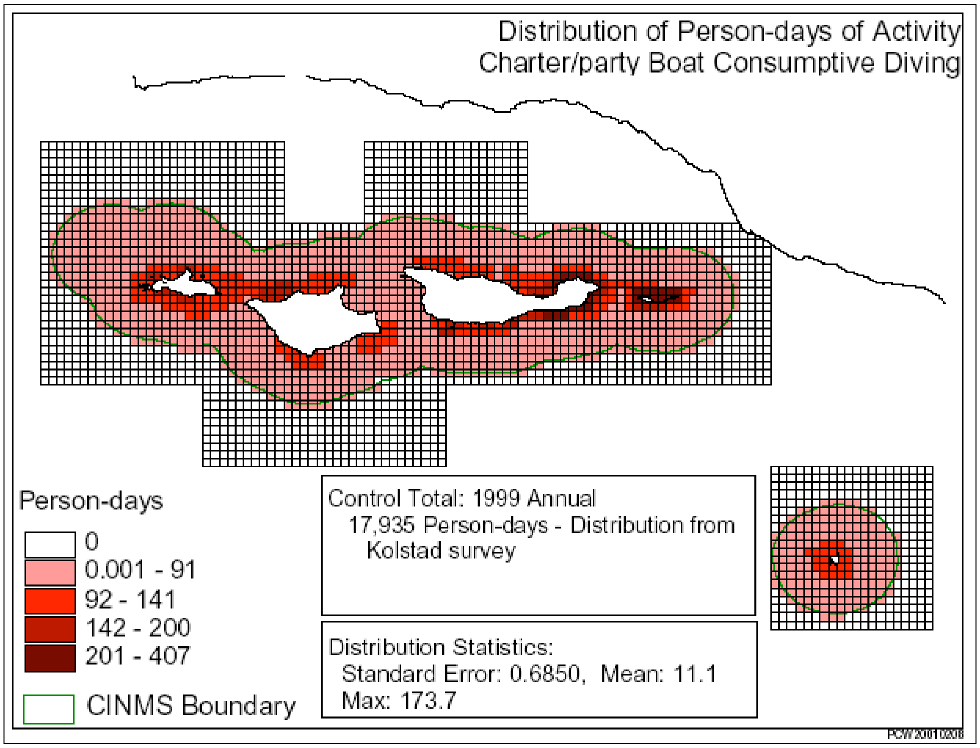

Figure 67. Spatial distribution of person-days of activity by charter/party boat consumptive diving (Leeworthy & Wiley 2002).

B.4. Harvesting of Plants

According to state law (CCR Title 14/Ch.4/Sect.30.10), no surfgrass or eelgrass may be cut or disturbed in California. There are 74 designated kelp beds in California which may be leased. Beds open to harvest by permitted companies exist around the entire perimeter of San Miguel, Santa Rosa and Anacapa, and about 75% of the coastline of Santa Cruz. Beds available for 20-year leases occur along ~25% the southwestern coast of Santa Cruz and entirely around Santa Barbara. In recent years ISP Alginates was the only company harvesting giant kelp in the Park, but their activity now (2005) is restricted to the San Diego area and they will soon be moving operations to Scotland (Dan Richards, Marine Biologist, Channel Islands National Park, pers. comm.). Figure 68 shows the spatial distribution of average annual revenue from kelp harvest in Park waters from 1996-1999. At least during these years, kelp harvest was concentrated around San Miguel and Santa Rosa (Figure 68).

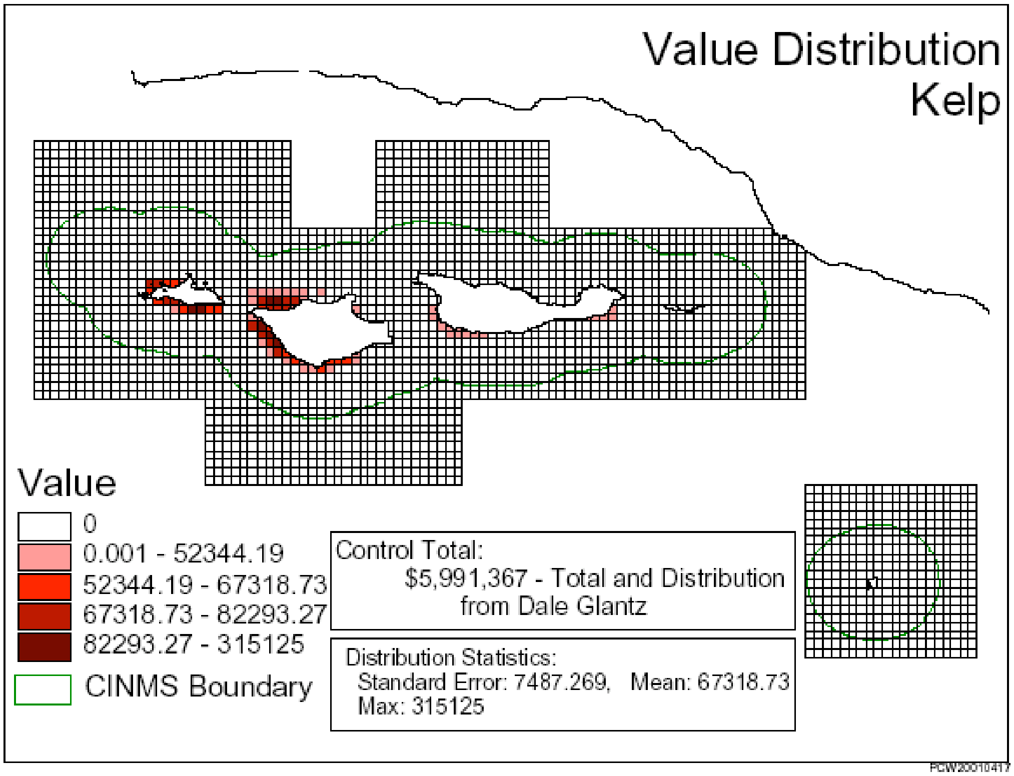

Figure 68. Spatial distribution of the average annual value of kelp harvested from Park waters (Leeworthy & Wiley 2002).

B.5. Pertinent Fishing Regulations

Sanctuary and Park waters belong to California's Commercial Fishing District #19 and the Southern Federal Groundfish Management Area. Many of the Park's nearshore fish are subject to management through the U.S. Pacific Coast Groundfish Fishery Management Plan (which pertains to all rockfish species and many sharks, skates, roundfish, and flatfish), and/or the California Nearshore Finfish Management Plan (which pertains to 19 species that frequent kelp beds and reefs in <120 ft of water, and includes 13 rockfish species). Although the Sanctuary and the Park are within state waters, California law concerning federally managed groundfish, coastal pelagic species, salmon, and highly migratory pelagic species must conform to the federal management plans for them.

A detailed explanation of fishing regulations for all species harvested within the Park is not provided here. Instead a tabular tool was created for this report (Appendix C) for all of the fish species reported from Park waters that are targets of commercial or sport fishing. In the table, fish are grouped according to (1) habitat (e.g., *Nearshore, Shelf, Pelagic*) and (2) taxonomic categories (e.g., *rockfish, groundfish, surfperch, flatfish*). References to on-line sources of information about species are provided, along with codes indicating which principal federal or state regulatory actions pertain to them. Finally, many details about fishing regulations (prohibitions, seasons, limits, gear restrictions, etc.) are provided in the table for each species/species group. Similarly, details about fishing regulations for commercially harvested invertebrates are included in the species table for Park invertebrates (Appendix B).

C. Nonconsumptive Use of Aquatic Resources

Nonconsumptive uses of aquatic resources in the Park include kayaking, whale watching, sailing, surfing, beach camping, and diving. Kayaking and private sightseeing by boat (e.g., sailboats) takes place mostly along the northern coast of Santa Cruz; off Santa Rosa in Becher's Bay, between Ford and South Pts., and between Carrington and Brockway Pts.; and off San Miguel from Cuyler Harbor to Cardwell Pt. (Figure 69). Whale watching is concentrated around Anacapa and from Carrington Point, on Santa Rosa, to Painted Cave on Santa Cruz (Figure 70).

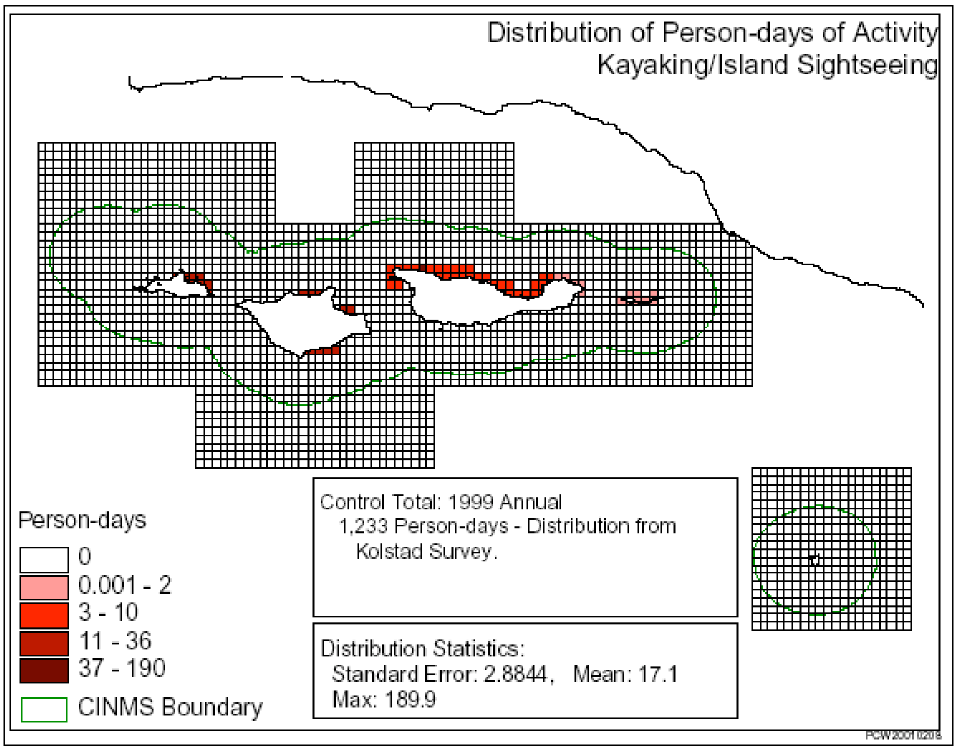

Figure 69. Spatial distribution of person-days of kayaking and island sightseeing in 1999 (Leeworthy & Wiley 2002).

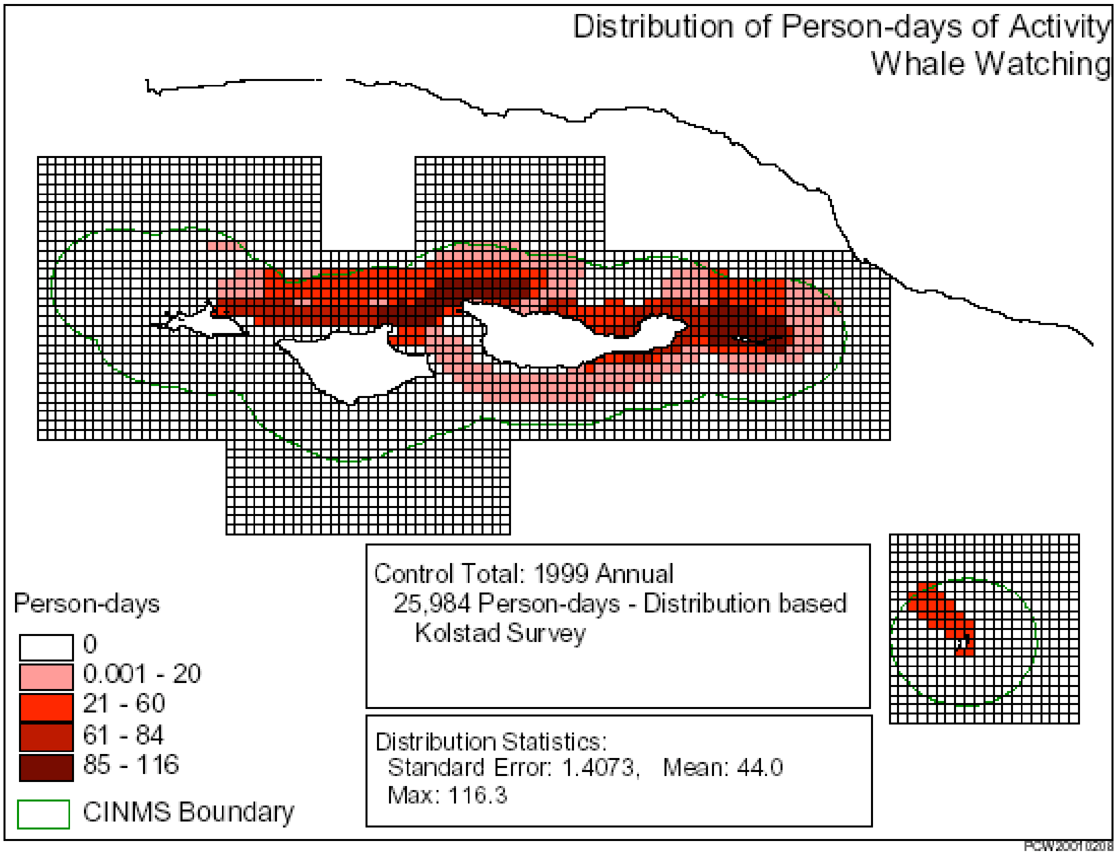

Figure 70. Spatial distribution of person-days of whale watching in 1999 (Leeworthy & Wiley 2002).

The Park protects important seabird and pinniped habitat through permanent and seasonal closures of certain trails, beaches, sea caves and sea cliffs. In addition, all access to offshore rocks and pinnacles is prohibited. For the most part, kayakers, hikers and campers comport themselves in a manner which does not threaten aquatic resources (Dan Richards, Marine Biologist, Channel Islands National Park, pers. comm.). During busy holiday weekends, illegal releases of sewage from private boats may be leading to short-term decreases in water quality in Park anchorages; high bacteria levels were measured on the Fourth of July weekend, 2005, in water at two anchorages at Santa Cruz (total coliform only-see Section II.C.7), and were presumably related to high numbers of private boats anchored there during the holiday weekend.

Examples of Park closures designed to protect aquatic life are listed below (obtained from the Park website).

Santa Barbara. Because the shoreline of Santa Barbara serves as a rookery and haulout for seals and sea lions, the shoreline, cliffs and beaches of Santa Barbara Island are closed to landing and public access except at the landing cove below the ranger station. Sections of trail may be temporarily closed on a seasonal basis to protect nesting California Brown Pelicans.

Anacapa. To protect nesting and roosting seabirds, several closures exist:

- On east Anacapa Island, the area east of a north/south line drawn 100 ft. west of the lighthouse is closed. The trail to the lighthouse is closed except with ranger escort.
- Middle Anacapa Island is closed, except for beaches.
- West Anacapa Island is closed except that boats may land at the beach at Frenchy's Cove.

Santa Cruz. Bat Cave is a dry sea cave where visitors would land on a beach and then walk into the cave. The cave is a nesting area for the endangered Xantus's murrelet in the spring. Beginning in July and August, the floor of the cave hosts the nests of storm petrels. There are more storm petrel nesting in this cave than in any other one place in world. For these reasons, Bat Cave and the Cavern Point Cave Complex are closed to entry.

Santa Rosa. The Sandy Point area is a substantial harbor seal and elephant seal refuge, consequently, it is closed to the public. This includes all beaches and land areas 300 ft. inland from 0.75 miles north from the Sandy Point benchmark to 0.85 miles south from the Sandy Point benchmark. In order to protect breeding and nesting snowy plovers, Skunk Point area of Santa Rosa Island, from March 1 to September 15, is accessible only by permit, from Sandy Point Ridge to the East Point Lagoon and 300 feet inland from the beach/grassland interface.

San Miguel. In order to protect the seal and sea lion rookery at Pt. Bennett, all areas west of the research station or west of a line drawn from Anubis Point to Ferrelo Point are closed to the public. San Miguel shoreline, cliffs and beaches are closed to landing except for the beach at Cuyler Harbor. The areas open to the public are the beach at Cuyler Harbor, Nidever Canyon trail, the Cabrillo Monument, campground, and the Lester Ranch site. A ranger escort is required outside these areas.

Sea Caves, generally. Because the ledges and cobble beaches inside dry sea caves are nesting habitat for seabirds. Visitors exploring sea caves by boat (including kayak or skiff) may not set foot ashore inside those caves.

D. Physical Impacts

Owing to its location within the Sanctuary, no alterations of the sea bed are allowed within the Park or within 6 nautical miles of island shores. At the time of this writing, the only planned changes to Park infrastructure that involve water bodies are:

1. Rebuilding the pier at Santa Rosa in Becher's Bay, near the mouth of Windmill Canyon.
2. Building new bridges at road crossings of Windmill and Cherry Creeks, near the ranger station at Becher's Bay.

Roads were built on Santa Cruz, Santa Rosa and San Miguel during the ranching era, and many either cross streams or are adjacent to them. These roads are unpaved, and many road sections are now entrenched, leading to gullying and sediment transport into some creeks (CINP 2002b). In response to the 1995 Clean-up or Abatement Order from the State (see Section II.C.3), restoration of abandoned sections of one of the main roads on Santa Rosa (the Smith "highway") was started in 2000; the reader is directed to CINP (2002b) for more detail. In July, 2002, an inventory of 46 road crossings of creek beds on Santa Rosa was undertaken. None of the crossings that still contained water at that time (8) had functional culverts, and most had tire ruts, some of which were severe and impeded stream flow. Road cut erosion was widespread, and at many crossings new channels were forming. The problems noted during this survey may be indicative of processes occurring on Santa Cruz, although no information was reviewed for this report about the condition of roads on Santa Cruz.

IV. CONCLUSIONS AND RECOMMENDATIONS

Below are brief summaries of (1) information gaps concerning water resources at the Park, (2) principal threats to freshwater and marine resources at the Park, and (3) recommendations for solving high priority information gaps. Table 26 categorizes the documented, and suspected, problems in the Park's aquatic systems.

A. WATER BODIES WITH UNDOCUMENTED STATUS

Streams. Numerous streams, temporary and permanent, occur on Santa Rosa, Santa Cruz, and to a lesser extent, on San Miguel. Aside from the monitoring of three streams on Santa Rosa for basic water quality parameters since 1993 (in Lobo, Quemada, and Old Ranch House Canyons), and one sampling of a stream on Santa Cruz in 1993, water quality in streams in the Park is virtually unstudied. Within-stream fauna and microflora are unstudied thoughout the Park.

Vernal pools. Vernal pools occur on Santa Cruz, Santa Rosa and San Miguel. Almost all of them are unmapped and poorly studied. Vernal pool invertebrates and water quality were last surveyed in twelve ponds on Santa Rosa in 1995, three years before cattle were removed from the island.

Coastal wetlands and lagoons. Small coastal wetlands occur at the mouths of numerous canyons on Santa Cruz and Santa Rosa, and in at least one canyon (Nidever Canyon) on San Miguel. Small wetland areas occur at the mouths of numerous streams on Santa Cruz and Santa Rosa Islands. The status of these sites can alternate from freshwater seeps; to impounded winter runoff with palustrine vegetation; to small, brackish or saline lagoons produced by wave overwash. Although emergent vegetation has been described for at least two of the palustrine wetlands on Santa Cruz (at Prisoner's Harbor and Scorpion Bay), aquatic fauna, microflora, water quality, and hydrology are undescribed at all of the coastal wetlands at Santa Cruz. Small, but persistent lagoons (produced by wave overwash) occur at at the mouths of Willows and Laguna Canyons, and at Christy Beach on Santa Cruz, and at six sites on Santa Rosa (at the mouths of Old Ranch, Old Ranch House, Water, La Jolla Vieja, and Arlington Canyons and Canada Tecelote). Two of the lagoons on Santa Rosa (Old Ranch, and Old Ranch House Lagoons), and one brackish wetland (Oat Point Wetland) have been monitored (water quality, invertebrate fauna, avifuana) on an annual basis since 1994. Other lagoons are unstudied.

Groundwater. Aside from bacterial counts from five wells at the Park (and presumably some water table information from a network of shallow wells installed at Prisoner's wetland in 2005), the condition of groundwater is unknown in the Park. Sources of groundwater contamination are lacking in the Park. The dramatic alteration of vegetation that occurred during the grazing era on the islands probably altered water yield in Park drainages, and possibly patterns of groundwater supply to springs and streams.

Seawater. Standard oceanographic parameters (salinity, transmissivity, nutrients, temperature) are routinely measured, and current speed and direction are continuously measured, at several sites around the islands. Concentrations of anthropogenic pollutants (organo-pesticides, PCBs, PAHs, trace metals, etc.) have not been measured in Park waters[19], although indirect evidence for their presence in the marine water column is provided by sentinel mussel data (see more below in recommendations). Bacterial counts have only been conducted in seawater a few times, in several anchorages at Anacapa and Santa Cruz.

B. Summary of Known or Potential Degradations of Freshwater Resources

Cattle, sheep, pigs, elk and deer

From water quality data and surveys of riparian vegetation and stream bed geomorphology, it is apparent that since the final removal of livestock from the island (cattle, in 1998), streams on Santa Rosa are recovering from past decades of use by sheep and cattle. However, a postulated lack of seed sources in many areas, and browsing of seedlings by the remaining elk and deer, are impeding the reestablishment of native woody riparian species (cottonwood and willow) on Santa Rosa. Although stream condition has not been formally studied on Santa Cruz, riparian vegetation and stream function were certainly altered there by decades of cattle and sheep grazing. Based on experience at Santa Rosa, a recovery process should be already be underway in streams on Santa Cruz. The ten years that transpired between the removal of cattle and sheep from the TNC-owned part of Santa Cruz (completed in 1988) and the final removal of feral sheep from the NPS-owned portion of Santa Cruz (completed in 1999) was enough time to produce a substantial difference in the rates of erosion and slope failures on the two parts of the island during torrential rains of the 1997/1998 El Niño. The removal of feral sheep from Santa Cruz has reportedly resulted in longer flows and deeper water in small estuaries on the southern side of the island. Because feral pigs have been present throughout Santa Cruz, and are just now being exterminated, it is not easy to distinguish their effects on stream habitat from the lingering effects of feral sheep. Consequently, it is not known how much stream habitat will benefit from the removal of feral pigs.

Owing to the facts that (1) cattle and feral sheep are now gone from all of the islands, (2) feral pigs are being eradicated now on Santa Cruz, (3) elk and deer are slated to be removed completely from Santa Rosa by 2011, and (4) even in the continuing presence of elk and deer, the streams on Santa Rosa have recovered substantially during the seven years without cattle, it is reasonable to expect that damaged streams on Park islands will continue to recover in several ways from the effects of introduced livestock without much human intervention. Basic water quality monitoring (temperature, DO, nutrients, etc.) of undocumented streams does not seem warranted. Transplantation of cottonwood and willow seedlings to stream reaches lacking mature specimens may be warranted on Santa Rosa, but seems impractical until the remaining elk and deer are removed. A survey of stream reaches may be warranted on Santa Cruz and Santa Rosa to identify reaches that would benefit from seedling transplantation.

Roads

From the available evidence from Santa Rosa, functioning culverts are lacking at many creek crossings in the Park, leading to deep tire ruts in stream beds, channel diversions, erosion, and stream flow interruption. A comprehensive survey of road crossings in the Park is not available.

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[19] Note: PISCO may have some measurements of trace metals in seawater at the islands from deployments of DGTs.

Currently, vehicles drive off-road across the floodplain at Scorpion Bay on Santa Cruz, and they may do so at other areas in the Park.

Physical alterations of watercourses

The lower stream courses and coastal wetlands at Prisoner's Harbor and Scorpion Bay on Santa Cruz were both substantially altered in the past by dredging, fill, and channelization. The Park is already considering the restoration of pre-settlement wetland geomorphology at Prisoner's wetland. In light of this potential undertaking, it seems prudent to gather baseline information about water flow, water quality, and aquatic biota in the existing remnant wetland at Prisoner's Harbor.

Non-native vegetation

Non-native tree species (*Eucalyptus* and olive) are colonizing riparian terraces in many stream reaches on Santa Cruz. It is unknown whether these trees have altered the water budget of affected streams. Invasive weeds (such as fennel) are widespread in canyon bottoms on Santa Cruz and Santa Rosa, as well as on hillsides. Many non-native plants have colonized the coastal wetlands at Scorpion Bay and Prisoners Harbor on Santa Cruz. A review of terrestrial vegetation was not conducted for this report, thus it is not known whether the other small coastal wetlands on Santa Cruz and Santa Rosa are similarly affected, or have even been surveyed. Introduced grasses were reported to surround many vernal pools on Santa Rosa in 1995.

C. Summary of Known or Potential Degradations of Marine Resources

Notable trends for marine taxa at the Park, and presumed causes (in parentheses), include:

- collapse of black abalone (overfishing and disease)
- same, for white abalone - a federally endangered species (overfishing)
- near disappearance of ochre sea stars, and declines in other sea stars, during recent El-Niños (bacteria-caused disease)
- elimination of eelgrass beds at Anacapa Island (feeding fronts of white urchins)
- declines in numbers of warty sea cucumbers (mostly commercial harvest)
- declines in harvestable sizes of red urchins (commercial harvest)
- purple urchin population explosions, creating urchin barrens (trophic cascade related to lobster fishing [more recently], and disappearance of sea otters [historically])
- appearance of a wasting disease affecting purple sea urchins (unnaturally high urchin densities)
- El-Niño related declines in extent of giant kelp (wave damage, higher temperatures, and lower nutrients)
- increasing numbers of typically more southern fish species (regime shift, beginning in 1977)
- decreases in primary productivity and zooplankton abundance (regime shift)
- declines in pelagic sea birds (regime shift)

- declines in commercial and recreational landings, and shifts in size structure, for many nearshore and shelf fish species (fishing pressure and regime shift)
- occasional sightings of previously locally extinct sea otters (numbers expected to increase since California Fish & Game Department ceased to relocate Park otters in 2001).
- ongoing recovery of breeding populations of California brown pelicans, peregrine falcons and bald eagles (reductions of DDT in the marine food chain)

<u>Storm plumes from the mainland</u>

Storm plumes resulting from winter rains potentially introduce a suite of contaminants, including bacteria, pesticides and herbicides, trace metals, DDTs, PCBs, and PAHs, into the coastal ocean near the Park. At least once a year, turbidity plumes covering about 20% of the surface of the Santa Barbara channel are produced by outflow from the Santa Clara River near Ventura and other smaller coastal drainages. Rain events with 2-year return intervals can produce jets of freshened surface water extending ~10 km from the mainland shore. Less frequent, larger storms (~10-year events) can produce turbidity plumes extending ~30 km into the Channel. However, analysis of several years of salinity data from stations spanning the Santa Barbara Channel, and from several locations near the Park islands, reveals that only during extraordinary rains (≥ 25-year events), such as occurred during the 2004/2005 winter, does mainland runoff dilute the surface ocean all the way across the Channel to Anacapa, Santa Cruz or Santa Rosa Islands. Long time series of satellite data from the vicinity of Los Angeles indicate that storm plumes entering Santa Monica Bay or the San Pedro Shelf are very unlikely to ever reach Park waters surrounding Santa Barbara Island. Acute toxicity in storm plumes in Santa Monica Bay appears to be restricted to portions of plumes containing at least 10% terrestrial runoff, a value which confines toxicity to within a few km of the mainland coast during runoff events in most circumstances. Whether the eventual advection of some fraction of fine particulates from mainland runoff to the Park, and subsequent settling there, contributes to background levels of contaminants in Park sediments is unknown. Based on available evidence, this route of contamination is probably very minor. In the Bight, sediments directly offshore from stormwater discharge sites along the mainland coast contain more cadmium, chromium, copper, lead and zinc than sediments further away, however only copper is *significantly* higher in sediments near these discharge points than away from them. Settling of particulates at stormwater discharge points is not currently producing DDT or PCB hotspots in sediments along the mainland coast.

<u>Contaminated sediments</u>

Sediments at most sites within the Santa Barbara Channel, contain concentrations of trace metals and organic contaminants that, in most cases, are below background levels for the Bight as a whole. Silver, nickel, zinc, lead, copper and chromium are considered anthropogenically enriched at a only few sites in the Channel which lay shoreward of the northern 200 m isobath in the Channel (thus close to the mainland coast). Interestingly, cadmium, nickel, and DDTs have been found in sediments at Channel Islands sites at concentrations that exceed the NOAA's ERLs for those constituents. However, of 25 sites sampled near Park islands, sediment was found to be moderately toxic to amphipods at only 1 site, near the 200 m isobath north of Santa Rosa (outside of Park boundaries). However, sediments near the mainland, especially off the Palos Verdes Peninsula (a notorious site of DDT and PCB contamination), Los Angeles Harbor, and Santa Monica Bay, are enriched with heavy metals, PAHs, DDTs, PCBs, and other synthetic organics. In addition, between 1947-1961, DDT-laced sludge was deposited in barrels onto the sea floor near Catalina Island (albeit in very deep water). Active dredge disposal sites in the Los Angeles/Long Beach are accumulating heavy metals, PCBs and PAHs. Chemical munitions, low-level radioactive waste, and explosives are among the materials that may also have been dumped in the ocean in past decades in the region. For many decades, DDT from sources outside the Park has entered the Park food web, and accumulated in avifauna and pinnipeds that use Park habitat. DDT-related damage to Park avifauna is diminishing over time, and breeding populations of California brown pelicans, bald eagles, and peregrine falcons are recovering at the Park. However, sport fish in the Los Angeles area (including rockfish, and other species that are prey for Park piscivores) remain sufficiently contaminated with DDTs and PCBs that limited consumption, or no consumption, by humans is advised by the State for many species. As recently as 2002, p,p'-DDE body burdens in female sea lions breeding at San Miguel were high enough to indicate that they obtain fish from the Palos Verdes shelf and Santa Monica Bay. The indirect transfer of harmful substances to the Park through seabirds and pinnipeds that consume contaminated fish at other sites continues to link the Park with contaminated sediments in the region.

<u>Offshore oil industry</u>

Of the 19 active oil platforms in the Santa Barabara Channel, Platforms Gail and Gina are the closest to the Park. Each is located approximately one nautical mile outside the boundary of the Sanctuary to the north of Anacapa. This locates them at least 6 nautical miles away from the marine boundary of the Park surrounding Anacapa. Produced water from oil platforms introduces heavy metals, PAHs, cyanides and organosulfur compounds (but not PCBs or DDTs) into the local environment. Based on dilution rates, and other evidence to date, produced water released at oil platforms results in sublethal harmful effects for a variety of invertebrates (larvae of bryozoans, ascidians and sea stars; sea urchins; mussels) up to 1 km from discharge points. The oil platforms are far enough away from the Park to ensure that produced water is not a direct threat to biota contained within Park boundaries.

Serving as artificial reefs and de-facto fishing reserves, oil platforms are often sites of extremely high densities of epibiota and fish (especially rockfish). Foraging at platforms by Park seabirds or pinnipeds may be a route by which metals and other contaminants from oil operations are transferred to Park habitat. The only report of body burdens found in this study for platform biota in the Channel was from the 1970s, which showed that concentrations of hexane-extractable materials, volatile solids, cadmium, chromium, copper, lead, molybdenum, nickel, silver, vanadium, and zinc, were not anomalously high (compared to control sites) in rockfish, crabs and mussels at two of the Channel platforms (Hilda and Hazel), with the exception of higher, but non-toxic, levels of vanadium in rockfishes. Hydrocarbons were not detected in mussels or crabs.

New measurements of trace metal body burdens in rockfish from area oil platforms should be available from researchers at UCSB sometime in 2006. These results should be evaluated to see whether the potential consumption of fish at oil platforms by Park piscivores should be of concern to Park managers. In addition, arrangements should be sought through the MMS, or NOAA, to survey epibiota (i.e., mussels) growing on oil platforms for a suite of trace elements and organic compounds. Unfortunately, commercial harvesters of mussels at area platforms are not required to analyze mussel tissue for any contaminants other than bacteria and paralytic shell-fish toxin.

Drilling muds and cuttings are not produced during the extraction of oil and gas, but there is evidence that drilling solids can disperse almost 7 km away from the debris mounds created at the platforms during drilling operations. This implies that some of the heavy metals and hydrocarbons in drilling wastes deposited at the platforms closest to the Park (Gail, Gina, Gilda and Grace) could have been advected to the benthic habitat surrounding Anacapa Island.

Intertidal habitat, sea birds and pinnipeds at Anacapa and Santa Cruz were directly impacted by the 80,000-barrel Santa Barbara Oil Spill of 1969, although birds were the only vertebrates killed by the oil slicks. Since 1969, there have been 843 small oil spills off southern California. Only one spill resulted in documented seabird mortality: the 163-barrel Platform Irene pipeline spill off Point Arguello in 1997, which resulted in the loss of more than 700 birds. Although the another large oil spill could happen again in the Santa Barbara Channel, it is worth observing that the largest natural oil seep in the area (Coal Oil Point seep field) naturally releases more than 100 barrels of oil per day into the coastal ocean near Santa Barbara, with no apparent ill effects to sea birds or marine mammals that use the affected area. Apparently, birds and mammals are able to avoid the natural slicks, which can extend up to 15 km in the crossshore direction and up to 50 km in the alongshore direction.

Marine Vessels

The only marine vessel traffic that *directly* impacts Park waters are privately-owned recreational fishing boats, charter boats (CPFVs), commercial fishing vessels, sailboats, whale watching and other sight-seeing boats, NPS and other agency boats, research vessels, and boats transporting visitors and staff to Park islands. These smaller vessels potentially release bilge water, fishing debris, untreated sewage, spilled fuel, and trash into Park waters. Ballast water, black and gray water, and other hazardous wastes are potentially discharged from container and other cargo ships, and cruise ships (the latter are infrequent) that use the international shipping lane that runs through the Channel, although now most of these discharges would be illegal if they occurred in state water. Dryfall of particulates from diesel exhaust may introduce metals and PAHs into the water column of the Park. The molecular signature of PAHs might reveal whether combustion byproducts (such as from diesel exhaust) are contributing to PAH levels in Park water, sediment or biota. For example, the relative importance of petrogenic PAHs versus pyrogenic PAHs could be compared in substrates (i.e., mussels, water, or sediments) at sites in the Park closest to the shipping lane (or in the prevailing lee of ship exhaust plumes) versus near natural oil seeps at the islands (e.g., Fraser Point) or other potential localized chronic sources of PAHs, such as creosote impregnated pilings at the pier at Anacapa (a petrogenic source)[20], or consistently crowded anchorages where small craft may be releasing fuel or oil.

Pinnipeds and sea birds as conduits for anthropogenic pollution

Although other avenues of entry are not ruled out by the information in this report, it seems highly likely that the pinnipeds and piscivorous seabirds that feed on contaminated fish outside the Park (and the Sanctuary), and then return to roost, haul-out, or breed, on Park islands are

[20]Leaching of creosote from submerged pilings results in PAHs with petrogenic signatures. There are only a few locations in the Park where creosote-impregnated pilings occur: (1) at the Santa Barbara pier (affected pilings are 20 years old and out of the water, (2) at Anacapa pier (affected pilings are over 20 years old, and are both in and out of the water, (3) at Santa Rosa pier (creosote is out of the water). Park staff are not sure whether any creosote pilings remain at Santa Cruz; an old pier at Prisoner's Harbor did have them, but was replaced a few years ago (Kate Faulkner, Chief of Natural Resources, Channel Islands National Park, pers. comm.).

contaminating other marine ecosystem compartments at the Channel Islands. The wide array of organo-pesticides, other synthetic organics, PAHs, and trace elements that are detected in Park mussels (many at high levels from the state and national perspective) bears evidence that pollutants without sources near the Park (and in some cases, without sources in most of the Channel) are entering the water column of the Park. Indeed, transfer of DDTs and PCBs to the Park via pinnipeds and piscivorous sea birds foraging elsewhere is one of the *only* routes by which these particular organic compounds can enter the the Park itself. DDT has accumulated in Park sediment sufficiently to exceed NOAA's ERL threshold in 34% of sites sampled at the Channel Islands by SCCWRP during Bight '03 (2003). In a 25-year old evaluation of sentinel mussel data, marine bird and pinniped colonies (including at Point Bennett on San Miguel) were invoked as the cause of mercury hot-spots that were remote from other sources of pollution on the Pacific coast (Flegal et al. 1981). Except for this study and a few measurements of DDE or PCBs in milk and blubber of sea lions at the Park, this avenue for water pollution at the Park appears to be unstudied.

<u>Natural shifts in oceanic conditions</u>

Although they are natural events, short-term shifts (El Niños, 1-2 years) and longer term shifts (multiple decades) in oceanic conditions strongly influence marine biota at the Channel Islands. El Niño conditions lead to significant losses of giant kelp for two main reasons: (1) higher temperatures and lower nutrient concentrations produced by intrusions of water masses from the South cause a deterioration in kelp growth rates, and (2) swell during powerful winter storms physically detaches and tears kelp plants. Increased frequency of El Niño events appears nested inside a recent longer-term shift in oceanographic conditions in the Bight, referred to as a *regime shift*. The current regime shift, which is believed to have begun in 1977, has produced warmer than average ocean temperatures (about 1°C) in the Bight. The regime shift is correlated with several key community changes documented at the Channel Islands during the 1980s and 1990s, including increased numbers of southern species at Santa Rosa and San Miguel, advection of typically tropical species into the Channel (such as albacore, barracuda, dorado, yellowfin tuna, marlin and triggerfish), decreases in primary productivity and macro- and micro-zooplankton abundance, decreases in nearshore fishes and invertebrates, declines in commercial fish landings, declines in pelagic sea bird numbers, invertebrate "disease" epidemics, and sea urchin overgrazing phenomena. For example, as recently as 1999, 11 of the Park's 16 kelp monitoring sites were dominated by sea urchins, or were urchin barrens.

<u>Fishing</u>

Recreational and commercial fishing is allowed by the State in Park waters, except in the areas included in the SMRs. The nearshore waters surrounding the islands, and especially the nearshore kelp beds, are especially well-exploited for market squid (by purse seine and lampara boats), sea urchins (by divers), sea cucumber (in the Park, by divers), spiny lobster (by traps), red rock crab (by traps), and nearshore finfish, especially rockfish spp. (*Sebastes*), and California sheephead (by hook and line, and live traps). Coastal pelagic species (such as anchovy, sardine, mackerel, and tuna), flatfish, and prawn are commercially important in the Sanctuary, but account for a smaller proportion of commercial harvest within Park waters. Several kinds of commercial fishing gear are prohibited within 1 nautical mile, or 3 nautical miles, of Park islands, such as trawls, and set- or drift-gill nets. Additionally, the numbers of hooks allowed per vessel is restricted in the nearshore finfish fishery, and a limited number of live-fish trap permits are issued in the nearshore fishery. Recreational fishing in Park waters (via hook and line, and diving) primarily targets rockfish, barred sand bass, calico kelp bass, ocean whitefish, lobster, and scallops.

Fishing is implicated in the regional declines, in many cases starting in the 1970s, in the stocks of many fish and invertebrates that are harvested within Park waters. Commercial stocks that have declined include several rockfish species (especially shelf rockfish spp.), lingcod, Pacific whiting, giant sea bass, pelagic sharks, spiny lobster, spot prawn, abalone, warty cucumber, red sea urchin. Commercial harvest of several Park species is closed in California, including uncultivated rock scallops, Pismo clams, all abalone, giant sea bass, California corbina, spotfin croaker, yellowfin croaker, kelp bass, barred sand bass, spotted sand bass, garibaldi, wolf eel, blacktip poacher, pygmy poacher, bluespotted poacher, ocean sunfish, great white shark, basking shark, and striped marlin. Recreational fishing dominates the take of many nearshore species (such as California scorpionfish, kelp greenlings, treefish, and calico, blue, olive, and kelp rockfishes); recreational landings of nearshore species declined by at least 65% between the 1980s and the 1990s.

The establishment, in 2003, of twelve no-fishing (and limited fishing) reserves that contain Park waters creates a new opportunity to differentiate between fishing pressure and natural stressors (such as regime shift, El Niños, and disease) as the causes of recent declines of many fish and invertebrates that occupy Park habitat. In addition, the reserves provide an avenue for investigating indirect impacts of fishing on community structure (such as through trophic cascades). The long record of data from the Park intertidal and kelp forest monitoring programs provides a good basis for such "before and after" studies. The Park has added 16 sites to its kelp forest monitoring program to better compare biological trends inside versus outside the SMRs. So far, comparison of monitoring data from inside versus outside protected areas at the Park has revealed that (1) spiny lobsters, as natural predators of sea urchins, reduce the incidence of urchin barrens at rocky reefs inside fishing refugia; (2) harvest of lobsters indirectly increases epidemics in sea urchins; and (3) the commercial dive fishery is responsible for 33-83% of the populations decline in sea cucumbers at the Park in recent years.

Exotic species

To the knowledge of the NPS, marine habitat at the Park has not been colonized by invasive seaweeds or other problematic exotic marine species. Because the invasive kelp *Undaria pinnatifida* has been found at Santa Barbara Harbor and Catalina Island, and has been seen on a boat that visited Park waters, this species poses a risk to the Park. Drift Arundo occasionally washes up and spouts on Park beaches (but is removed when discovered); vigilance is required to prevent Arundo from colonizing Park drainages and wetlands.

Disease

Several Park invertebrate species are experiencing regional declines, in some cases severe, from diseases. Withering syndrome has reulted in nearly complete disappearance of black abalone since the mid-1980s along mainland shores south of Point Conception and at many of the Channel Islands. A number of sea star species, including *Pisaster ochraceus* (ochre sea stars), *P. giganteus*, and *Asterina miniata*, have been struck by wasting diseases in the Park, usually associated with strong El Niños, such as in 1997. A warm-water bacterium in the genus *Vibrio* is blamed for the ochre sea star disease. An urchin-specific bacterial disease entered the Channel Islands region after 1992 and has acted since then as a density-dependent mortality source. Regime shift, and trophic cascades caused by fishing pressure on predators (leading to extremely dense urchin populations), are among the hypothesized causes of disease emergence in the region.

Absence of a keystone mammalian predator

Once common at the Channel Islands, the federally endangered southern sea otter (*Enhydra lutris nereis*) was hunted to local extinction by the end of the 1800's. As predators of sea urchins, their absence is hypothesized as one of the factors allowing for localized population explosions of sea urchins, and consequently the formation of urchin barrens in habitat that normally supports kelp forest. Now, a few sea otters are spotted in the Park. From 1987-2001, USFWS caught and relocated all sea otters that appeared south of a line drawn from Pt. Conception to San Miguel Island. Relocation areas were near the city of Santa Cruz and Moss Landing to the north, and San Nicolas Island to the south. This activity was part of a political compromise designed to placate commercial fishermen of crab, urchins and lobsters in the Santa Barbara area, who were competing with the otters for crab, urchins and lobsters. On October 5, 2005, the USFWS announced its intent to end the relocation program and to allow sea otters to recolonize the Southern California coast at a natural rate. As a result, although sea otters have been essentially absent from the Park for almost a century, it is reasonable to expect that they will begin to recolonize the Channel Islands at some point in the future.

Non-consumptive use of aquatic resources

Nonconsumptive use of aquatic resources in the Park include kayaking, whale watching, sailing, surfing, beach camping, and diving. Kayaking and private sightseeing by boat takes place mostly along the northern coast of Santa Cruz; off Santa Rosa in Becher's Bay, between Ford and South Pts., and between Carrington and Brockway Pts.; and off San Miguel from Cuyler Harbor to Cardwell Pt.. Whale watching is concentrated around Anacapa and from Carrington Point, on Santa Rosa, to Painted Cave on Santa Cruz. The Park protects important seabird and pinniped habitat through permanent and seasonal closures of certain trails, beaches, sea caves and sea cliffs. In addition, all access to offshore rocks and pinnacles is prohibited. Limited opportunities for primitive camping and hiking occur on all five Park islands. According to Park staff, kayakers, hikers and campers generally comport themselves in a manner which does not impair aquatic resources. During busy holiday weekends, illegal releases of sewage from private boats may be leading to short-term decreases in water quality in Park anchorages; high bacteria levels were measured on the Fourth of July weekend, 2005, in water at two anchorages at Santa Cruz, and were presumably related to high numbers of private boats anchored there during the holiday weekend.

Table 26. Existing and hypothesized degradations of aquatic resources at Channel Islands National Park. Codes are as follows:
EP - existing problem based on direct evidence; PP - potential and likely problem; OK - not currently, or expected to be, a problem;
Shaded - evidence is lacking, limited, or indirect; ? - not enough information available to categorize threat level; blank - not applicable

	Streams/Riparian Habitat			Vernal Pools			Coastal wetlands		Lagoons		Ground-water	Rocky inter-tidal	Subtidal, Reefs, & Kelp	Seabirds, Pinnipeds
Stressor	S.Mig.	S.Rosa	S.Cruz	S.Mig.	S.Rosa	S.Cruz	S.Rosa	S.Cruz	S.Rosa	S.Cruz				
Water Quality														
high N & P	OK	OK	PP	?	?	?	OK	?	OK	OK	?			
Low DO	OK	OK	OK	OK	OK	OK	?	?	OK	OK				
Turbidity	?	EP	PP	PP	PP	PP	?	?	OK	OK				
Water Quantity														
Altered depth/duration of flow	PP	PP	PP	?	?	?	PP	PP	OK	OK	?			
Pollutants														
Fecal bacteria	OK	OK	PP	OK	OK	PP	OK	PP	OK	PP	OK	OK	EP[1]	
Heavy metals/trace elements	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	EP	PP	PP
Pesticides & other organics	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	EP	PP	EP
Physical Disturbance														
Feral pigs (rooting)			EP			PP		PP		PP				
Lingering effects of past cattle & sheep	PP	EP	EP	PP	EP	PP	PP	EP	PP	PP				
Dredging/fill			EP					EP						
Road crossings	OK	EP	EP				EP	EP						
Watershed erosion	PP	EP	EP				EP	EP	EP					
Other														
Non-native flora or algae	PP	EP	EP	PP	EP	PP	PP	EP	PP	PP		PP	OK	
Elk & deer browsing		EP			PP		PP		PP					
Fishing - Direct												PP	EP	
Fishing - Indirect												PP	EP	EP[3]
El Niños	PP[2]	PP[2]	EP[2]				PP[2]	PP[2]				PP	EP	EP
Regime Shift												PP	EP	EP
Absence of sea otters													EP	
Disease												EP	EP	OK

[1]Refers to bacterial contamination at anchorages
[2]Refers to El Niño related floods, erosion, and landslides
[3]Refers to disruption of nocturnal seabird activity from squid boats (although ingestion of hooks and entanglement with gear is applicable, but not addressed in this report)

D. RECOMMENDATIONS FOR ADDRESSING INFORMATION GAPS

Below, steps are suggested to address many of the information gaps identified in this study. Priority is given to investigation of known or hypothesized anthropogenic influences; studies are not described for all of the undocumented features of the Park's water bodies listed at the beginning of this section. Omitted are studies about the consequences of natural phenomena (such as regime shift and El Niño) on aquatic resources at the Park, which are not mitigable. Recommendations are assigned the letters H, M, or L to indicate high, medium, or low priority, respectively.

1. Continuation of all aspects of the Park's existing monitoring programs is highly recommended (H).

2. Digitally map the coastal wetlands and lagoons in the Park (L). With the exception of the lagoons that are monitored on Santa Rosa, the locations of the Park's coastal wetlands and lagoons are not in the Park's GIS. The areal extent of wetlands and lagoons is unmapped.

3. Rigorously monitor beaches, coastal wetlands and stream mouths for recruitment of highly invasive exotic plant species that directly affect aquatic habitat, such as Arundo (H).

4. Discover the post-grazing status of vernal pools on Santa Rosa (L). Resurvey the twelve vernal pools visited by L. Furlong on Santa Rosa in 1995. In addition, it seems prudent to map the locations of all vernal pools on Santa Cruz, Santa Rosa and San Miguel for inclusion in the Park GIS. Vernal pools on Santa Cruz may have been impacted by feral pigs, and should be compared to those on Santa Rosa.

5. Evaluate stream function and riparian zone condition on Santa Cruz (H). Feral sheep have been absent from the TNC-owned portion of Santa Cruz for about 10 years longer than on the NPS-owned portion of the island. A study of riparian zone condition and stream function (such as was conducted on Santa Rosa in 1995 and 2002) in strategically selected watersheds on the island may clarify expectations for future changes in Park streams as watersheds and riparian zones (presumably) continue to recover from the effects of sheep grazing. In light of planned restoration work at Prisoner's wetland, inclusion of the stream in Cañada del Puerto in such a study is a priority. In addition, the study would provide baseline information for detecting changes that may result from the removal of feral pigs, which have been present throughout the island, and which are being eliminated as of this writing.

6. Prepare a strategy for enhancing recovery of native woody riparian vegetation on Santa Rosa and Santa Cruz (the latter, if warranted by the results of #5 above) (M). The feasibility of transplanting willow and cottonwood seedlings to stream reaches that no longer host mature specimens should be evaluated. A first step would be to map remaining stands of mature trees on both islands for inclusion in the Park GIS.

7. Expand baseline data in anticipation of restoration work at Prisoner's wetland and in its watershed, Cañada del Puerto (M). Some features of the altered wetland at Prisoner's Harbor were recently described (soil profiles, vegetation, shallow wells installed). To this information should be added baseline data about the volume of flow in the stream that enters the wetland, and water quality and aquatic fauna in the currently existing wetland. A hydrologic study utilizing shallow groundwater wells above and below selected stream reaches containing *Eucalyptus* stands in Cañada del Puerto would contribute to understanding the ecological impact of these non-native trees on water flow in streams and coastal wetlands in the Park.

8. Conduct a thorough survey of road crossings of water courses (H). Armed with a GPS and a digital camera, road crossings of streams and wetlands on Santa Rosa and Santa Cruz could be surveyed and entered into the Park GIS. Locations for culvert construction, or other mitigation steps, could be prioritized. It may be possible to compare the current and past status of some road crossings using archived photos in the possession of the Park.

9. Better exploit sentinel mussels to map spatial variation and temporal changes in seawater contamination in the Park (H). The last time sentinel mussels were sampled at each of the Park islands is as follows:

San Miguel: west island 1978, Tyler Bight, 1988
Santa Rosa: never
Santa Cruz: Fraser Point, 2002
Anacapa: 1980
Santa Barbara: 1978

Both of the times that mussels from San Miguel were analyzed, levels of total DDT and two or more trace elements exceeded the national 85th percentiles for those constituents. The single time mussels from Santa Barbara were analyzed, four trace metals that can be toxic to marine biota (cadmium, lead, silver, and zinc) were present at levels that exceeded the national 85th percentiles for them.

The only time series of body burdens available for Park mussels is from Fraser Point, on Santa Cruz, which is not near breeding colonies, or other especially large congregations, of pinnipeds or seabirds (which may be one of the most significant entry points in the Park for mainland-derived contaminants). This time series does not provide clear evidence for a steady decline in total DDT in mussels at Fraser Point since 1977. Total DDT in mussels at Fraser Point was above the national 85th percentile as recently as 1996. NOAA (which surveys mussels every 2 years) should be approached about restarting mussel sampling at San Miguel, Santa Rosa, Anacapa and Santa Barbara Islands.

10. Compare sediment loads of priority contaminants at sites within the Park reflecting different chronic exposure levels to potential sources of pollutants such as ship traffic, mainland runoff, and seabird and pinniped colonies (M for most sites, H for seabird and pinniped colonies). Lobby for inclusion of more nearshore sediment sampling sites at the Channel Islands during Bight '07. SCCRWP has sampled sediment for toxicity and chemistry at numerous locations in the Sanctuary during its Bight surveys, but few sites are located within Park boundaries and previous sites are not well located to investigate spatial trends of contamination that may be associated with some of the sources identified in this report.

11. Measure pollutants in the water column at the Park using moorable, passive in-situ exposure samplers (H). Body burdens in sentinel mussels at the Park prove that within the last decade (and as recently as 2002 in some cases) the following constituents (at a minimum) resided at least part time in the water column at the Park:

Trace elements: Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Se, Zn
Organics: alphachlordane

transnonachlor
heptachlor, heptachlor-epoxide
DDT, DDD, DDE
PAHs (any of:1,6,7-trimethylnaphthalene, 1-methylnaphthalene, 2,6-dimehtylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(k)fluoranthene, benzanthracene, benzo(g,h,i)perylene, benzo-a-pyrene, benzo-b-pyrene, benzo-e-pyrene, benzo-k-flouranthene, biphenyl, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, perylene, phenanthrene, pyrene)
PCBs
aldrin
dieldrin
organotin
chlorpyrifos
cis-nonachlor
gamma chlordane
chrysene
dibenzothiophene
endosulfan
fluorene
alpha, beta and delta HCH
lindane
hexachlorobenzene
mirex
naphthalene
oxychlordane
pentachloroanisole
tetrachlorobenzene

Concentrations of selected organics and trace elements should be compared in areas at the islands with and without aggregations of seabirds and pinnipeds, and in areas that are differentially exposed to other potential sources such as from the shipping lane, or mainland runoff.

Synoptic studies of water quality using towed or ship-board instruments would be expensive and would require collaborators with research vessels and sophisticated equipment. Filtration methods can require processing as much as 2500 L to achieve detection for organic constituents and trace elements in seawater (e.g., Zeng et al. 2002). Other options for real-time measurements exist. For example, real-time ship-board measurements of trace metals in seawater were achieved by Esser & Volpe (2002) using separation chemistry with inductively coupled plasma mass spectrometry. The U.S. Navy employs a real-time data acquisition system dubbed MESC for synoptic surveys in San Diego Bay. The MESC includes a towed sensor package and on-board equipment that measures dissolved copper (using potentiometric stripping analysis) and PAH (using uv-fluorescence).

The most practical way to directly measure trace metals and organics in seawater at the Park might be to deploy (i.e., moor) passive *in-situ* exposure samplers which integrate background levels in the water column over weeks or months. These techniques were not reviewed for this report. In-situ exposure techniques in use for trace metals in natural waters include diffusion gradient thin-film gels (DGT), hollow fiber permeation liquid membranes (HFPLM), and Donnan membrane technique (DMT) (Sigg et al. 2006). Solid phase microextraction samplers, which consist of glass fiber coated with poly(dimethylsiloxane) in copper casings were moored at coastal sites along southern California for 2-3 months at a time to measure p,p'-DDE in seawater (Zeng et al. 2005). Another option are passive samplers called *semi-permeable membrane devices* (SPMD)[21]. SPMDs are porous plastic tubes containing a fatty material that mimics fish membrane lipids. As water passes through the membrane material, hydrophobic compounds are retained as they would be in fish fatty tissues. These sampling devices are usually deployed in an aquatic environment for three to four weeks and target hydrophobic contaminants such as organopesticides, PAHs, and PCBs. PISCO maintains a number of instrument moorings around Park islands, which might be utilized for such a project.

12. Utilize NOAA's SAMSAP data to map current patterns of fishing effort outside the MPAs (H). With the help of Sanctuary staff, publically available SAMSAP data should be examined to see how spatial patterns of fishing effort in Park waters have changed since the creation of the MPAs.

13. Prioritize the synthesis of time series data from the Park's monitoring programs to discover the impacts of fishing on Park biota (H). Several years of data from the intertidal and kelp forest monitoring programs, much of which precedes the establishment of the SMRs, have been presented in annual reports (yearly snapshots), but most of the data has not been synthesized (e.g., years compared, trends examined). Consequently, monitoring data were not easily used during this project to evaluate the status of Park species that are targets of recreational or commercial fishing, or that may be indirectly affected by fishing. Instead, inferences about stock conditions and fishing effort were made using data from economic surveys, state landings data, regional stock descriptions, and a few scientific articles that were produced in the last few years using Park data. It is probably more important at this juncture to use existing, and incoming, data from the Park's long-term marine monitoring program for new analyses, than it is to consider new sampling programs. The recent doubling of kelp forest monitoring sites (strategically located to compare conditions inside and outside fishing reserves) increases the importance of dedicating resources to data analysis and manuscript preparation.

[21] see Huckins, JN, Petty, JD, Lebo, JA, Orazio, CE, Clark, RC, Gibson, VL. (January 3, 2002). SPMD Technology Tutorial (3rd Edition). U.S. Geologic Survey (USGS). Retrieved on June 15, 2006 from http://wwwaux.cerc.cr.usgs.gov/SPMD/SPMD-Tech_Tutorial.htm

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APPENDIX A . Marine Plants and Macroalgae of Channel Islands National Park.

Common Name	Scientific Name	Habitat (as applies to Channel Islands)	Geographic range	Why of note?[a]
FLOWERING PLANTS (Anthophyta)				
Scoulder Surfgrass	Phyllospadix scoulei	Rocky shorelines, heavy surf and waves	Entire California coast	Habitat forming **RI-Monit** **SB-Monit (in wrack)**
Torrey Surfgrass	Phyllospadix torreyi	Protected sandy intertidal and subtidal	Entire California coast	Habitat forming **RI-Monit** **SB-Monit (in wrack)**
Eelgrass	Zostera spp.	Prefer protected bays and lagoons, muddy or sandy, intertidal to 40 ft (in clear water up to 100 ft	Alaska to Mexico	Habitat forming
BROWN ALGAE (Phaeophyta)				
Giant Kelp	Macrocystis pyrifera	5-20m depth on hard substrate, in water <20oC and light > 1% incident	Central California to Baja California. Well over half of the linear extent (miles of coast) of Southern California kelp beds occur around the Channel Islands.	Provides critical habitat. Commercially important (not currently harvested in CINP). Sensitive to El Nino related shifts in water temperature. **KF-Monit** **RI-Monit** **SB-Monit (in wrack)**
Feather Boa Kelp	Egregia menziesii, Egregia laevigata	Middle intertidal to 20 m	Alaska to Punta Eugenio, Baja California	Habitat forming **RI-Monit** **SB-Monit (in wrack)**
Elk Kelp	Pelagophycus porra	Subtidal on gravel	Point Conception to Isla San Benito, Baja California	Habitat forming
Oar Weed	Laminaria farlowii	Subtidal to 50 m	British Columbia to Bahia del Rosario, Baja California	Habitat forming **KF-Monit**
Brown Algae	Agarum fimbriatum	Subtidal to 115 m Rocks, wood, other algae	Alaska to Channel Islands	Habitat forming
Brown Algae	Colpomenia peregrina	Intertidal		**RI-Monit**
Brown Algae	Colpomenia sinuosa	Intertidal		**RI-Monit**
Brown Algae	Cylindrocarpus rugosus	Intertidal		**RI-Monit**
Brown Algae	Dictyota flabellata	Intertidal		**RI-Monit**
Brown Algae	Dictyota phchydictyon	Intertidal		**RI-Monit**
Brown Algae	Eisenia arborea	Low intertidal and subtidal to 10 m, forms dense subtidal groves	Vancouver Island to Isla Magdalena, Baja California	Habitat forming **RI-Monit**
Brown Algae	Endarachne binghamiae	Intertidal		**RI-Monit**
Brown Algae	Halidrys dioca	Intertidal		**RI-Monit**
Brown Algae	Hesperophycus californicus	Intertidal		**RI-Monit**

Common Name	Scientific Name	Habitat (as applies to Channel Islands)	Geographic range	Why of note? [a]
Brown Algae	Pseudolitho-derma nigra	Intertidal		**RI-Monit**
California Sea Palm	Pterygophora californica	Forms extensive beds 7-20 m, occasionally low intertidal	Vancouver Island to Bahia del Rosario, Baja California	Habitat forming **KF-Monit**
Southern Sea Palm	Etsenta arborea	kelp forest		**KF-Monit**
Brown Algae	Ralfsia sp.	Intertidal		**RI-Monit**
Brown Algae	Sargassum muticum	Intertidal		**RI-Monit**
Brown Algae	Scytosiphon dotyi	Intertidal		**RI-Monit**
Brown Algae	Scytosiphon lomentaria	Intertidal		**RI-Monit**
Brown Algae	Soranthera ulvoidea	Intertidal		**RI-Monit**
Acid weed	Desmarestta sp.	kelp forest		**KF-Monit**
Bladder chain kelp	Cytosetra sp.	kelp forest		**KF-Monit**
Articulated and encrusting coralline algae	Corallinaceae	kelp forest		**KF-Monit**
Brown Algae	Endarachne binghamiae	intertidal		**RI-Monit**
Brown Algae	Halidrys dioica	intertidal		**RI-Monit**
Brown Algae	Hesperophycus californicus	intertidal		**RI-Monit**
Brown Algae	Silvetia compresa	intertidal		**RI-Monit**
Brown Algae	Punctaria occidentalis	eelgrass epiphyte		
RED ALGAE (Rhodophyta)				
Red Algae	Acrosorium uncinatum	Intertidal		**RI-Monit**
Red Algae	Amphiroa zonata	Intertidal		**RI-Monit**
Red Algae	Bossiella sp.	Intertidal		**RI-Monit**
Red Algae	Calliarthron tuberculosum	Intertidal		**RI-Monit**
Red Algae	Callithamnion pikeanum	Intertidal		**RI-Monit**
Red Algae	Callophyllis sp.	Intertidal		**RI-Monit**
Red Algae	Carpopeltis bushiae	Intertidal		**RI-Monit**
Red Algae	Ceramium sp.	Intertidal		**RI-Monit**
Red Algae	Chondracanthus canaliculatus	Intertidal		**RI-Monit**
Red Algae	Chondracanthus corymbiferus	Intertidal		**RI-Monit**
Red Algae	Chondracanthus harveyanus	Intertidal		**RI-Monit**
Red Algae	Chondracanthus spinosus	Intertidal		**RI-Monit**
Red Algae	Chondria californica	Intertidal		**RI-Monit**
Red Algae	Corrallina officinalis	Intertidal		**RI-Monit**
Red Algae	Corrallina vancouveriensis	Intertidal		**RI-Monit**
Red Algae	Cryptopleura crispa	Intertidal		**RI-Monit**
Red Algae	Cryptopleura violacea	Intertidal		**RI-Monit**
Red Algae	Cumagloia andersonii	Intertidal		**RI-Monit**

Common Name	Scientific Name	Habitat (as applies to Channel Islands)	Geographic range	Why of note? [a]
Red Algae	Endocladia muricata	Intertidal		**RI-Monit**
Red Algae	Erythrocystis saccata	Intertidal		**RI-Monit**
Red Algae	Gastroclonium coulteri	Intertidal		**RI-Monit**
Agar Weed	Gelidium sp.	Intertidal and Kelp		**RI-Monit** **KF-Monit**
Agar Weed	Gelidium purpurascens	Intertidal		**RI-Monit**
Agar Weed	Gelidium robustum	Intertidal		**RI-Monit**
Tongue weed	Gigartina sp	kelp forest		**KF-Monit**
Red Algae	Gracilaria sjoestedtii	Intertidal		**RI-Monit**
Red Algae	Gracilaria verrucosa	Intertidal		**RI-Monit**
Red Algae	Grateloupia sp.	Intertidal		**RI-Monit**
Red Algae	Haliptylon gracile	Intertidal		**RI-Monit**
Red Algae	Laurencia pacifica	Intertidal		**RI-Monit**
Red Algae	Laurencia spectabilis	Intertidal		**RI-Monit**
Red Algae	Laurencia snyderi	Intertidal		**RI-Monit**
Red Algae	Laurencia subopposita	Intertidal		**RI-Monit**
Red Algae	Liagora californica	Intertidal		**RI-Monit**
Red Algae	Lithothamnion sp.	Intertidal		**RI-Monit**
Red Algae	Lithothrix aspergillium	Intertidal		**RI-Monit**
Red Algae	Mastocarpus papillatus	Intertidal		**RI-Monit**
Red Algae	Mazzaella affinis	Intertidal		**RI-Monit**
Red Algae	Mazzaella leptorhynchos	Intertidal		**RI-Monit**
Red Algae	Melobesia marginata	Intertidal		**RI-Monit**
Red Algae	Melobesia mediocris	Intertidal		**RI-Monit**
Red Algae	Microcladia coulteri	Intertidal		**RI-Monit**
Red Algae	Nemalion helminthoides	Intertidal		**RI-Monit**
Red Algae	Neorhodomella larix	Intertidal		**RI-Monit**
Red Algae	Nienburgia andersoniana	Intertidal		**RI-Monit**
Red Algae	Plocamium cartilagineum	Intertidal		**RI-Monit**
Red Algae	Polysiphonia	Intertidal		**RI-Monit**
Red Algae	Porphyra perforata	Intertidal		**RI-Monit**
Red Algae	Prionitis lanceolata	Intertidal		**RI-Monit**
Red Algae	Pterocladia sp.	Intertidal		**RI-Monit**
Red Algae	Pterosiphonia sp.	Intertidal		**RI-Monit**
Red Algae	Rhodymenia sp.	Intertidal		**RI-Monit**
Red Algae	Sarcodiotheca sp.	Intertidal		**RI-Monit**

Common Name	Scientific Name	Habitat (as applies to Channel Islands)	Geographic range	Why of note? [a]
Red Algae	Smithora naiadum	Intertidal		**RI-Monit**
GREEN ALGAE (Chlorophyta)				
Green Algae	Bryopsis	Intertidal		**RI-Monit**
Green Algae	Chaetomorpha linum	Intertidal		**RI-Monit**
Green Algae	Cladophora columbiana	Intertidal		**RI-Monit**
Green Algae	Cladophora graminea	Intertidal		**RI-Monit**
Green Algae	Codium fragile	Intertidal		**RI-Monit**
Green Algae	Enteromorpha intestinalis	Intertidal		**RI-Monit**
Green Algae	Ulva californica	Intertidal		**RI-Monit**
Green Algae	Ulva taeniata	Intertidal		**RI-Monit**

[a] RI-Monit: abundance recorded in monitoring sites of the Rocky Intertidal Monitoring program at the Park.

KF-Monit: abundance recorded in monitoring sites of the Kelp Forest Monitoring program at the Park.

SB-Monit: abundance recorded in monitoring sites of the Sand Beach/Coastal Lagoon Monitoring program at the Park.

Monitoring reports available on-line at http://www.nature.nps.gov/im/units/chis/HTMLpages/AnnlReports/MarineReports.htm

APPENDIX B . Marine macroinvertebrates of Channel Islands National Park. Some sandy beach species are included. Microinvertebrates (e.g., zooplankton) are not included.

Common Name	Scientific Name	Habitat in Channel Islands	Geo-graphic range	Other details *	Harvest Details; Commercial or Sport Take Regulations
Cnidaria (Coelenterata)					
Aggregating Anemone	Anthopleura elegantissima	On rocks,in tidepools and crevices or pilings in middle intertidal of semiprotected rocky shores		Indicator or sensitive species **RI-Monit**	
	Plumuraria sp.	intertidal		**RI-Monit**	
	Corymorpha sp.	intertidal		**RI-Monit**	
Anemone	Anthopleura solis	Intertidal		**RI-Monit**	
Giant green anemone	Anthopleura xanthogrammica	Intertidal		**RI-Monit**	
Strawberry anemone	Corynactis californica	kelp forest		**KF-Monit**	
White-spotted rose anemone	Urticina lofotensis	kelp forest		**KF-Monit**	
Anemone	Epiactis prolifera	Intertidal		**RI-Monit**	
California Hydrocoral	Allopora/Stylasterc alifornica	Under ledges and boulders shaded from sunlight in low intertidal, wave swept, rocky	Alaska to San Diego	Indicator or sensitive species **KF-Monit**	
La Jolla cup coral	Astrangia lajollaensis	Kelp forest		**KF-Monit**	
Orange cup coral	Balanophyllia elegans	Kelp forest		**KF-Monit**	
Hydroid	Abietinaria spp.	Under ledges and boulders shaded from sunlight in low intertidal, wave swept, rocky shores	Alaska to San Diego	Indicator or sensitive species	
Ostrich-Plume Hydroid	Aglaophenia latirostris	on rocks and larger red and brown algae in low intertidal to 35m in subtidal, semiprotected rocky shores	Southern Alaska to Santa Barbara	Indicator or sensitive species,	
Ostrich-Plume Hydroid	Aglaophenia struthionides	low intertidal, subtidal to 160m, usually < 16m, rocky reefs and pinnacles, wave swept	Southern Alaska to San Diego	Indicator or sensitive species,	
Hydroid	Clytia bakeri	on shells of snails (Nucifera fossatus, Olivelaa biplicata) and bivalves (Tivela stultorum, Donax gouldii), low intertidal, shallow subtidal, sandy beaches	San Fransisco to Baja California	Indicator or sensitive species,	

Common Name	Scientific Name	Habitat in Channel Islands	Geo-graphic range	Other details *	Harvest Details; Commercial or Sport Take Regulations
Hydroid	Garveia annulata	Common seasonally shaded areas in low intertidal and subtidal to 120m on open or semiprotected rocky shores, usually on sponges or braned coralline algae Bossiella, Calliarthon	Sitka, Alaska to Channel Islands	Indicator or sensitive species,	
Hydroid	Obelia spp.	Common on rocks, pilings, seaweeds, shells, in low intertidal and subtidal to 50 m.	Pacific coast and worldwide	Indicator or sensitive species,	
Hydroid	Sarsia spp.	Common on rocks and pilings, low intertidal, protected coasts. Also in bays on eelgrass Zostera.	British Columbia to Chile, and North Atlantic	Indicator or sensitive species	
Hydroid	Sertularella turgida	Under rocks and ledges, low intertidal and subtidal to 160 m, exposed shores.	Britsh Columbia to San Diego	Indicator or sensitive species	
Hydroid	Sertularia frucata	On bases of blades of surfgrass (Phylolospadix spp.) and red algae, low intertidal and subtidal to 50 m, exposed rocky shores.	Britsh Columbia to San Diego	Indicator or sensitive species	
Hydroid	Tubularia crocea	On pilings and floats, harbors and bays, intertidal and subtidal to 40 m		Indicator or sensitive species	
Red Gorgonian	Lophogorgia chilensis	On rock, esp. offshore pinnacles, subtidal 16-66 m		Indicator or sensitive species **KF-Monit**	
California Golden Gorgonian	Muricea californica	On rocks, esp. offshore pinnacles		Indicator or sensitive species **KF-Monit**	
Brown Gorgonian	Muricea fructicosa	On rocks, pipes, wrecks, subtidal 16-33 m.		Indicator or sensitive species **KF-Monit**	
Miscellanous Taxa					
southern staghorn bryozoan	Diaporecia californica	Kelp forest		**KF-Monit**	

Common Name	Scientific Name	Habitat in Channel Islands	Geo-graphic range	Other details *	Harvest Details; Commercial or Sport Take Regulations
sponge	Leucetta losangelensis (Porifera)	Intertidal		**RI-Monit**	
sponge	Leucilla nuttingi (Porifera)	Intertidal		**RI-Monit**	
gray moon sponge	Spheciospongia confoederata	Intertidal		**RI-Monit**	
orange puffball sponge	Tethya aurantia	Kelp forest		**KF-Monit**	
Colonial Sand Tube Worm, sand caste worm	Phragmatopoma californica (Polychaeta)	on rock where sufficient sand washes by for the worms to build and maintain tubes, intertidal and subtidal to 80 m		Indicator or sensitive species **KF-Monit** **RI-Monit**	
Ornate tube worm	Diopatra ornata	Kelp forest		**KF-Monit**	
Blood Worm	Euzonus mucronata (Polychaeta)	Sandy beach		**SB-Monit**	
Polychaete Worm	Nephtys californicus (Polychaeta)	Sandy Beach		**SB-Monit**	
Flatworm	Leptoplana sp. (Platyhelminthes)	Intertidal		**RI-Monit**	
Peanut worm	(Sipuncula)	Intertidal		**RI-Monit**	
Ribbon worm	Tubulanus sexlineatus (Nemertea)	Intertidal		**RI-Monit**	
Reef building worm	Dodecaceria fewkesi (Polychaeta)	Intertidal		**RI-Monit**	
Sand castle worm	Phragmatopoma californica (Polychaeta)	Intertidal		**RI-Monit**	
Fragile tube worm	Salmacina tribranchiata (Polychaeta)	Intertidal		**RI-Monit**	
Christmas tree worm	Spirobranchus spinosus (Polychaeta)	Intertidal		**RI-Monit**	
Flatworm	Phylloplana viridis (Platyhelminthes)	Epiphyte on eelgrass			
Arthropoda					
Dark backed isopod	Cirolana harfordi	Intertidal		**RI-Monit**	
Isopod	Excirolana chiltoni	Sand Beach		**SB-Monit**	
Isopod	Alloniscus percovexus	Sand Beach		**SB-Monit**	
Gammarid amphipods	(Gammaridea)	Intertidal		**RI-Monit** **SB-Monit**	
Beach hoppers	Megalorchestia spp.	Sand Beach		**SB-Monit**	
Rove Beetles	Thinopinus pictus (Staphylinidae)	Sand Beach		**SB-Monit**	
Rock louse	Ligia occidentalis	Intertidal		**RI-Monit**	
Smooth sided barnacle	Balanus glandula	Intertidal		**RI-Monit**	
Shotgun barnacle	Chthamalus dalli	Intertidal		**RI-Monit**	
Pacific gooseneck barnacle	Pollicipes polymerus	Intertidal		**RI-Monit**	
Red thatched barnacle	Tetraclita rubescens	Intertidal		**RI-Monit**	

Common Name	Scientific Name	Habitat in Channel Islands	Geo-graphic range	Other details *	Harvest Details; Commercial or Sport Take Regulations
Giant Acorn Barnacle	Balanus nubilus	Rocks or pilings in strong currents or waves, intertidal and subtidal to 90m		Indicator or sensitive species	
California Spiny Lobster	Panulirus interruptus (Crustacea)	Under rocks and in crevices during day, in open at night in low intertidal and subtidal to 60m.	San Luis Obispo Co., CA to Bahia Rosala, Baja California	Commerical importance **KF-Monit**	CCR Title 14/Div. 1/Subdiv. 1/Ch.4/Sect. 29.90 CCR Title 14/Div.1/Subdiv. 1/Ch. 6/Sect. 122 CF&G Sect. 7256, 8250-8259, 9000-9024 (traps) **Commercial take**: The southern California Lobster Fishery is now a limited-entry fishery, and is considering adopting an individual transferrable quota system (ITQ). Lobsters be over 3.25in long. May only be taken during Oct-Mar. Traps can only be raised or placed from dusk to dawn, each trap must be have a buoy with commercial license number displayed, must not be within 750 ft of public pier, etc. and not set within 250 ft of navigation channels. **Sport**: May only be taken with sport fishing license and using hoop net or by hand. Limit 7, min. size 3.25in. Same season as for Commerical take.
Red Rock Shrimp	Lysmata californica (Crustacea)	Among rocks and alage in low intertidal, subtidal to 60m.	Santa Barbara, CA to Bahia Sebastian Vizcaino, Baja California.	Commercial Importance	CCR Title 14/ Div. 1/Subdiv. 1/Ch.4/Sect.29.80 CCR Title 14/ Div. 1/Subdiv. 1/Ch.6/Sect.120 CF&G Sect. 8590-8595, 8830-8843, 9000-9024 (traps) **Commercial take**: Depth, equipment (re. trawls and traps), season and incidental catch restrictions apply. Trawling only allowed >3 nautical miles from land. Traps may not be used S. of Pt Conception inside 50 fathom depth. **Sport take**: May only be taken by hand, or by shrimp and prawn traps with openings ≤0.5in (south of Pt. Conception).

Common Name	Scientific Name	Habitat in Channel Islands	Geo-graphic range	Other details *	Harvest Details; Commercial or Sport Take Regulations
Spot Prawn	Pandalus platyceros (Crustacea)	Rocky intertidal to over 259 fm in depth.	NE Pacific Ocean, southern Alaska to S. California, and Sea of Japan.	Commercial Importance	As of April, 2003, spot prawn may not be taken by trawl nets, except as incidental catch up to 50 lbs. for ridgeback shrimp trawlers. Otherwise, same as for Red Rock Shrimp. Fishing spot prawn using traps is regulated and new rules are pending as of 9/2005.
Ridgeback Prawn	Sicyonia ingentis (Crustacea)		Monterey, CA to Cedros Island, Baja California. <u>Fishery is centered in SB Channel and off Santa Monica Bay</u>	Commercial Importance	same as for Red Rock Shrimp except that special trawling provisions for ridgeback shrimp contained in CCR Title 14/ Div. 1/Subdiv. 1/Ch.6/Sect.120.3
Hairy Hermit Crab	Pagurus hirsutiusculus	Intertidal		**RI-Monit**	
Crab	Pagurus granosimanus	Intertidal		**RI-Monit**	
Blue-clawed Hermit Crab	Pagurus samuelis	Intertidal		**RI-Monit**	
Porcelain Crab	Petrolisthes sp.	Intertidal		**RI-Monit**	
Purple lined Shore Crab	Pachygrapsus crassipes	Intertidal		**RI-Monit**	
Lumpy Crab	Paraxanthias taylori	Intertidal		**RI-Monit**	
Northern Kelp Crab	Pugettia producta	Intertidal		**RI-Monit**	
Kelp Crab	Pugettia richii	Intertidal		**RI-Monit**	
Red Crab	Cancer productus (Crustacea)	Middle intertidal and subtidal to 79m, common in gravel and boulder beaches. Protected coasts and bays.	Kodiak, Alaska to San Diego	Commerical importance	CCR Title 14/ Div. 1/Subdiv. 1/Ch.4/Sect.29.85 CCR Title 14/ Div. 1/Subdiv. 1/Ch.6/Sect. 123 CF&G Sect. 8254, 9001 **Commercial take**: Permit required for commercial take between high tide mark and 1000 ft below low tide mark. Are allowed as by catch in permitted lobster traps. **Sport**: Open season all year, limit=35, must be ≥4 in.

Common Name	Scientific Name	Habitat in Channel Islands	Geo-graphic range	Other details *	Harvest Details; Commercial or Sport Take Regulations
Rock Crab	Cancer antennarius (Crustacea)	low rocky intertidal and subtidal to 40m around bases of kelp and in gravel.	Coos Bay, Oregon to Baja California	Limited sport fishery exists **RI-Monit**	CCR Title 14/ Div. 1/Subdiv. 1/Ch.4/Sect.29.85 CCR Title 14/ Div. 1/Subdiv. 1/Ch.6/Sect. 125 (rock crab) CF&G Sect. 8254, 9001 **Commercial take:** Commerical permit needed for rock crab. Every trap or string of traps must be marked with buoys bearing the commercial fishing license identification number issued to operator (FGC§9006). Traps made of wire mesh, not less than 1 7/8 inches by 3 7/8 inches inside measurement, with the 3 7/8 inches measurement parallel to the floor of the trap shall have at least one rigid circular opening of not less than 3 1/4 inches inside diameter in an outside wall of the rearmost chamber of the trap. All other traps must have two such openings in an outside wall of the rearmost chamber of the trap Traps must be emptied at least every 96 hours (weather permitting), and must not be abandoned. Every trap must have at least one destruct device which meets specifications approved by the Department (FGC§9004). **Sport**: Same as for Red Crab.
Sheep Crab	Loxorhynchus grandis (Crustacea)	low intertidal and (usually) subtidal to 124 m.	Cordell Bank, CA to Punta San Bartolome, Baja California	Commercial importance	Same as for Red Crab.
Common Sand Crab	Emerita analoga	Sand Beach		**SB-Monit**	
Spiny Sand Crab	Blepharipoda occidentalis	Sand Beach		**SB-Monit**	
Echinodermata					
Giant Starfish	Pisaster giganteus (Echinodermata)	very low intertidal and subtidal to 88m, protected coast, occas. subtidal sand		keystone predator of bivalves, snails, chitons, barnacles **RI-Monit** **KF-Monit**	
Ochre Starfish	Pisaster ochraceus (Echinodermata)	middle and low intertidal and subtidal to 88 m on wave swept rocky shores, rare in C. and S. California		keystone predator of bivalves, snails, chitons, barnacles **RI-Monit**	
Six armed starfish	Leptasterias sp.	intertidal		**RI-Monit**	

Common Name	Scientific Name	Habitat in Channel Islands	Geo-graphic range	Other details *	Harvest Details; Commercial or Sport Take Regulations
Bat star	Asterina miniata	intertidal, kelp forest		**RI-Monit** **KF-Monit**	
Spiny brittle star	Ophiothrix spiculata	intertidal		**RI-Monit**	
Starfish	Henricia sp.	intertidal		**RI-Monit**	
	Lissothiria sp.	intertidal		**RI-Monit**	
Sunflower star	Pycnopodia helianthoides	kelp forest		**KF-Monit**	
California Sea Cucumber	Parastichopus californicus (Echinodermata)	on rocky shores w. strong wave action & pilings in open bays, usually subtidal to 90 m in California		commercial importance	CF&G Sect. 8405-8405.4 **Commercial harvest**: Permits required. Most of sea cucumber harvest occurs off the Northern Channel Islands in water 6-20 fm. Harvest is primarily by trawlers. A holder of a commercial sea cucumber permit is not required to possess a Tidal Invertebrate Permit (CCR Title 14/ Div. 1/Subdiv. 1/Ch.6/Sect. 123).
Warty Sea Cucumber	Parastichopus parvamensis (Echinodermata)	sandy/mud surfaces between rocks in low intertidal in bays - and rocks, sand, or mud in well-protected rocky shores, subtidal to 27 m		commercial importance **KF-Monit**	CF&G Sect. 8405-8405.4 **Commercial harvest**: Permits required. Most of sea cucumber harvest occurs off the Northern Channel Islands in water 6-20 fm.Harvest is almost exclusively by divers. A holder of a commercial sea cucumber permit is not required to possess a Tidal Invertebrate Permit (CCR Title 14/ Div. 1/Subdiv. 1/Ch.6/Sect. 123).
sea cucumber	Pachythyone rubra	kelp forest		**KF-Monit**	
Red Sea Urchin	Strongylo-centrotus franciscanus (Echinodermata)	uncommon in very low intertidal on open, rocky shore; more abundanct subtidally to 90m		commercial importance, habitat forming species (consumes red and brown algae, particularly Giant Kelp) **RI-Monit** **KF-Monit**	CF&G Sect. 9054-9055 CCR Title14/ Div. 1/Subdiv. 1/Ch.6/ Sect.120.7. Red sea urchins harvested by divers equipped with hooka gear. Majority of SoCal landings come from the northern Channel Islands. **Commercial harvest**: Permits required. Intermittent closures (certain days and weeks). Catch limits for small urchins apply. A sea urchin diver or sea urchin crewmember operating under the provisions of this section is not required to possess a Tidal Invertebrate Permit (CCR Title 14/ Div. 1/Subdiv. 1/Ch.6/Sect. 123)

Common Name	Scientific Name	Habitat in Channel Islands	Geo-graphic range	Other details *	Harvest Details; Commercial or Sport Take Regulations
Purple Sea Urchin	Strongylo-centrotus purpuratus (Echinodermata)	Common in lower intertidal on rocky shores in moderate to strong waves and subtidal to 160m		indicator or sensitive species, habitat forming species (consumes red and brown algae, particularly Giant Kelp) **RI-Monit** **KF-Monit**	
White sea urchin	Lytechinus anamesus	kelp forest		**KF-Monit**	
Coronado sea urchin	Centrostephanus coronatus	kelp forest		**KF-Monit**	
MOLLUSCA					
Pink Abalone	Haliotis corrugata	subtidal from 6-60 m on exposed rock, commonly in giant kelp		Historic commercial importance, rapid decline experienced **KF-Monit**	CCR Title 14/ Div. 1/ Subdiv. 1/ Ch.4/ Sect.29.15. **No commercial or sport take allowed.**
Black Abalone	Haliotis cracherodii	under rocks and in crevices in high intertidal down to 6 m		Candidate species, rapid decimated by disease **RI-Monit**	As for Pink Abalone
Green Abalone	Haliotis fulgens	low intertidal and subtidal to 10 m. In crevices where surfgrass and algae is dense, esp. at 2-3 m in deep crevices in strong waves.		commercial importance, rapid decline experienced **KF-Monit**	As for Pink Abalone
Red Abalone	Haliotis rufescens	intertidal in rocky shores with strong waves, more abundant subtidal 6-17m, possible down to >180m		World's largest abalone, Commercial importance, rapid decline **KF-Monit**	CCR Title 14/ Div. 1/Subdiv. 1/Ch.4/Sect.29.15. **No commercial take allowed.** **Sport take**: (None in SB Channel) Red abalone may only be taken north of line drawn due west magnetic through center of mouth of San Fransisco Bay, daily bag limit is 3, annual bag limit 24.

Common Name	Scientific Name	Habitat in Channel Islands	Geo-graphic range	Other details *	Harvest Details; Commercial or Sport Take Regulations
White Abalone	Haliotis sorenseni	subtidal from 25-66m, in open, exposed areas		Historic commercial importance Candidate endangered species (listed 1/2000), **most are found at Channel Islands** **KF-Monit**	As for pink abalone
Owl limpet	Lottia gigantea	high and mid intertidal on cliff faces and rocks in high surf		Maintains algal patches by physically excluding other grazers, indicator or sensitive species **RI-Monit**	
White cap limpet	Acmaea mitra	intertidal		**RI-Monit**	
Nuttall's hornmouth	Ceratostoma nuttali	intertidal		**RI-Monit**	
limpet	Collisella digitalis	intertidal		**RI-Monit**	
file limpet	Collisella limatula	intertidal		**RI-Monit**	
shield limpet	Collisella pelta	intertidal		**RI-Monit**	
rough limpet	Collisella scabra	intertidal		**RI-Monit**	
limpet	Collisella strigatella	intertidal		**RI-Monit**	
keyhole limpet	Fissurella volcano	intertidal		**RI-Monit**	
giant keyhole limpet	Megathura crenulata	intertidal, kelp forest		**RI-Monit** **KF-Monit**	
seaweed limpet	Notoacmaea insessa	intertidal		**RI-Monit**	
limpet	Notoacmaea paleacea	intertidal		**RI-Monit**	
emarginate dog winkle	Nucella emarginata	intertidal		**RI-Monit**	
circled dwarf triton	Ocenebra circumtexta	intertidal		**RI-Monit**	
cup and saucer limpet	Trimusculus reticulatus	intertidal		**RI-Monit**	
snail	Acanthina punctulata	intertidal		**RI-Monit**	
limpet	Tectura depicta	epifauna unique to Zostera (eelgrass)			
ridged dwarf turban snail	Homalopoma luridum	intertidal		**RI-Monit**	
Joseph's coat amphissa	Amphissa versicolor	intertidal		**RI-Monit**	
Slipper snails	Crepidula sp.	intertidal		**RI-Monit**	
Tinted wentle trap	Epitonium tinctum	intertidal		**RI-Monit**	
Kobelt's spindle	Fusinus kobelti	intertidal		**RI-Monit**	
Painted spindle	Fusinus luteopictus	intertidal		**RI-Monit**	
Kelp snail	Norrisia norrisi	intertidal		**RI-Monit**	
periwinkle	Littorina keenae	intertidal		**RI-Monit**	
periwinkle	Littorina scutulata	intertidal		**RI-Monit**	
purple olive snail	Olivella biplicata	intertidal		**RI-Monit** **SB-Monit**	
tube snail	Petaloconchus montereyensis	intertidal		**RI-Monit**	

Common Name	Scientific Name	Habitat in Channel Islands	Geo-graphic range	Other details *	Harvest Details; Commercial or Sport Take Regulations
scaled-tube snail	Serpulorbis squamigerus	intertidal, kelp forest		**RI-Monit** **KF-Monit**	
black turban snail	Tegulla funebralis	intertidal		**RI-Monit**	
limpet-like snail	Siphonaria brannani	intertidal		**RI-Monit**	
speckled turban snail	Tegula gallina	intertidal		**RI-Monit**	
Wavy Turban/top Snail	Lithopoma undosa	low intertidal on rocks, more common (esp. larger ind.s) subtidally in kelp beds	Californian Province: occurs south of Point Conception	Indicator or sensitive species **KF-Monit**	
Red Turban/top snail	Lithopoma gibberosum	kelp forest		**KF-Monit**	
Kellet's Whelk	Kelletia kellettii (Mollusca)	rare in low intertidal under rock ledges, common subtidally to 70 m o rock and gravel	Point Conception to Isla Asuncion, Baja California	Indicator or sensitive species **KF-Monit**	
chestnut cowry	Cypraea spadicea	kelp forest		**KF-Monit**	
California sea hare	Aplysia californica	intertidal, kelp forest		**RI-Monit** **KF-Monit**	
sea hare	Phyllaplysia taylori	epifauna unique to Zostera (eelgrass)			
sea slug	Anisodoris nobilis	intertidal		**RI-Monit**	
sea slug	Aldisia sanguinea	intertidal		**RI-Monit**	
sea slug	Dialula sandiegensis	intertidal		**RI-Monit**	
sea slug	Hermissenda crasicornis	intertidal		**RI-Monit**	
sea slug	Phidiana pugnax	intertidal		**RI-Monit**	
chitons	Lepidochitona sp.	intertidal		**RI-Monit**	
mossy chiton	Mopalia muscosa	intertidal		**RI-Monit**	
chiton	Nuttalina californica	intertidal		**RI-Monit**	
reversed chama	Pseudochama exogyra	intertidal		**RI-Monit**	
octopus	Diplodontia orbellus	intertidal		**RI-Monit**	
California Mussel	Mytilus californianus	Abundant on rocks in upper-middle intertidal, subtidal to 24 m	Aleutian Islands, Alaska to S. Baja California	Commercial importance, provides habitat for other species **RI-Monit**	CCR Title 14/ Div. 1/Subdiv. 1/Ch.6/Sect. 123 CF&G Sect. 8344, 5669-5675 (bivalve toxic areas), 5700-5702 **Commercial take**: Tidal Permits required for commercial take between high tide mark and 1000ft below the low tide mark. In the 1990s, Ecomar used oil platforms in the channel for mussel aquaculture. **Sport take**: limit of 10 lbs (in shell) for California mussels + bay mussel in combination.

Common Name	Scientific Name	Habitat in Channel Islands	Geo-graphic range	Other details *	Harvest Details; Commercial or Sport Take Regulations
Bay mussel	Mytilus edulis	intertidal		**RI-Monit**	CCR Title 14/ Div. 1/Subdiv. 1/Ch.6/Sect. 123 CF&G Sect. 8344, 5669-5675 (bivalve toxic areas), 5700-5702 **Commercial take**: Tidal Permits required for commercial take between high tide mark and 1000ft below the low tide mark. Ecomar used oil platforms in the channel for mussel aquaculture. **Sport take**: limit of 10 lbs (in shell) for California mussels + bay mussel in combination.
Rock Scallop	Hinnites giganeus (multirugosus) or Crassedoma giganteus	Common is rock crevices in low intertidal and subtidal to 50m.	Queen Charlotte Islands, British Columbia, to Punta Abreojos, Baja California	Commercial importance **KF-Monit**	CCR Title 14/ Div. 1/Subdiv. 1/Ch.4/Sect. 29.60 CF&G Sect. 8345, 5669-5675, 5700-5702 **Commerical**: It is unlawful for any person to sell or purchase any rock scallops (Hinnites multirugosus) or scallops (Pecten circularis), except scallops cultivated pursuant to Division 12 (commencing with Section 15000) which may be sold or purchased subject to regulations of the commission. **Sport take**: Limit is 10. Can only be taken by hand using dive knives or abalone irons in compliance with Sect. 29.15(e).
Pismo Clam	Tivela stultorum (Mollusca)	Low intertidal and subtidal to 25m on sandy in strong surf	Half Moon Bay, CA to Bahia Magdalena, Baja California	Commerical importance, exhibited rapid decline **SB-MONIT**	CCR Title 14/ Div. 1/Subdiv. 1/Ch.4/Sect. 29.40 CF&G Sect. 7290, 7332, 8346, 10711 **Commerical take**: None may be sold or purchased that were taken in CA. **Sport take**: None shall be possessed out of the shell except when being prepared for immediate consumption. No clam tools may be possessed between dusk and dawn. May be taken in Santa Cruz and Monterrey Co.s, during only some months. May be taken in other counties year round. Limit 10, minimum size 4.5-5 in. (depending on area). No take in clam reserves.

Common Name	Scientific Name	Habitat in Channel Islands	Geo-graphic range	Other details *	Harvest Details; Commercial or Sport Take Regulations
Geoduck Clam	Panopea generosa (Mollusca)	In burrows in sand much in low intertidal and subtidal in protected bays	Forrester Island, Alaska to Scammon Lagoon, Baja California	Commercial importance	CCR Title 14/ Div. 1/Subdiv. 1/Ch.4/Sect. 29.30 CF&G Sect. 7332, 8340 No clam tools may be possessed between dusk and dawn. Limit: Three. The first three geoduck clams dug must be retained as the bag limit regardless of size or broken condition.
Market Squid	Loligo opalescens (Mollusca)	Pelagic except when schooling and spawning on muddy sand in shallow inshore areas	S. British Columbia to Isla Guadalupe (Mexico) and Bahia Asuncion, Baja California	Commerical Importance	CCR Title 14/ Div. 1/Subdiv. 1/Ch.4/Sect. 29.70 CF&G 8420-8429.7 **Commercial take**: Vessel permits required, must use dip, purse seine or lampara nets. No permit needed if used for live bait. From the US-Mexico border north squid may be taken for commercial purposes between noon on Sunday and Noon on Friday each week. This does not apply to vessels pursuing squid for live-bait purposes only. Not more that 2 tons may be taken per day without a valid Market Squid Vessel Permit. Each vessel fishing for squid or attracting squid shall shield the entire filament of each bulb used to attract squid. The illumination shall be oriented directly downward or be completely under the surface of the watter. Vessels fishing for squid or lighting for squid will utilize a total of no more than 30,000 watts to attract squid at any time. **Sport take**: No limit. May only be taken with hand-held dip nets.

*KF-Monit: species included in the Park's Kelp Forest Monitoring Program

RI-Monit: species included in the Park's Rocky Intertidal Monitoring Program

APPENDIX C . Fish species that are targets of commercial or sport fishing in Channel Islands National Park, along with information about regulatory actions and fishing regulations. Table is not an exhaustive list of fishing regulations. NOTE: seasons for commercial and recreational catch are subject to change from year to year.

Common Name	Scientific Name	On-line Infor. sources*	Pertinent Regula-tory Actions**	Details about commercial or recreational catch.
pertaining to ALL FISH	Pursuant to U.S. Supreme Court decision 436 U.S. 32 (1978), commercial and recreational fishing is allowed in Channel Islands National Park waters in accordance with State regulations, except in the State Marine Reserves. Owing to the MRPA, **gill nets (set- and drift gill nets) and trammel nets shall not be used** to take any species in waters between a line extending due west true from Point Arguello in Santa Barbara County south to the U.S.-Mexico border that are less than 70 fathoms in depth or within one mile, whichever is less, around the islands of San Miguel, Santa Rosa, Santa Cruz, Anacapa, San Nicolas, Santa Barbara, Santa Catalina, and San Clemente. **Trawling for any species is PROHIBITED in state waters** except that targeting California Halibut in a strip of coast between 1-3 mile offshore between Pt. Magu and Pt. Arguello *called THE CALIFORNIA HALIBUT TRAWLING ZONE*			
NEARSHORE FISH				
Rockfish, Generally	Sebastes spp.	A	CA-NFMPlan CA-RCG CCCA	Commercial catch of all rockfish is regulated owing to status as Federally managed groundfish, and inclusion in the state's Nearshore Fisheries Management Plan . No rockfish may be taken by gill nets or trammel nets within 1 nautical mile or 70 fathoms (whichever is less) of the Channel Islands (owing to the MRPA). **COMMERCIAL CATCH** of nearshore (shallow and deeper) rockfish requires a Limited Entry Nearshore Finfish permit. Take by finfish trap requires a Nearshore Live Fish Trap Endorsement. Seasons, area and depth restrictions apply. **RECREATIONAL CATCH** is regulated by **Rules for the RCG Complex** (includes all species of Rockfish, Cabezon and Greenlings in combination), which in 2006 state that catch by boat-based anglers open Mar.1-Dec. 31 in waters 0-60 fm, except during Sep. and Oct. when restricted to waters 0-30 fm). Shore-based anglers and divers open year round. The aggregate daily bag and possession limit is 10 fish per person within the RCG Complex (includes all species of Rockfish, Cabezon and Greenlings in combination) with smaller sub-limits on bocaccio, cabezon, and greenlings, which become included in the 10-fish RCG Complex aggregate limit. Recreational catch of **Yelloweye rockfish, canary rockfish and cowcod are PROHIBITED** (bag limit: zero).
Shallow Nearshore Rockfish		**Commercial catch of these species is affected by general rockfish rules above. In addition, a Limited Entry Nearshore Fishery Permit is required for these species.** Seasonal closures apply. As of 2006, only 57 permits are available in the South coast Region, with 39 finfish trap endorsements. Without a **Nearshore Finfish Trap Endorsement**, fishing can only be by line. It is unlawful to use more than 150 hooks on a vessel, or to use more than 15 hooks per line, to take nearshore fish stocks for commercial purposes in ocean waters within one mile of shore within Fish and Game District 19. Specific depths are closed during specific periods in the Cowcod Conservation Areas (one of which surrounds Santa Barbara Island). **Recreational catch** subject to RCG Complex rules, described under "Rockfish".		
Black and yellow rockfish	Sebastes chrysomelas	A, C, D	CA-NFMPlan NFPermit GMP CA-RCG CCCA GMP	Taken primarily by recreational anglers from boat or shore, or by divers, minor component of commercial and recreational catch, caught primarily north of Pt Conception.

Common Name	Scientific Name	On-line Infor. sources*	Pertinent Regula-tory Actions**	Details about commercial or recreational catch.
China rockfish	Sebastes nebulosus	A, C, D	CA-NFMPlan NFPermit GMP CA-RCG CCCA	Rare in SoCal, taken primarily by recreational anglers from boat or shore, or by divers, minor component of commercial and recreational catch, caught primarily north of Pt Conception.
Gopher rockfish	Sebastes carnatus	A, B, D	CA-NFMPlan NFPermit GMP CA-RCG CCCA	Reasonably important in CPFVs landing in Morro Bay area, caught primarily north of Pt Conception.
Grass rockfish	Sebastes rastrelliger	A, B, D	CA-NFMPlan NFPermit GMP CA-RCG CCCA	Taken primarily by recreational anglers from boat or shore, or by divers, minor component of commercial and recreational catch, caught primarily north of Pt Conception
Kelp rockfish	Sebastes atrovirens	A, B, D	CA-NFMPlan NFPermit GMP CA-RCG CCCA	Taken primarily by recreational anglers from boat or shore, or by divers, minor component of commercial and recreational catch, caught primarily north of Pt Conception
Deeper Nearshore Rockfish		**Commercial catch of these species is affected by general rockfish rules above. In addition, a Deeper Nearshore Species Fishery Permit is required for these species.** Catch by Traps requires a **Nearshore Fishery Trap Endorsement.** Specific depths are closed during specific periods in the Cowcod Conservation Areas (one of which surrounds Santa Barbara Island). Recreational catch of these species is subject to **RCG Complex** rules.		
Black rockfish	Sebastes melanops	A, B, C, D	CA-NFMPlan DNSFPermit GMP CA-RCG CCCA	Rare in S.California, minor commercial sp., in NoCal, more important in NoCal to recreational divers and from CPFVs, increasing in live fish market
Blue rockfish	Sebastes mystinus	A, B, C, D	CA-NFMPlan DNSFPermit GMP CA-RCG CCCA	Caught in N. Channel Islands and northward (hook&line, limited entry for finfish traps), important to divers, one of most important sp. for recreational anglers on skiffs and CPFVs
Brown rockfish	Sebastes auriculatus	A, B, C, D	CA-NFMPlan DNSFPermit GMP CA-RCG CCCA	Important sport fish from boat or shore, 3rd most common rockfish landed in commercial nearshore fishery, caught for dead and live fish markets with hook&line
Calico rockfish	Sebastes dalli	A, B, C, D	CA-NFMPlan DNSFPermit GMP CA-RCG CCCA	Taken by CPFVs and party boats, minor portion of commercial catch. subject to illegal "high grading" discard in both recreational and commercial rockfish fisheries, appear as by catch in prawn trawls
Copper rockfish	Sebastes caurinus	A, B, C, D	CA-RCG DNSFPermit GMP CCCA	Caught in live fish fishery, sport fish from skiff and CPFVs, prime target for sport divers
Olive rockfish	Sebastes serranoides	A, B, C, D	CA-NFMPlan DNSFPermit GMP CA-RCG CCCA	Minor part of commercial take by hook&line and small number end up in live fish fishery, common in N. Channel Islands
Quillback rockfish	Sebastes maliger	A, B, C, D	CA-NFMPlan DNSFPermit GMP CA-RCG CCCA	Rare in S.California, Channel Islands are at southern end of range

Common Name	Scientific Name	On-line Infor. sources*	Pertinent Regula-tory Actions**	Details about commercial or recreational catch.
Treefish	Sebastes serriceps	B, D	CA-NFMPlan DNSFPermit GMP CA-RCG CCCA	Taken primarily by recreational anglers from boat or shore, or by divers, minor component of commercial and recreational catch
Whitebelly rockfish	Sebastes vexilaris		GMP CCCA CA-RCG	
Nearshore Groundfish				
California Halibut	Paralichthys californicus	A, F, G	trawliing in state waters restricted to the "California Halibut Trawling Grounds", this sp. not on the list of federally regulated groundfish	Important commerical and recreational sp., commercial catch w. hook&line, set nets (in EEZ), and bottom trawls **Note: trawling for any spp. is PROHIBITED in State water** except that targeting California Halibut in a strip of coast between 1-3 mile offshore between Pt. Magu and Pt. Arguello *called THE CALIFORNIA HALIBUT TRAWLING ZONE*; **gill and trammel nets PROHIBITED within CINP boundaries owing to the creation in 1990 of the Marine Resources Protection Zone.** **Recreational catch** is by hook&line, spear, or hand - sport size limit applies
Starry Flounder	Platichthys stellatus	A, F	GMP CCCA	As a **federally regulated groundfish**, commercial limits and quotas apply and the recreational catch, equipment rules,and seasons match those for the RCG complex (see Rockfish, generally, above). Uncommon south of Pt. Conception, commercial and recreational catch declined dramatically in 1990s, commercial catch by trawl, gill and trammel nets; recreational catch by pier, boat and shore. Cowcod Conservation Areas rules apply.
Sanddab, Pacific	Citharichthys sordidus	A, F	GMP CCCA	As a **federally regulated groundfish**, commercial limits and quotas apply and the recreational catch equipment rules and seasons match those for the RCG complex (see Rockfish, generally, above). Prized for edibility, recreational anglers from boats. commercial catch by otter trawls, hook&line. Cowcod Conservation Areas rules apply.
Sanddab, Speckled	Citharichthys stigmaeus	A		prized for edibility, recreational anglers from boats
Sanddab, Longfin	Citharichthys xanthostigma	A, F		prized for edibility, recreational anglers from boats commercial otter trawls, hook&line
Sanddab, Gulf	Citharichthys fragilis	A		prized for edibility, recreational anglers from boats
Nearshore Croakers				
California Corbina	Menticirrhus undulatus	A, F		**Commercial catch illegal**. No sport catch allowed via nets. Popular w. sport anglers owing to fighting behavior.
Spotfin Croaker	Roncador stearnsii	A, F		**Commercial catch illegal**. No sport catch allowed via nets. Anglers from shore and piers. Found south of Pt. Conception
Queenfish	Seriphus politus	F		Sport finfish regulations apply.
White Seabass	Atractoscion nobilis	A, F	CA-WSFMP	Seasons, size limits, bag limits and gear restrictions apply. Catch concentrated south of Pt. Conception and at Channel Islands, set gillnet catch PROHIBITED in 1994, drift gillnet primary method used currently plus some commercial hook&line. Popular with anglers using live bait, spearfishing by free divers. The recreational fishery for white seabass is open year round. The daily bag and possession limit is three fish except that only one fish may be taken in waters south of Point Conception between March 15 and June 15. The minimum size limit is 28 inches total length or 20 1⁄2 inches alternate length.
White Croaker	Genyonemus lineatus	A, F		Commercial catch allowed-occurs mostly by gillnet, sold in fresh fish market . Most sport catch in SoCal by anglers from piers, and boats. Consumption prohibited for those caught on Palos Verdes shelf, owing to DDT contamination.

Common Name	Scientific Name	On-line Infor. sources*	Pertinent Regula-tory Actions**	Details about commercial or recreational catch.
Black Croaker	Cheilotrema saturnum			
Yellowfin Croaker	Umbrina roncador	A, F		**Commercial catch illegal.** No sport catch allowed via nets. Anglers from shore and piers. Found south of Santa Barbara
Surfperches (family Embiotocidae)				
Barred surfperch	Amphistichus argenteus	A, F		Popular recreational fishes - easy to catch angling from beaches, jetties, and boats. Commerical landings have declined since early 1980s. The recreational fishery for surfperch (family Embiotocidae) remains open all year. The daily bag and possession limit is 5 fish in combination of all species except shiner surfperch (Cymatogaster aggregata) , which have a separate bag limit of 20 fish.
Black perch	Embiotoca jacksoni	G		
Calico surfperch	Amphistichus koelzi	A		
Dwarf perch	Micrometrus minimus	G		
Island seaperch	Cymatogaster aggregata gracilis	G		
Kelp perch	Brachyistius frenatus	G		
Pile perch	Rhachochilus vacca	A		
Pink seaperch	Zalembius rosaceus	G		
Shiner perch	Cymatogaster aggregata	F, G		
Sharpnose seaperch	Phanerodon atripes	G		
Striped seaperch	Embiotoca lateralis	A		
Silver surfperch	Hyperprosopon ellipticum	F, G		
Spotfin	Hyperprosopon anale	G		
White seaperch	Phanerodon furcatus	G		
Walleye surfperch	Hyperprosopon argenteum	A, F		
Rainbow seaperch	Hypsurus carvi	G		
Redtail	Amphistichus rhodoterus	A, F		
Reef perch	Micrometus aurora	G		
Rubberlip	Rhacochilus toxotes	A, F		
Other Nearshore Fish				
Cabezon	Scorpaenichthys marmoratus	A	CA-NFMPlan NFPermit GMP CA-RCG CCCA	<u>Federally regulated groundfish.</u> Also, a limited entry **Nearshore Fishery Permit** required for commercial catch of Cabezon. <u>Cowcod conservation area rules apply</u>. Prized by sport divers, less important for anglers on CPFVs, commercially caught for live fish industry (ca. 90%) with limited entry traps and hook&line. **Recreational** catch regulated by the RCG Complex Rules (see "Rockfish", above) , except that only one Cabezon at least 15" is allowed per day.
California Scorpionfish	Scorpaena guttata		CA-NFMPlan NFPermit GMP CCCA	<u>Federally regulated groundfish.</u> Also, a limited entry **Nearshore Fishery Permit** required for commercial catch of California Scorpionfish. <u>Cowcod conservation area rules apply</u> Ca. 80% of commerical catch is for live fish industry by finfish traps and hook&line, moderate take from sport boats. **Recreational** catch regulated by the RCG Complex Rules (see "Rockfish", above) , except that Daily bag limit =5 for this species, with size limit of 10"

Common Name	Scientific Name	On-line Infor. sources*	Pertinent Regula-tory Actions**	Details about commercial or recreational catch.
California Sheephead	Semicossyphus pulcher		CA-NFMPlan NFPermit CCCA	Federally regulated groundfish. Also, a limited entry **Nearshore Fishery Permit** required for commercial catch of California Sheephead. **Commercial take PROHIBITED < 13 inches.** Recent renewed commercial interest, some finfish traps used, taken by sport divers and angler, and increasingly caught for live fish commercial industry. **Recreational** catch regulated by the RCG Complex Rules (see "Rockfish", above) , except that Daily bag limit =5 for this species, with size limit of 12"**.**
Greenling, Kelp	Hexagrammos decagrammus	A	CA-NFMPlan NFPermit GMP CA-RCG CCCA	Federally regulated groundfish. Also, a limited entry **Nearshore Fishery Permit** required for commercial catch of Hexagrammos. Cowcod conservation area rules apply. Rare in S.California, some finfish traps used for live fish market, they occur as by catch in lingcod fishery, speared by divers. **Recreational** catch regulated by the RCG Complex Rules (see "Rockfish", above) , except that only one kelp or rock greenling is allowed per day, with size limit of 12"**..**
Greenling, Rock	Hexagrammos lagocephalus		CA-NFMPlan NFPermit CA-RCG CCCA	Federally regulated groundfish. Also, a limited entry **Nearshore Fishery Permit** required for commercial catch of Hexagrammos. Cowcod conservation area rules apply Some finfish traps used. **Recreational** catch regulated by the RCG Complex Rules (see "Rockfish", above) , except that only one kelp or rock greenling is allowed per day, with size limit of 12"**.**
Greenling, Painted	Oxylebius pictus		CCCA	Cowcod Conservation Area rules apply
Greenling, Whitespotted	Hexagrammos stelleri		CCCA CA-RCG	Cowcod conservation area rules apply. RCG Complex rules for recreational catch apply
Monkeyface Prickleback	Cebidichthys violaceus	A	CA-NFMPlan	Commercial catch regulated owing to status as Federally managed groundfish, and inclusion in Nearshore Fisheries Management Plan Uncommon south of Pt. Conception, minor component of recreational and commercial catch, speared by divers, and taken by "poke poles" by shore anglers. No depth restrictions for recreational catch.
Southern spearnose poacher	Agonopsis sterletus			**Commercial take PROHIBITED (all poachers).**
Lingcod	Ophiodon elongatus	A	GMP CCCA	Federally managed groundfish . Federal quotas and size limits apply, important commercial sp., caught by trawls and hook&line, lingcod recently entered live fish market. Illegal to catch using drift- ore set-gill nets in waters surrounding the Channel islands that are < 70 fm deep, or within 1 nm of shore. **Recreational** boat-based anglers allowed Apr-Sept, shore-based anglers and divers allowed Apr-Nov. Apr-June - only allowed in water 30-60 fm , July-Sept only in water <40fm. Cowcod Conservation Area rules apply
Giant Seabass	Stereolepis gigas	A, F, G		**Commercial catch PROHIBITED.** In permanent decline for several decades. Only 1 fish in incidental catch per trip allowed for commercial fishermen
Kelp Bass	Paralabrax clathratus	A, F		**Commercial catch PROHIBITED.** Popular nearshore sportfish using hook&line from peirs, shore, boats. Channel Islands are one of more productive kelp bass fishing areas.
Barred Sand Bass	Paralabrax nebulifer	A, F		**Commercial catch PROHIBITED.** Sport size and bag limits apply, CPFV catch increasing, sport catch by hook&line. No depth restrictions for recreational catch.
Spotted Sand Bass	Paralabrax maculato-fasciatus	A, F		**Commercial catch PROHIBITED.** Rare north of Santa Monica Bay, popular with nearshore sport anglers, exclusive tournaments exist for the species. No depth restrictions for recreational catch.
Yellowtail	Seriola lalandi	A		sport and commercial catches confined to south of Pt. Conception, catch usually nearshore near kelp, hook&line, catch by gillnet legal only outside 3 miles. No depth limits for recreational catch.
Opaleye	Girella nigricans	A		not part of designated fishery, appears as incidental catch, small number entering live fish market. Recreational Catch regulated

Common Name	Scientific Name	On-line Infor. sources*	Pertinent Regula-tory Actions**	Details about commercial or recreational catch.
Garibaldi	Hypsypops rubicundus			**Commercial and sport take PROHIBITED**.
Wolf eel, northern wolfish	Anarrhichthys ocellatus			**Commercial take PROHIBITED.**
California lizardfish	Synodus lucioceps			general finfish regulations (bag limits, etc.) apply
Pacific butterfish	Peprilus simillimus			general finfish regulations (bag limits, etc.) apply
Ocean whitefish	Caulolatilus princeps	G		Recreational equipment rules and seasons match those for the RCG Complex (see Rockfish, generally, above). Recreational bag limit = 10, with no size limit.
Spotted ratfish	Hydrolagus colliei		GMP	As a federally regulated groundfish, commercial limits and quotas apply, and the recreational catch equipment rules and seasons match those for the RCG Complex (see Rockfish, generally, above)
Salema	Xenistius californiensis			general finfish regulations (bag limits, etc.) apply
Half Moon	Medialuna californiensis	A		Not part of a designated fishery, appears as incidental catch, small number entering live fish market. General finfish regulations apply
Skates and Rays				
Shovelnose guitarfish	Rhinobatos productus	A, F		target of small sport fishery
Piked dogfish	Squalus acanthias	F	GMP	As a federally regulated groundfish, commercial limits and quotas apply, and the recreational catch, equipment rules and seasons match those for the RCG Complex (see Rockfish, generally, above)
Bat ray	Myliobatis californica	A, F		target of small sport fishery
California Skate	Raja inornata	A	GMP CCCA	As a federally regulated groundfish, commercial limits and quotas apply, and the recreational catch, equipment rules and seasons match those for the RCG Complex (see Rockfish, generally, above). Specific depths are closed for this species during specific months in the Cowcod Conservation Areas (one of which surrounds Santa Barbara Island).
Round stingray	Urolophus halleri	A, F		mostly caught south of Pt. Conception
Silversides - principal commercial effort is in bays using gillnets, lampara nets and round haul nets				
Jacksmelt	Atherinopsis californicus	A		no commercial limits, not desired by anglers
Topsmelt	Atherinops affinis	A		no commercial limits, most ubiquitous and abundant sp. in surfgrass - impotant to least terns
Grunion	Leuresthes tenuis	A		not commercially targeted, provides recreational fishery (hands only) on beaches during grunion runs. The recreational fishery for California grunion is open from June -March.
Gobies				
Bluebanded goby	Lythrypnus dalli	A		minor aquarium trade
Zebra goby	Lythrypnus zebra	A		minor aquarium trade
Nearshore Sharks. Drift gill net fishery for shark and swordfish subject to permit, season, and area restrictions. Sharkfins may not be landed without a corresponding carcass. State ban on gillnets applies only within 1 nm from offshore islands.				
Pacific Angel Shark	Squatina californica			large commercial fishery developed off Santa Barbara Co. and around Santa Cruz and Santa Rosa Islands in 1980s, using drift gillnets. Gillnet ban in most state waters in 1991 contributed to dramatic decline in catch.

Common Name	Scientific Name	On-line Infor. sources*	Pertinent Regula-tory Actions**	Details about commercial or recreational catch.
Leopard Shark	Triakis semifasciata	F	GMP CCCA	Commercial catch < 36 inches PROHIBITED. Commercial catch by set net, hook&line and trawl and is now mostly incidental. Sport catch by angling and spearfishing. Sport size and bag limits apply in sport fishery, size limit applies to commercial fishery. As a federally regulated groundfish, commercial limits and quotas apply and the recreational catch depth restrictions and seasons match those for the RCG complex (see Rockfish, generally, above) - except in Newport, San Diego and Mission Bays - in which boat based anglers are allowed year round at all depths. Specific depths are closed for this species during specific months in the Cowcod Conservation Areas (one of which surrounds Santa Barbara Island).
Soupfin Shark	Galeorhinus galeus		GMP CCCA	Prized by recreational anglers, commercial catch (historically sought for shark liver oil) has declined since 1980s (although listed here, this sp. is also **Highly migratory).** As a federally regulated groundfish, commercial limits and quotas apply and the recreational catch depth restrictions and seasons match those for the RCG complex (see Rockfish, generally, above). Specific depths are closed for this species during specific months in the Cowcod Conservation Areas (one of which surrounds Santa Barbara Island).
DEEPER WATER FISH				
DTS Complex (thornyheads, Dover sole, sablefish)				DTS complex is the most important element in the Californian groundfish fishery. As federally regulated groundfish, **commercial limits and quotas** for these species apply, recreational size limits and bag limits apply, and recreational; depth restrictions and seasons match those for the RCG Complex (see Rockfish, generally, above). Specific depths are closed for these species during specific periods in the Cowcod Conservation Areas (one of which surrounds Santa Barbara Island).
Longspine thornyhead	Sebastolobus altivelis	A	GMP CCCA	caught mostly north of Pt. Conception, taken with bottom trawl and longline on sand or fine sediment, first regulated in 1990, owing to lack of swimbladder they enter the live fish market.
Shortspine thornyhead	Sebastolobus alascanus	A	GMP CCCA	
Dover sole	Microstomus pacificus	A	GMP CCCA	caught mostly north of Pt. Conception.
Sablefish	Anoplopoma fimbria		GMP CCCA	trawls and gill nets for mixed spp. catch, longline and traps for sp.-specific catch.
Pacific hake (whiting)	Merluccius productus		GMP CCCA	Is the largest groundfish resource managed by the PFMC's Groundfish Management Plan. Commerical catch in California is in NoCal, but coastal stock spawns between central California and Baja California, thus spawning fish aggregate in the Southern California Bight. Factory trawlers take part of the catch.
Petrale sole	Eopsetta jordani	F	GMP CCCA	usually incidental catch by sport anglers on CPFVs in 100-300 feet.
SHELF ROCKFISH.	Commercial catch of these species is affected by general rockfish rules above. As federally regulated groundfish, **commercial limits and quotas** for these species apply. Commercial catch is mostly by trawl, set gillnet (little used now), hook&line. Specific depths are closed during specific periods in the Cowcod Conservation Areas (one of which surrounds Santa Barbara Island). For Recreational fishing, the **RCG Complex** rules for seasons, equipment, aggregate bag limits and size limits apply (as described under "Rockfish, generally" above).			
Bocaccio ("red snapper")	Sebastes paucispinis		GMP CA-RCG CCCA	Was dominant rockfish in early longline and bottom trawl fisheries, important species in recreational and commercial catches until declined precipitously and declared "overfished" by PFMC. **Recreational** bag limit for bocaccio is 1.
Cowcod	Sebastes levis		GMP CA-RCG CCCA	Remaining productive grounds are well offshore, declared "overfished" by PFMC in 2000. **RECREATIONAL CATCH PROHIBITED IN AREA 19** (which includes all Channel Islands).

Common Name	Scientific Name	On-line Infor. sources*	Pertinent Regula-tory Actions**	Details about commercial or recreational catch.
Chilipepper	Sebastes goodei		GMP CA-RCG CCCA	Recently ranked first in commercial rockfish landing in NoCal, not so much in SoCal, PFMC sets total allowable catch.
Canary rockfish	Sebastes pinniger	A	GMP CA-RCG CCCA	N of Bodega bay, trawl catch historically dominant, recent dramatic decline, still taken by trawl, commercial and sport hook&line. **RECREATIONAL CATCH PROHIBITED IN AREA 19** (which includes all Channel Islands)
Shortbelly rockfish	Sebastes jordani	A	GMP CA-RCG CCCA	No commercial fishery has ever developed, most abundant rockfish off California and large numbers are off Channel Islands, adults form large schools near bottom. Is currently fished very little. Owing to its small size, targeted bottom trawling for this sp. would incur much bycatch.
Halfbanded Rockfish	Sebastes semicinctus		GMP CA-RCG CCCA	
Rosy Rockfish	Sebastes rosaceus		GMP CA-RCG CCCA	
Greenspotted rockfish	Sebastes chlorostictus		GMP CCCA CA-RCG	
Starry rockfish	Sebastes constellatus		GMP CCCA	
Squarespot rockfish	Sebastes hopkinsi		GMP CCCA CA-RCG	
Stripetail Rockfish	Sebastes saxicola		GMP CA-RCG CCCA	
Vermillion Rockfish	Sebastes miniatus	A C	GMP CA-RCG CCCA	moderately important in commercial and sport fishery, comprised 8% of rockfish catch from 1983-1988 landed south of Pt. Conception.
Yelloweye Rockfish	Sebastes ruberrimus		GMP CA-RCG CCCA	As a Federally managed groundfish, commercial catch is limited. **NO RECREATIONAL CATCH ALLOWED IN AREA 19** (which includes all Channel Islands)
Yellowtail Rockfish	Sebastes flavidus		GMP CA-RCG CCCA	Rare south of Pt. Conception. Where found, commercially important.
Greenblotched rockfish	Sebastes rosenblatti		GMP CA-RCG CCCA	
Widow rockfish	Sebastes entomelas		GMP CCCA	
Pink rockfish	Sebastes eos		GMP CCCA	
Rosethorn rockfish	Sebastes helvomaculatus		GMP CA-RCG CCCA	
Speckled rockfish	Sebastes ovalis		GMP CA-RCG CCCA	
Flag rockfish	Sebastes rubrivinctus		GMP CA-RCG CCCA	
Slope Rockfish		Commercial catch of these species is affected by general rockfish rules (see "Rockfish, generally" above). As federally regulated groundfish, **commercial** limits and quotas for these species apply. Commercial catch is mostly by trawl, set gillnet (little used now), hook&line. Particular depths are closed during particular periods in the Cowcod Conservation Areas (one of which surrounds Santa Barbara Island). For Recreational Fishing the **RCG Complex** rules for seasons, equipment, aggregate bag limits and size limits apply (as described under "Rockfish, generally" above).		
Blackgill Rockfish	Sebastes melanostomus	A	GMP CA-RCG CCCA	Most taken in central and southerr California currently w. horizontal set lines. Landings decreased dramatically from 1983, much of commercial catch goes to Asia.

Common Name	Scientific Name	On-line Infor. sources*	Pertinent Regula-tory Actions**	Details about commercial or recreational catch.
Bank Rockfish	Sebastes rufus		GMP CA-RCG CCCA	
Splitnose rockfish	Sebastes diploproa		GMP CA-RCG CCCA	
Redbanded rockfish	Sebastes babcocki		GMP CA-RCG CCCA	
Deeper Flatfish, generally		Those marked GMP are federally regulated groundfish, the recreational catch equipment rules and seasons match those for the RCG complex (see Rockfish, generally, above). Also, specific depths are closed for the species marked CCCA during specific months in the Cowcod Conservation Areas (one of which surrounds Santa Barbara Island).		
Pacific Halibut	Hippoglossus stenolepsis	A, F	GMP CCCA	extensively monitored by the International Pacific Halibut Commission (IPHC), uncommon in California waters, caught by trawl and set longlines.)
Rex sole	Errex zachirus, Glyptocephalus zachurus	A	GMP CCCA	supports a moderate commercial fishery, landings declined in 1990s along with other groundfish.
English sole	Pleuronectes vetulus	A	GMP CCCA	was leading commercial flat fish until Dover sole fishery developed, little taken south of Pt. Conception.
Rock Sole	Pleuronectes bilineatus	C	GMP CCCA	These deeper flatfish occur mostly as incidental catch in otter trawls.
Butter Sole	Pleuronectes isolepsis		GMP CCCA	
Fantail Sole	Xystreurys liolepis			
Sand Sole	Psettichthys malanostictus	C	GMP CCCA	
Slender Sole	Lyopsetta exilis			
Lefteyed flounders	Bothidae			
Bigmouth Sole	Hippoglossina stomata			
California tonguefish	Symphurus atricauda			
Curlfin turbot	Pleuronichthys decurrens	C	GMP CCCA	
Hornyhead turbot	Pleuronichthys verticalis	C		
Spotted turbot	Pleuronichthys ritteri	C		
Diamond turbot	Hypsopsetta guttulata			
C-O sole	Pleuronichthys coenosus	C		
Arrowtooth flounder	Atheresthees stomias		GMP CCCA	
Skates and Rays				
Big skate	Raja binoculata		GMP CCCA	Generally not sought commercially - appear as incidental catch in bottom trawlers. Skate wings marketed only (for Asia), most commercial catch north of Monterey, landings are increasing owing to increased effort for other species. Big skate and longnose skate are federally regulated groundfish, for them the recreational catch equipment rules and seasons match those for the RCG complex (see Rockfish, generally, above), and rules for the Cowcod Conservations Areas also apply to them.
Longnose Skate	Raja rhina		GMP CCCA	
Sandpaper skate	Bathyraja interrupta			
Starry skate	Raja stellulata			
OTHER DEEPER FISH: Benthopelagic/Bathypelagic/Bathydemersal				
Blacktip poacher	Xeneretmus latifrons			COMMERCIAL TAKE PROHIBITED
Pygmy poacher	Odontopyxis trispinosa			COMMERCIAL TAKE PROHIBITED

Common Name	Scientific Name	On-line Infor. sources*	Pertinent Regula-tory Actions**	Details about commercial or recreational catch.
Bluespotted poacher	Xeneretmus triacanthus			COMMERCIAL TAKE PROHIBITED
Yellowtail jack	Seriola dorsalis			No depth restrictions for recreational fishing.
Spiny dogfish	Squalus acanthias	F	GMP	Federally managed groundfish. Recreational catch limits, equipment rules and seasons match those for the RCG complex (see Rockfish, generally, above)
EPIPELAGIC AND COASTAL PELAGIC SPECIES				
Pacific Bonito	Sarda chiliensis	A, F		Bonito is one of top 15 recreational spp. by hook&line and trolling with lures. commercial catch mostly by purse seine (seasonally targeted by "wetfish" seiners that usually harvest mackeral and sardines) but also taken by troll, gillnets, pole&line. Nearly all wetfish seiners are based in San Pedro and fish in San Pedro and Santa Barbara Channels, market demand low, commercial landings down in 1990s
California Barracuda, Pacific Barracuda	Sphyraena argentea	A		Barracuda commercially caught by gillnet and hook&line. Size limits apply. Sport anglers use live bait, or lures, sometimes w. chumming. No depth restrictions apply to recreational fishing.
Pacific Sardine	Sardinops sagax	A	CPSMP	There is a limited-entry purse seine fleet for *coastal pelagic fisheries* that operates in Southern California bight, including the Channel Islands. This fishery targets Pacific sardine, Northern Anchovy, Pacific mackerel and jack mackerel and market squid using purse and drum seine and lampara nets. Anchovy catch for reduction (fish meal, oil) is limited by specific permits in state waters. Pacific Mackerel taken by sport fishermen, owing to abundance rather than desire. Sardines are used for human food and pet food.
Northern Anchovy, Californian anchoveta	Engraulis mordax	A	CPSMP Special permits required in state waters if caught for reduction	
Pacific mackerel	Scomber japonicus	A, F	CPSMP	
Jack Mackerel	Trachurus symmetricus	A	CPSMP	
King Salmon (Chinook)	Onchorhynchus tshawytscha	A	SMP	Federally managed areas, seasons, quotas, gear, size and landing limits
Steelhead (Rainbow trout)	Onchorhynchus mykiss	A	SMP	The steelhead fishery in southern California (south of San Luis Obispo) has been closed due to severe declines and extirpation of many of the runs and a listing of others under the federal Endangered Species Act (ESA). No retention of steelhead trout allowed by recreational fishermen.
Ocean sunfish	Mola mola			Commercial take PROHIBITED.
Great white shark	Carcharodon carcharias			Commerical take PROHIBITED. Incidental catch allowed in specific net fisheries.
Basking shark	Cetorrhinus maximus			Commercial take PROHIBITED.
HIGHLY MIGRATORY PELAGIC FISHES		Drift gill nets are prohibited in State Waters. Drift gill net fishery for shark and swordfish in Federal waters is subject to permit, season, and area restrictions. Sharkfins may not be landed without a corresponding carcass.		
Albacore tuna	Thunnus alalunga	A, F	HMSMP	Enthusiastic sport fishing from CPFVs around the Channel islands. Commercially targeted by troll fishery (mostly by foreigners in international waters).
Broadbill swordfish	Xiiphias gladius	A	HMSMP	S. California landings are important to both commercial and recreational fisheries
Pacific Northern Bluefin Tuna	Thunnus orientalis	A, F	HMSMP	S. California landings are important to both commercial and recreational fisheries
Skipjack Tuna	Katsuwonus pelamis	A, F	HMSMP	S. California landings are important to both commercial and recreational fisheries.
Yellowfin Tuna	Thunnus albacares	A, F	HMSMP	S. California landings are important to both commercial and recreational fisheries
Striped Marlin	Tetrapturus audax	A	HMSMP	**Commercial Catch Prohibited.** The California Legislature curtailed the sale and import of striped marlin in 1937 thus preserving the southern California fishery entirely for recreational anglers. Currently, most striped marlin fishing is from privately owned boats based in local southern California marinas. On high seas, taken as incidental catch in tuna longline fisheries.

Common Name	Scientific Name	On-line Infor. sources*	Pertinent Regula-tory Actions**	Details about commercial or recreational catch.
Shortfin Mako Shark	Isurus oxyrinchus	A, F	HMSMP	Currently, mako sharks are taken by drift gillnets (not allowed in State waters) and hook-and-line. Most mako sharks, however, are bycatch taken in the drift gillnet fishery for thresher sharks and swordfish. The shortfin mako shark is also taken by the high seas shark and sword•sh drift longline •shery, which developed between 1991 and 1994. This fishery operates outside the 200-nautical-mile Exclusive Economic Zone in international waters.
Common Thresher Shark	Alopius vulpinus	A, F	HMSMP	the leading commercial shark landed in California, however, commercial catch by drift gillnet can occur only in Federal waters
Blue Shark	Prionace glauca	A, F	HMSMP	Not a target of California commercial or recreational fisheries owing to inedibility (flesh becomes ammonified after death). Occur as bycatch in drift gillnet fisheries.
Opah	Lampris guttatus	A		94% taken commercially as bycatch in the drift gillnet fishery (Federal waters only). Majority landed in California since 1990 were landed from San Luis Obispo County south. Many sport caught opah are taken from the northern Channel Islands south to just below the Mexico border.
Louvar	Luvarus imperialis	A		seasonal transients associated with warm water currents late in the year. Considered a desirable, but incidental catch species primarily in the shark and swordfish drift gillnet fishery. Majority of catches occur off the Southern California Bight, most in the area of Point Loma, San Clemente Island, and Cortez Bank.
Dolphinfish (Mahi-Mahi, Dorado)	Coryphaena hippurus	A	HMSMP	Occurs in the California recreational catch primarily during warm water years. Most catches occur in the Southern California Bight, especially south of Los Angeles. In commercial fisheries, an estimated average of 1,084 dolphin have been landed and 324 released per year by the high seas longline fishery.

***SOURCES OF ON-LINE INFORMATION ABOUT SPECIES**

A: California Dept. Fish & Game, Status of Living Marine Resources (http://www.dfg.ca.gov/mrd/status/index.html)
B: Nearshore Fishery Management Plan (NFMP). Appendix D. Description of Stocks. http://www.dfg.ca.gov/mrd/nfmp/pdfs/appendix_d.pdf
C: Chapter 4, Environmental Settings. Final Environmental Document. Marine Protected Areas in NOAA's Channel Islands National Sanctuary (http://www.dfg.ca.gov/mrd/ci_ceqa/index.html).
D: Nearshore Finfish Profiles. Detailed pdf downloads for selected nearshore finfish species (http://www.dfg.ca.gov/mrd/rockfish/index.html)
E: Status of the California Sheephead Stock for 2004 (1st stock assessment completed under the Marine Life Management Act -NFMP) (http://www.dfg.ca.gov/mrd/sheephead2004/index.html)
F: California Dept. Fish & Game, California Marine Sportfish, http://www.dfg.ca.gov/mrd/msfindx0.html
G: Annual Status of the Fisheries Report Through 2003, California Dept. Fish & Game (http://www.dfg.ca.gov/mrd/status/index.html)

****EXPLANATIONS OF CODES FOR PERTINENT REGULATORY ACTIONS**

MZPA = Marine Zone Protection Act of 1990 (led to certain gear restrictions in state waters)
MRPZ = Marine Resources Protection Zone (within 3 miles of mainland and 1 mile, or 70 fathoms depth, of Channel Islands)
CA-WSFMP = Cal. Fish & Game White Seabass Fishery Management Plan (http://www.dfg.ca.gov/mrd/wsfmp/index.html), not yet law.
CA-NFMPlan = 19 species are regulated by the Cal. Fish & Game Nearshore Fishery Management Plan:
(1) black rockfish *(Sebastes melanops)*, (2) black-and-yellow rockfish *(S. chrysomelas)*, (3) blue rockfish *(S. mystinus)*, (4) brown rockfish *(S. auriculatus)*, (5) cabezon *(Scorpaenichthys marmoratus)*, (6) calico rockfish *(Sebastes dallii)*, (7) California scorpionfish (sculpin) *(Scorpaena guttata)*, (8) California sheephead *(Semicossyphus pulcher)*, (9) China rockfish *(Sebastes nebulosus)*, (10) copper rockfish *(Sebastes caurinus)*, (11) gopher rockfish *(Sebastes carnatus)*, (12) grass rockfish *(Sebastes rastrelliger)*, (13) greenlings of the genus *Hexagrammos (2 spp)*, (14) kelp rockfish *(Sebastes atrovirens)*, (15) monkeyface eel *(Cebidichthys violaceus)*, (16) olive rockfish *(Sebastes serranoides)*, (17) quillback rockfish *(Sebastes maliger)*, and (18) treefish *(Sebastes serriceps)* (http://www.dfg.ca.gov/mrd/nfmp/index.html).
NFPermit = Cal. Fish & Game issued Commercial Nearshore Fishery Permit (NFPermit) required for the commercial take of the following species of nearshore fish stocks: black-and-yellow rockfish, gopher rockfish, kelp rockfish, California scorpionfish, greenlings of the genus *Hexagrammos*, China rockfish, grass rockfish, California sheephead, and cabezon. Size and gear limits apply to these species. Within one mile of shore - no commercial catch allowed except by rod and reel or hand lines - and hook numbers, rod numbers, and line strength are regulated.
DNSFPermit = Cal. Fish & Game issued Commercial Deeper Nearshore Species Fishery Permit (DNSFP) required for these species in state water
GMP = species federally regulated by the Pacific Fishery Management Council's Groundfish Management Plan (fishing regs. for state waters must be consistent with federal law)

SMP = species federally regulated by the Pacific Fishery Management Council's Salmon Management Plan (fishing regs. for state waters must be consistent with federal law)

HMSMP = species federally regulated by the Pacific Fishery Management Council's Highly Migratory Management Plan (fishing regs. for state waters must be consistent with federal law)

CPSMP - species federally regulated by the Pacific Fishery Management Council's Coastal Pelagic Species Fishery Management Plan (fishing regs. for state waters must be consistent with federal law)

CA-RCG = Recreational Catch regulated in state waters by Cal. Fish & Game Rockfish Cabezon Greenling Complex regulations

CCCA = Ocean depth restricts allowable fishing locations for these species within the California Cowcod Conservation Areas

APPENDIX D. Seabirds associated with the Channel Islands National Park. Adapted from Ugoretz (2002)

Common Names of Bird Families and Species	Scientific Names	Breeds in the Park?	Monitored at the Park?[a]	Conser-vation Status[b]	Occurrence in Channel Islands[c]
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*	BREEDS			Winter visitor; several spring breeding records; uncommon to locally common in summer
Clark's Grebe	*Aechmophorus clarkii*	BREEDS			Winter visitor; several spring breeding records; very uncommon to locally common in summer
Albatrosses (offshore)	*Family: Diomedeidae*				
Black-footed Albatross	*Phoebastria nigripes*			IUCN-VU	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*			IUCN-LR/nt	Casual winter visitor offshore
Murphy's Petrel	*Pterodroma ultima*			IUCN-LR/nt	Very rare visitor well offshore
Cook's Petrel	*Pterodroma cookii*			IUCN-CR	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*			IUCN-VU	Very rare in winter; common visitor in spring/summer
Flesh-footed Shearwater	*Puffinus carneipes*				Casual visitor offshore
Buller's Shearwater	*Puffinus bulleri*			IUCN-VU	Very rare fall visitor well offshore

Common Names of Bird Families and Species	Scientific Names	Breeds in the Park?	Monitored at the Park?[a]	Conser-vation Status[b]	Occurrence in Channel Islands[c]
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*			IUCN-VU	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*			CA-SC	Casual visitor in winter/spring
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	BREEDS	**MONIT**		Uncommon to common in winter/spring/fall; uncommon in summer, breeds on islands
Ashy Storm-Petrel	*Oceanodroma homochroa*	BREEDS	**MONIT**	CA-SC, FED-BCC, IUCN-LR/nt	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*	BREEDS	**MONIT**	CA-SC	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*	BREEDS		CA-E, FED-E	Common year-round. Breeds on Anacapa, Santa Cruz, Santa Barbara islands
Cormorants (onshore and offshore)	*Family: Phalacrocoracidae*				
Double-crested Cormorant	*Phalacrocorax auritus*	BREEDS	**MONIT**		Winter visitor, uncommon and local in summer, breeds on islands
Brandt's Cormorant	*Phalacrocorax penicillatus*	BREEDS	**MONIT**		Common to very common winter visitor. Breeds on Channel Islands
Pelagic Cormorant	*Phalacrocorax pelagicus*	BREEDS	**MONIT**		Fairly common to common winter visitor; fairly common summer resident, breeds on islands.
Frigatebirds (offshore)	*Family: Fregatidae*				
Magnificent Frigatebird	*Fregata magnificens*				Rare summer visitor

Common Names of Bird Families and Species	Scientific Names	Breeds in the Park?	Monitored at the Park?[a]	Conser-vation Status[b]	Occurrence in Channel Islands[c]
Geese (onshore and offshore)	*Family: Anatidae*				
Brant's Goose	*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*	BREEDS		FED-T	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*	BREEDS			Common permanent resident year round, breeds on islands
Oystercatchers (onshore)	*Family: Haematopodidae*				
Black Oystercatcher	*Haematopus bachmani*	BREEDS			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

Common Names of Bird Families and Species	Scientific Names	Breeds in the Park?	Monitored at the Park?[a]	Conser-vation Status[b]	Occurrence in Channel Islands[c]
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
Semipalmated Sandpiper	*Calidris pusill*				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 lobatu*				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

Common Names of Bird Families and Species	Scientific Names	Breeds in the Park?	Monitored at the Park?[a]	Conservation Status[b]	Occurrence in Channel Islands[c]
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
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*			IUCN-LR/nt	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*			CA-SC	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*	BREEDS	**MONIT**		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*			CA-SC FED-BCC	Casual visitor
Caspian Tern	*Sterna caspia*			CA-SM FED-BCC	Very rare to rare in winter; fairly common summer visitor
Royal Tern	*Sterna maxima*			CA-SC	Fairly common winter visitor; uncommon in spring; casual in summer; fairly common transient in fall

Common Names of Bird Families and Species	Scientific Names	Breeds in the Park?	Monitored at the Park?[a]	Conser-vation Status[b]	Occurrence in Channel Islands[c]
Elegant Tern	*Sterna elegans*			CA-SC FED-BCC IUCN-LR/nt	Casual in winter; rare in spring; common in summer/fall
Common Tern	*Sterna hirundo*				One winter record; rare summer visitor
Arctic Tern	*Sterna paradisaea*			FED-BCC	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*			CA-E, FED-E	Fairly common but local resident in summer
Black Tern	*Chlidonias niger*				Rare and declining
<u>Skimmers (onshore and offshore)</u>	*Family: Laridae*				
Black Skimmer				CA-SC FED-BCC	Very rare visitor, increasing
<u>Alcids (onshore and offshore)</u>	*Family: Alcidae*				
Common Murre	*Rhynchops niger*				Uncommon to common winter transient and offshore visitor; rare in spring/summer
Pigeon Guillemot	*Cepphus columba*	BREEDS	**MONIT**		Casual in winter/spring/fall; common summer resident. Breeds on North Coast and Channel Islands
Marbled Murrelet	*Brachyramphus marmoratus*			CA-E, FED-T, FED-BCC, IUCN-VU	Very rare visitor in winter/summer/fall; casual in spring
Xantus's Murrelet	*Synthliboramphus hypoleucus*	BREEDS	**MONIT**	CA-C, CA-CS, FED-BCC, IUCN-VU	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*	BREEDS		CA-SC, FED-BCC	Widespread in winter; locally common in summer. Breeds on Channel Islands
Parakeet Auklet	*Cyclorrhynchus psittacula*				Casual vagrant well offshore
Rhinoceros Auklet	*Cerorhinca monocerata*	BREEDS		CA-SC	Fairly common to common transient and visitor. Breeds at Point Arguello
Tufted Puffin	*Fratercula cirrhata*	BREEDS		CA-SC	Very rare visitor well offshore in winter/spring/fall, breeding records from the islands.
Horned Puffin	*Fratercula corniculata*				Casual spring visitor well offshore

[a]Breeding activity monitored by CINP. Monitoring protocols (locations, species) have varied from 1985-present. Since 1997, monitoring efforts are concentrated on Santa Barbara Island. On-line reports are available at http://www.nature.nps.gov/im/units/chis/HTMLpages/AnnlReports/MarineReports.htm

[b]Conservation status obtained from *The California Current Marine Bird Conservation Plan* (2005) Ed. KL Milles, WJ Sydeman & PJ Hodum, Point Reyes Bird Observatory Conservation Science, accessed on-line 10/2005 (http://www.prbo.org/cms/index.php?mid=66&module=browse).

Explanation of state (CA) and Federal (FED) conservation codes: BCC = Bird of Conservation Concern; C = State Candidate; SC = Special Concern; SM = State Monitor; T = Threatened; E = Endangered

IUCN Rank Codes: CR = Critically Endangered; VU = Vulnerable; LR/nt = Lower Risk/Near Threatened

Sources cited by PRBO for CA and FED status:

- State and Federally Listed Endangered and Threatened Animals of California, Dept. of Fish and Game, Habitat Conservation Division, July 2003
- Draft (2003) California Bird Species of Special Concern List, www.prbo.org/BSSC/index.htm
- Birds of Conservation Concern 2002. U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, VA.
- 2002 IUCN Red List of Threatened Species, http://www.redlist.org

[c]Notes on occurrence following *The Birds of Santa Barbara County, California* by Paul E. Lehman (1994) Vertebrate Museum, University of California, Santa Barbara:

- *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

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APPENDIX E . List of dischargers with NPDES wastewater permits in selected hydrologic units of Region 3 and Region 4. List includes all dischargers along the mainland coast from Pt. Conception to the mouth of the Los Angeles River. As of 9/2005, some of permits on this list were expired, however the permitees remained enrolled in the program, owing to administrative extension (see text). List does *not* include state issued NPDES *stormwater permits* (municipal, industrial and construction), see Table 9 for a summary of stormwater permits. Ratings (R) are explained at the end of the table. Waste type codes are explained at the end of the table.

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	WASTE TYPE	RECEIVING WATER
CENTRAL COAST REGIONAL WATER QUALITY MANAGEMENT DISTRICT - STATE REGION 3					
South Coast - Hydrologic Unit 15					
Arguello Company	Gaviota Oil Heating Facility				Pacific Ocean
Chevron USA	Gaviota Terminal		CA0049018		Pacific Ocean
Cultured Abalone Inc.	Cultured Abalone Aquaculture Facility		CA0049433		Pacific Ocean
Goleta Sanitary District	GSD Wastewater Treatment Facility (WWTP)		CA0048160	DOMEST	Pacific Ocean
City of Santa Barbara	El Estero WWTP		CA0048143	DOMEST	Pacific Ocean
Montecito Sanitary District	MSD WWTP		CA0047899	DOMEST	Pacific Ocean
Carpinteria Sanitary District	CSD WWTP		CA004364	DOMEST	Pacific Ocean
Summerland Sanitary District	SSD WWTP		CA0048054	DOMEST	Pacific Ocean
Ambassador Laundry			CA0049654		
Northern Channel Islands - Hydrologic Unit 16 (SAN MIGUEL, SANTA ROSA, and SANTA CRUZ ISLANDS)					
None					

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
LOS ANGELES REGIONAL WATER QUALITY MANAGEMENT DISTRICT - STATE REGION 4						
Channel Islands Watershed Management Area Wastewater Permits - NPDES						
MAJOR						
Avalon, City of	Avalon WWTF	AVALON	CA0054372	1	DDOMEST	Pacific Ocean
MINOR						
Southern California Edison Co.	Pebbly Beach Desalination Plt	AVALON	CA0061191	2	DFILBRI	Pacific Ocean
US Navy Naval Air Weapons Stat	San Nicholas Island Desalinati	SAN NICHOLAS ISLAND	CA0061794	3	DFILBRI	SAN NICHOLAS ISLAND
US Navy Region Southwest	NALF, San Clemente Island WWTP	SAN CLEMENTE ISLAND	CA0110175	1	DDOMEST	SAN CLEMENTE ISLAND
University Of Southern Calif.	Wrigley Institute For Environ.	TWO HARBORS	CA0056651	3	DMISCEL	SANTA CATALINA ISLAND
GENERAL						
Southern California Edison Co.	Pebbly Beach Hydrotest Proj	AVALON	CAG674001	3	DCNWTRS	SANTA CATALINA ISLAND
Miscellaneous Ventura Coastal Watershed Management Area Wastewater Permits - NPDES						
MAJORS						
Oly Mandalay Bay **GENERAL** Partn	Oly Mandalay Bay Sea Bridge	OXNARD	CA0064505	3	DDOMEST	EDISON CANAL
Oxnard Wastewater Division	Oxnard WWTP	OXNARD	CA0054097	1	DDOMIND	VENTURA COASTAL STREAMS
Reliant Energy Mandalay, LLC	Mandalay Generating Station	OXNARD	CA0001180	1	DPROCES	VENTURA COASTAL STREAMS
Reliant Energy Mandalay, LLC	Ormond Beach Generating Station	OXNARD	CA0001198	1	DNONCON	VENTURA COASTAL STREAMS
MINOR						
Channel Island Marine Resource	Channel Island Marine Resource	VENTURA	CA0064131	3	DMISCEL	PORT HUENEME HARBOR
Culligan Industrial Water Trea	Puretec Harris Ind. Water	VENTURA	CA0059935	3	DPROCES	VENTURA COASTAL STREAMS
Edison Pipeline & Terminal Co.	Port Hueneme Fuel Oil Supply	PORT HUENEME	CA0057932	3	DSTORMS	PORT HUENEME HARBOR
Harris Water Conditioning	Culligan Water	VENTURA	CA0060267	3	DMISCEL	ARUNDELL BARRANCA
Pneumo Abex Aerospace, Inc.	Pneumo Abex Aerospace Corp.	OXNARD	CA0063894	3	DMISCEL	VENTURA COASTAL STREAMS
Rayne Water Systems of Ventura	Soft Water Sales & Svc,Ventura	VENTURA	CA0002658	3	DFILBRI	ARUNDELL BARRANCA
Stellar Biotechnologies	Stellar Biotechnologies	PORT HUENEME	CA0063070	3	DMISCEL	PORT HUENEME HARBOR

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Tosco Corp.	Gasoline Service Stations	OXNARD	CA0064360	3	DCNWTRS	VENTURA COUNTY STORM DRAINS
Ventura Port District	Ventura Marina	VENTURA)	CA0057738	3	DWSHWTR	VENTURA MARINA
GENERAL						
Caltrans	DOT District 7	OXNARD	CAG994004		IDOMEST	VENTURA COASTAL STREAMS
Edison Pipeline & Terminal Co.	EPTC Pipeline (Ventura River)	PORT HUENEME NAVAL CONSTRUCTION BATTALION CENTER	CAG674001	3	DMISCEL	VENTURA COASTAL STREAMS
Oxnard, City Of	Blending Stn 3 & Well PumpFac	OXNARD	CAG994005		NCNWTRS	VENTURA COASTAL STREAMS
Padre Associates, Inc.	Redwood Trunk Sewer Project	OXNARD	CAG994004		DCNWTRS	CHANNEL ISLANDS HARBOR
Shell Oil Products US	Shell-Rose Service Station	OXNARD	CAG834001	2	DCNWTRS	VENTURA COASTAL STREAMS
Ventura Co Dept of Airport	Former Condor Luft Site	OXNARD	CAG834001	2	DCNWTRS	CHANNEL ISLANDS HARBOR
Ventura Co Watershed Prot Dist	Arundell Barranca	VENTURA	CAG994004		HCNWTRS	ARUNDELL BARRANCA
Ventura Co Watershed Prot Dist	Hueneme Drain Pump Station	PORT HUENEME	CAG994004			ORMOND BEACH
Ventura Co Watershed Prot Dist	Hueneme Drain/Road Cuevert	PORT HUENEME	CAG994004			PORT HUENEME HARBOR
World Oil Marketing Co.	World Oil Station #54	VENTURA	CAG834001	2	HCNWTRS	ARUNDELL BARRANCA
Ventura River Watershed Wastewater Permits - NPDES						
MAJOR						
Ojai Valley San Dist	Ojai Valley WWTP	VENTURA	CA0053961	1	DDOMIND	VENTURA RIVER
GENERAL						
Casitas Municipal Water Dist.	Aquatic Pesticide Gen. Permit	OAK VIEW	CAG990003	3		LAKE CASITAS
City of Ventura, DPW	Aquatic Pesticide Gen. Permit	VENTURA	CAG990003	3	HMISCEL	VENTURA RIVER
Edison Pipeline & Terminal Co.	EPTC Pipeline (Ventura River)	PORT HUENEME NAVAL CONSTRUCTION BATTALION CENTER	CAG674001	3	DMISCEL	VENTURA RIVER
Equilon California Pipeline Co	Equilon- Ventura Terminal	VENTURA	CAG674001	3	NMISCEL	VENTURA RIVER
San Buenaventura, City of	Foster Park Well Field	VENTURA	CAG994001	3	IMISCEL	VENTURA RIVER
Southern California Water Co.	Ojai System	OJAI	CAG674001	3	DMISCEL	VENTURA RIVER

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Santa Clara River Watershed Wastewater Permits - NPDES						
MAJORS						
LA Co Sanitation Districts	Valencia WWRP	VALENCIA	CA0054216	1	DDOMIND	SANTA CLARA RIVER
LA Co Sanitation Districts	Saugus WWRP	SAUGUS	CA0054313	1	DDOMIND	SANTA CLARA RIVER
San Buenaventura, City of	Ventura WWRP	VENTURA	CA0053651	1	DDOMIND	SANTA CLARA RIVER
Santa Paula, City of/OMI	Santa Paula WWRP	SANTA PAULA	CA0054224	1	DDOMIND	SANTA CLARA RIVER
MINOR						
Castaic Lake Water Agency	Earl Schmidt Filtration Plant	CASTAIC	CA0059030	3	DMISCEL	CASTAIC LAKE
Dept of Water Resources	William E. Warne Power Plant	PYRAMID LAKE	CA0059188	3	DPROCES	PYRAMID LAKE
Fillmore, City of	Fillmore WWTP	FILLMORE	CA0059021	2	DDOMIND	SANTA CLARA RIVER
HR Textron Inc.	Valencia Facility	SANTA CLARITA	CA0003271	3	DMISCEL	SANTA CLARA RIVER
Keysor-Century Corp	Pvc-Pva Copolymer Mfg, Saugus	SAUGUS	CA0057126	2	DSTORMS	SOUTH FORK SANTA CLARA RIVER
LA Co Dept of Parks&Recreation	Val Verde Co. Park Swim Pool	SAUGUS	CA0062561	3	DMISCEL	SANTA CLARA RIVER
Los Angeles City of DWP	Castaic Power Plant	CASTAIC	CA0055824	2	DPROCES	ELDERBERRY FOREBAY
Los Angeles City of DWP	Tunnel No. 104	SANTA CLARITA	CA0058432	3	DCNWTRS	NEWHALL CREEK
Metropolitan Water Dist. Of SC	Foothill Feeder Power Plant	CASTAIC	CA0059641	3	DNONCON	CASTAIC LAKE
Santa Clarita, City of	Drainage Ben. Assess Area 6&18	SANTA CLARITA	CA0061638	3	DMISCEL	SANTA CLARA RIVER
Six Flags Magic Mountain	Amusement Park, Valencia	VALENCIA	CA0003352	2	DMISCEL	SANTA CLARA RIVER
GENERAL						
Augeas Corporation	Former Just Gas	OXNARD	CAG834001	2	HCNWTRS	SANTA CLARA RIVER
Caltrans	Santa Clarita River Bridge Exp	VENTURA	CAG994004		DCNWTRS	SANTA CLARA RIVER
Castaic Lake Water Agency	Three Prod. Well Aquifer Test	SANTA CLARITA	CAG914001	2	DCNWTRS	SOUTH FORK SANTA CLARA RIVER
CH2M Hill	SCLLC Porta Bella Dev. Project	SANTA CLARITA	CAG914001	2	DCNWTRS	SANTA CLARA RIVER

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
DOKKEN ENGINEERING	Bouquet Canyon Bridge Widening	SANTA CLARITA	CAG994004		DMISCEL	SANTA CLARA RIVER
LA Co Sanitation Districts	Valencia WWRP	VALENCIA	CAG994004		DMISCEL	SANTA CLARA RIVER
McDonald's Restaurant	Mcdonald's Restaurant	GORMAN	CAG994001	3	DMISCEL	PYRAMID LAKE
Newhall County Water District	Well Nos. 7 & 10	SANTA CLARITA	CAG994005		NMISCEL	NEWHALL CREEK
Newhall Land and Farming Co.	Hart/Pony Baseball & Auto Mall	VALENCIA	CAG994004			SANTA CLARA RIVER
Ogden Constructors	Santa Paula Improvement,Reach2	SANTA PAULA	CAG994001	3	IMISCEL	SANTA CLARA RIVER
Santa Clarita Community Colleg	College Of The Canyons	SANTA CLARITA	CAG994003	3	DMISCEL	SANTA CLARA RIVER
Santa Paula, City of/OMI	Well #11	SANTA PAULA	CAG994005		NMISCEL	SANTA CLARA RIVER
Southern California Gas Co.	Fair Oaks Ranch-Phase II	SANTA CLARITA	CAG674001	3		SANTA CLARA RIVER
The Painted Turtle Camp	The Painted Turtle Camp	LAKE HUGHES	CAG994001	3	DMISCEL	LAKE ELIZABETH
Valencia Water Company	Valencia Water Co. Well #206	CASTAIC	CAG994005		NMISCEL	SANTA CLARA RIVER
Calleguas Creek Watershed Wastewater Permits - NPDES						
MAJORS						
Camarillo Sanitary District	Camarillo Water Reclam. Plant	CAMARILLO	CA0053597	1	DDOMIND	CONEJO CREEK
Camrosa Water District	Camrosa WWRP	CAMARILLO	CA0059501	3	DDOMEST	CALLEGUAS CREEK
Simi Valley, City Of	Simi Valley WWRP	SIMI VALLEY	CA0055221	1	DDOMIND	ARROYO SIMI
Thousand Oaks City of DPW	Hill Canyon WWTP	CAMARILLO	CA0056294	1	DDOMIND	ARROYO CONEJO
Ventura Co Water Works Dist. 1	Moorpark WWTP	MOORPARK	CA0063274	2	DDOMIND	ARROYO LAS POSAS
MINOR						
Cemex Construction Materials	Moorpark Facility	MOORPARK	CA0059315	3	DMISCEL	ARROYO SIMI
Emery Forwarding	Pti Technologics	NEWBURY PARK	CA0064050	2	HCNWTRS	ARROYO CONEJO
ExxonMobil Refining Supply Co.	RAS#7-8712	TORRANCE	CA0063304	1	DMISCEL	CALLEGUAS CREEK
Skyworks Solutions, Inc.	Skyworks Solutions, Inc.	NEWBURY PARK	CA0060348	3	HCNWTRS	ARROYO CONEJO
Teleflex Inc.	The Talley Site, Newbury Park	NEWBURY PARK	CA0059609	2	HCNWTRS	ARROYO CONEJO

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Tosco Corp.	Tosco Gasoline Service Station		CA0064343	3	DCNWTRS	CALLEGUES CREEK
GENERAL						
Calleguas Municipal Water Dist	Las Posas Feeder Unit 3 Proj.	MOORPARK	CAG994004		DCNWTRS	ARROYO SIMI
Calleguas Municipal Water Dist	RSMP- Brine Line Phase 1	VENTURA	CAG994004		NMISCEL	REVOLON SLOUGH
Calleguas Municipal Water Dist	Grimes Canyon Wellfield #2	MOORPARK	CAG994005		DMISCEL	ARROYO LAS POSAS
Calleguas Municipal Water Dist	Well Field No.1	MOORPARK	CAG994005		IMISCEL	ARROYO LAS POSAS
Camarillo, City of	Aquatic Pesticide Gen. Permit	CAMARILLO	CAG990003	3	HMISCEL	VENTURA RIVER
ConocoPhillips Company	Former 76 Station #5228	CAMARILLO	CAG914001	2	HCNWTRS	REVOLON SLOUGH
ExxonMobil Oil Corporation	Former ExxonMobil SS#7-2827	CAMARILLO	CAG834001	2	DMISCEL	VENTURA COASTAL STREAMS
Pleasant Valley Rec & Park Dis	Freedom Park	CAMARILLO	CAG834001	2	DCNWTRS	CALLEGUAS CREEK
Southern California Gas Co.	Oxnard Gas Line Reloc. Proj	OXNARD	CAG674001	3	NWSHWTR	REVOLON SLOUGH
Unocal Corp.	Former Unocal Station #4687	THOUSAND OAKS	CAG834001	2	DCNWTRS	ARROYO CONEJO
Ventura Co Fire Dept.	Ventura County Fire Station#30	THOUSAND OAKS	CAG834001	2	HCNWTRS	ARROYO CONEJO
Ventura Co Flood Control Dist.	Santa Clara Unit IIB	VENTURA	CAG994004		NMISCEL	REVOLON SLOUGH
Ventura County Transportation	Santa Clara Ave. Improve. SC-2	VENTURA	CAG994004			REVOLON SLOUGH
Santa Monica Bay Watershed Management Area Wastewater Permits - NPDES						
Ballona Creek						
MINOR						
4201 Wilshire, LLC	Harbor Assoicates	LOS ANGELES	CA0054861	3	DMISCEL	BALLONA CREEK
Adams Plaza	Adams Plaza	LOS ANGELES	CA0058297	3	DNONCON	BALLONA CREEK
Beverly Hot Springs	Beverly Hot Springs	LOS ANGELES	CA0062189	3	DMISCEL	BALLONA CREEK
ExxonMobil Oil Corporation	Mobil SS#18-LDM	LOS ANGELES	CA0064262	3	DCNWTRS	BALLONA CREEK
ExxonMobil Oil Corporation	Service Station #18-FX-5	CULVER CITY	CA0064301	2	DCNWTRS	BALLONA CREEK

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Korean World Tower	Los Angeles Apartment Bldg	LOS ANGELES	CA0053091	3	DNONCON	BALLONA CREEK
L.A. Hospitality, Inc.	Holiday Inns	LOS ANGELES	CA0053490	3	DMISCEL	BALLONA CREEK
Pine Realty, Inc.	Gateway West Bldg, LA	LOS ANGELES	CA0053287	3	DMISCEL	BALLONA CREEK
Pivotal Century Plaza Hotel	Century Plaza Hotel & Tower	LOS ANGELES	CA0055638	3	DMISCEL	SEPULVEDA CHANNEL
Plains Expl. & Prod. Co.	Inglewood Oil Fd,Baldwin Hills	LOS ANGELES	CA0057827	2	DSTORMS	CENTINELA CREEK CHANNEL
Platinum Equity	North Crescent Realty V, LLC	BEVERLY HILLS	CA0055786	3	DNONCON	BALLONA CREEK
RMR Properties	Rmr Properties	LOS ANGELES	CA0054615	3	DMISCEL	BALLONA CREEK
Salvation Army, The	Red Shield Yth & Community Ctr	LOS ANGELES	CA0055409	3	DMISCEL	BALLONA CREEK
Santa Monica, City Of	Santa Monica Water Trt. Plant	LOS ANGELES	CA0054101	2	DFILBRI	BALLONA CREEK
Shell Oil Products US	Shell Station #204-1944-0100	CULVER CITY	CA0064289	2	DCNWTRS	BALLONA CREEK
University Of Southern Calif.	University Park Swimming Pool	LOS ANGELES	CA0054453	3	DMISCEL	BALLONA CREEK
GENERAL						
331 North Maple LLC	Office Building	BEVERLY HILLS	CAG994004		DMISCEL	BALLONA CREEK
5055 Wilshire Limited Partner	5055 Wilshire Limited	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
AL-SAL OIL CO, INC.	Station No. 4	LOS ANGELES	CAG834001	2		BENEDICT CANYON
Amir Development Co.	Wilshire/Carson Office Build	BEVERLY HILLS	CAG994001	3	DMISCEL	BALLONA CREEK
Arco Petroleum Products Co.	Arco Station #1057	LOS ANGELES	CAG834001	2	HCNWTRS	BALLONA CREEK
Arden Realty L. P.	New Wilshire Building	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Arden Realty L. P.	Wilshire-San Vicente Plaza	BEVERLY HILLS	CAG994004		DCNWTRS	BALLONA CREEK
Arden Realty L. P.	Comstock Building	LOS ANGELES	CAG994004		DCNWTRS	BALLONA CREEK
ARYA Investments, LLC	Wilshire West Executive Center	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK
Atlantic Richfield Company	Arco Station #0194	CULVER CITY	CAG834001	2	HCNWTRS	BALLONA CREEK
Atria West	Office Building West	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK
Atria West	Office Building East.	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
B. N. Y. California Inc.	B. N. Y. California Inc.	BEVERLY HILLS	CAG994004		DMISCEL	BALLONA CREEK
Bernard Cohen	Former Pierce Service Station	LOS ANGELES	CAG834001	2	DMISCEL	BALLONA CREEK
Beverly Connection, LLC	Shopping Mall	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Beverly Hills, City of	Fire Station No. 3	BEVERLY HILLS	CAG834001	2	DCNWTRS	BALLONA CREEK
Beverly Hills, City of	Beverly RO Treatment Plant	BEVERLY HILLS	CAG994002	3	NMISCEL	BALLONA CREEK
Beverly Hills, City of	Site "A" South Parking Struct	BEVERLY HILLS	CAG994004		DMISCEL	BALLONA CREEK
Beverly Hills, City of	City Well of Beverly Hills	BEVERLY HILLS	CAG994005		DMISCEL	BALLONA CREEK
Braille Institute Of America	Braille Institute of America	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK
Brentwood Property, LLC	The Gardens @ Darlington	BRENTWOOD	CAG994001	3		BALLONA CREEK
Calclean Inc.	Culver Motor Clinic	CULVER CITY	CAG834001	2	NCNWTRS	BALLONA CREEK
Calclean Inc.	Former Bug City/Studio Express	LOS ANGELES	CAG834001	2	NCNWTRS	BALLONA CREEK
California Fed. Enterprises	The Wilshire	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Casden Park La Brea "A", LLC	Park La Brea, Parcel A	LOS ANGELES	CAG994002	3	DCNWTRS	BALLONA CREEK
Casden Park La Brea "B", LLC	Park La Brea Parcel "B"	LOS ANGELES	CAG994002	3	HCNWTRS	BALLONA CREEK
Casden Properties, LLC	Casden Properties	BEVERLY HILLS	CAG994001	3	DMISCEL	BALLONA CREEK
Casden Properties, LLC	Park La Brea, Parcel C	LOS ANGELES	CAG994002	3	DCNWTRS	BALLONA CREEK
CBS, Inc. Television City	Cbs, Inc.	LOS ANGELES	CAG994002	3	DMISCEL	BALLONA CREEK
Cedars-Sinai Medical Center	Cedars-Sinai Medical Center	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK
Cedars-Sinai Medical Center	Cedars Sinai-North Care Twr	LOS ANGELES	CAG994004		DMISCEL	SEPULVEDA CHANNEL
Center For Early Education	Center For Early Education	LOS ANGELES	CAG914001	2	HCNWTRS	BALLONA CREEK
Center West	Center West	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Century Sports Club & Day Spa	Century Sports Club & Day Spa	LOS ANGELES	CAG834001	2	HCNWTRS	BALLONA CREEK

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Children's Hospital Los Angele	Children's Hospital	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Chong H. Lim	Maplewood Apts.	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Clarity Partners, LP	Clarity Partners, LP	BEVERLY HILLS	CAG994004		DMISCEL	BALLONA CREEK
Cochran Island Apartments LLC	Cochran Ave. Apt	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
ConocoPhillips Company	76 Station #0981	LOS ANGELES	CAG834001	2	DCNWTRS	BALLONA CREEK
ConocoPhillips Company	Unocal SS #1715	LOS ANGELES	CAG834001	2	HCNWTRS	BALLONA CREEK
Copperfield Investment & Devel	Wilshire-Highland Bldg.	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
CWD Cloverdale Ii Associates	328 Cloverdale Apts	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Doheny Estates HOA Inc.	Doheny Estates	BEVERLY HILLS	CAG994001	3	DMISCEL	BALLONA CREEK
Douglas Emmett & Company	Century Park Plaza	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Douglas, Emmett & Co.	Wilshire Landmark II Building	LOS ANGELES	CAG994004		DCNWTRS	BALLONA CREEK
EQUILON ENTERPRISES LLC	Shell Station-Western L.A.	LOS ANGELES	CAG834001	2	DCNWTRS	BALLONA CREEK
Equity Office Properties	The Tower	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
ExxonMobil Oil Corporation	Former Exxon Station 7-7221	LOS ANGELES	CAG834001	2	DCNWTRS	BALLONA CREEK
Francis Property Management	585 North Rossmore, Ltd.	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK
G & L Realty Corp.	Office Building Parking Garage	BEVERLY HILLS	CAG994001	3	DMISCEL	BALLONA CREEK
George & Erika Kabor Family Tr	La Cienega Center	BEVERLY HILLS	CAG994002	3	DMISCEL	BALLONA CREEK
Goldrich & Kest Management Co.	Museum Terrace Apartment	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Harrison/Roberts Environmental	Yoshioka Property	LOS ANGELES	CAG994004		IMISCEL	BALLONA CREEK
Harry's Auto Body Inc.	Subterranean Parking Structure	LOS ANGELES	CAG994002	3	NCNWTRS	BALLONA CREEK
Holt Regency HOA	1200 Holt Ave. Condo	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Honeywell Inc.	Sepulveda Site	LOS ANGELES	CAG914001	2	DCNWTRS	BALLONA CREEK

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
HPG Management	Burnside Apartment	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
HPG Management	Detroit Apartment, 618 S	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
HPG Management	Detroit Apartment, 360 S	LOS ANGELES	CAG994002	3	DMISCEL	BALLONA CREEK
HPG Management	Hancock Park Place Apts	LOS ANGELES	CAG994002	3	DMISCEL	BALLONA CREEK
InterActive Corp.	Ticketmaster Building	WEST (BR. P.O.NAME FOR WEST HOLLYWOOD)	CAG994001	3	DMISCEL	BALLONA CREEK
Jizhak Family Trust	Huntley Drive Apartment	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK
John O'Keefe	Santa Monica Gateway	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK
Kennedy-Wilson Properties	Kennedy-Wilson Properties	BEVERLY HILLS	CAG994001	3	NMISCEL	BALLONA CREEK
L. Flynt, Ltd.	Great Western Savings Center	BEVERLY HILLS	CAG994001	3	DMISCEL	BALLONA CREEK
LA Co Dept of Public Works	West Coast Barrier Proj, 3&4	MANHATTAN BEACH	CAG994001	3	DMISCEL	BALLONA CREEK
LA Co Dept of Public Works	Hollyhills Drain Unit 8	HOLLYWOOD	CAG994004		NCNSOIL	BALLONA CREEK
LA Co Dept of Public Works	West Coast Barrier Proj, 2	MANHATTAN BEACH	CAG994005		DMISCEL	BALLONA CREEK
LA Co Dept of Public Works	West Coast Barrier Proj, 1	EL SEGUNDO	CAG994005		DMISCEL	BALLONA CREEK
LA Co Dept of Public Works	West Coast Barrier Proj, 9	EL SEGUNDO	CAG994005		DMISCEL	BALLONA CREEK
LA Co Dept of Public Works	West Coast Barrier Proj, 5	HERMOSA BEACH	CAG994005		DMISCEL	BALLONA CREEK
LA Co Museum of Nature Science	George C Page Museum	LOS ANGELES	CAG994002	3	IMISCEL	BALLONA CREEK
LA Unified School District	Tank Leak Site- Elem. School	LOS ANGELES	CAG914001	2	HCNWTRS	BALLONA CREEK
LB Property Management	Office Building	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK
Le Montrose Hotel	Le Montrose Hotel	WEST HOLLYWOOD	CAG994002	3	DMISCEL	BALLONA CREEK
Los Angeles City of DWP	Stone Hollywood Trunk Line - 4	LOS ANGELES	CAG674001	3	DMISCEL	BALLONA CREEK
Los Angeles City of DWP	Palm Service Center	LOS ANGELES	CAG834001	2	HCNWTRS	BALLONA CREEK
Los Angeles City of DWP	Stone Hollywood Trunk Line - 4	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK
Los Angeles Convention Center	Los Angeles Convention Center	LOS ANGELES	CAG994003	3	DMISCEL	BALLONA CREEK

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Los Angeles Maison	Hotel Sofitel Los Angeles	LOS ANGELES	CAG994004		HCNWTRS	BALLONA CREEK
M & H Realty Partners	Villa Marina Market Pl	MARINA DEL REY	CAG994002	3		BALLONA CREEK
Maple Associates, Ltd	407 North Maple Drive	BEVERLY HILLS	CAG994004		IMISCEL	BALLONA CREEK
Marina del Rey Ventura LLC	Apartment Bldg	MARINA DEL REY	CAG994004			BALLONA CREEK
Marina Pacific Association	Marina Harbor Apartments	MARINA DEL REY	CAG994004		DCNWTRS	LOS ANGELES HARBOR
Marina Two Holding Partnership	Esprit, Marina Parcel 12	MARINA DEL REY	CAG994004		DMISCEL	LOS ANGELES HARBOR
Marsh Holtzman	Wilshire Place	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Masselin Manor	Masselin Manor Apartment	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Mercury Casualty Company	Home Office Building	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Metropolitan Water Dist. Of SC	Venice Power Plant	LOS ANGELES	CAG994003	3	DMISCEL	BALLONA CREEK
Mole-Richardson Company	Mole-Richardson Company	HOLLYWOOD	CAG994004		DMISCEL	BALLONA CREEK
MPI, Ltd.	Mpi, Ltd.	BEVERLY HILLS	CAG994004		DMISCEL	BALLONA CREEK
NPS Management Corp.	West Hollywood Facility	WEST (BR. P.O.NAME FOR WEST HOLLYWOOD)	CAG994002	3	DMISCEL	BALLONA CREEK
OHR Haemet Institute	Office-1030 Robertson Blvd. La	LOS ANGELES	CAG914001	2	HCNWTRS	BALLONA CREEK
One Hundred Towers LLC	Century Plaza Towers, Offices	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Paramount Pictures Inc.	Marathon Office Building	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Park La Brea	Park La Brea	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Park Place Terrace Apartments	Park Place Terrace Apartments	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Philmont Management	Equitable City Center	LOS ANGELES	CAG994004		HMISCEL	BALLONA CREEK
Playa Capital Co., LLC	Playa Vista Site	LOS ANGELES	CAG914001	2	DCNWTRS	BALLONA CREEK
Playa Capital Co., LLC	Playa Phase I Commercial	LOS ANGELES	CAG994004		DCNWTRS	BALLONA CREEK
PMG, Inc.	Tiffany Court Apartments	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK
RealTech, Inc.	Maple Plaza	BEVERLY HILLS	CAG994004		DMISCEL	BALLONA CREEK
Reno Apartments	Reno Apartments	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Rodeo Owner Corp.	Two Rodeo Associates	BEVERLY HILLS	CAG994004		DMISCEL	BALLONA CREEK
Rossmore House Partners, LP	Rossmore Apartments	LOS ANGELES	CAG994004			BALLONA CREEK
RP 120, LLC	RP 120, LLC	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Santa Monica, City Of	Charnock Mun. Water Wellfield	LOS ANGELES	CAG994004		HCNWTRS	BALLONA CREEK
Shell Oil Products US	Shell Oil Gasoline S	WEST HOLLYWOOD	CAG834001	2	HCNWTRS	BALLONA CREEK
Sikh Study Circle, Inc.	Sikh Study Circle, Inc.	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
SK Management Co. LLC	The Monet	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
SK Management Co. LLC	Metro Apartments	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Southern California Water Co.	Sentney Filtration Plant	CULVER CITY	CAG994002	3	DMISCEL	BALLONA CREEK
St. Vincent Medical Center	Institute Plaza	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Temple Beth Am	Temple Beth Am	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
The Korean Times Los Angeles	Fremont Plaza	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK
Third Fairfax, LLC	K-Mart	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
TMW Real Estate Management	Beverly Mercedes Place	BEVERLY HILLS	CAG994001	3	DMISCEL	BALLONA CREEK
Topa Management Corp.	Gateway East Office Bldg, La	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK
U.S. Geological Survey	Ballona Creek - Hydrologic	LOS ANGELES	CAG994005		NCNWTRS	BALLONA CREEK
Unocal Corp.	Former Unocal Station #4823	LOS ANGELES	CAG834001	2		BALLONA CREEK
Unocal Corp.	Service Station #3016	CULVER CITY	CAG914001	2	HCNWTRS	BALLONA CREEK
Urban Retail Property	Century City Shopping Center	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Villa Marina East Board of Dir	Villa Marina East V	MARINA DEL REY	CAG994001	3	DMISCEL	BALLONA CREEK
Wells Fargo Bank	Data Processing Center	LOS ANGELES	CAG994003	3	DNONCON	BALLONA CREEK
Wilroad Associates c/o Hines	Wilshire Rodeo Plaza	BEVERLY HILLS	CAG994001	3	DMISCEL	BALLONA CREEK
Wilshire Borgata Owner Assoc.	Wishire Borgata Condominiums	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Wilshire Landmark LLC	High-Rise Condominium	LOS ANGELES	CAG994001	3	NMISCEL	BALLONA CREEK TO ESTUARY
Wilshire Owners Association	Wilshire Owners Association	LOS ANGELES	CAG994001	3	DMISCEL	BALLONA CREEK
Wilshire West Partners	Wilshire Renaissance Apts.	LOS ANGELES	CAG994002	3	DMISCEL	BALLONA CREEK
World Oil Marketing Co.	World Oil Station No. 17	LOS ANGELES	CAG834001	2	HCNWTRS	BALLONA CREEK
World Oil Marketing Co.	Former World Oil Station #20	LOS ANGELES	CAG834001	2	HCNWTRS	BALLONA CREEK
World Oil Marketing Co.	World Oil Marketing 27	LOS ANGELES	CAG834001	2	HCNWTRS	BALLONA CREEK
World Oil Marketing Co.	World Oil Station #62(Cleanup)	BEVERLY HILLS	CAG914001	2		BALLONA CREEK
WRC Properties, Inc.	Office Building, LA	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK
Writers Guild of A. West Inc.	Fairfax Plaza	LOS ANGELES	CAG994004		DMISCEL	BALLONA CREEK
Malibu Creek						
MAJOR						
Las Virgenes MWD	Tapia WRF	CALABASAS	CA0056014	1	DDOMIND	MALIBU CREEK
GENERAL						
HVR Associates LP	Hidden Valley Ranchos	THOUSAND OAKS	CAG994001	3	IMISCEL	POTRERO VALLEY CREEK
Las Virgenes MWD	Tapia WRF Groundwater Disch	CALABASAS	CAG994001	3	DMISCEL	MALIBU CREEK
Malibu, City of	Big Rock Mesa Drainage Facilit	MALIBU	CAG994004		DMISCEL	MALIBU CREEK
State Farm Mutual Auto Ins Co	Insurance Office, Westlake Vil	WESTLAKE VILLAGE	CAG994003	3	DMISCEL	SANTA MONICA BAY
URS Corporation	Eaton Corporation	WESTLAKE VILLAGE	CAG994004		HMISCEL	TRIUNFO CREEK
Vintage Communities LLC	Hidden Park Bridge Dewatering	CORNELL	CAG994001	3	IMISCEL	TRIUNFO CREEK
Westlake Lake Mgnt Association	Aquatic Pesticide Gen Permit	WESTLAKE VILLAGE	CAG990003	3		POTRERO JOHN CREEK
Greater Santa Monica Bay						
MAJORS						
AES Redondo Beach, LLC	Redondo Generating Station	REDONDO BEACH	CA0001201	1	DPROCES	SANTA MONICA BAY
Chevron U.S.A. Inc.	El Segundo Refinery	EL SEGUNDO	CA0000337	1	HSTORMS	SANTA MONICA BAY

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
El Segundo Power, L.L.C.	El Segundo Generating Station	EL SEGUNDO	CA0001147	1	DPROCES	SANTA MONICA BAY
LA Co Sanitation Districts	JWPCP, Carson	CARSON	CA0053813	1	DDOMIND	PACIFIC OCEAN
LA City Bureau of Sanitation	Hyperion WWTP	PLAYA DEL REY	CA0109991	1	DDOMIND	SANTA MONICA BAY
Los Angeles City of DWP	Scattergood Generating Station	PLAYA DEL REY	CA0000370	1	DCONTAC	SANTA MONICA BAY
MINOR						
ExxonMobil Refining Supply Co.	RAS#7-8712	TORRANCE	CA0063304	1	DMISCEL	SANTA MONICA BAY
LA Co Dept of Public Works	Malibu Mesa WWRP	MALIBU	CA0059099	1	DDOMEST	SANTA MONICA BAY
Redondo Beach, City of	Seaside Lagoon	REDONDO BEACH	CA0064297	3	DMISCEL	SANTA MONICA BAY
West Basin Municipal Water Dis	West Basin WWRP	EL SEGUNDO	CA0063401	3	DDOMEST	SANTA MONICA BAY
West Basin Municipal Water Dis	Carson Regional WRP	CARSON	CA0064246	3	DMISCEL	SANTA MONICA BAY
GENERAL						
1800 Rosecrans Partners, LLC	Former Fairchild Controls	MANHATTAN BEACH	CAG994004		DMISCEL	SANTA MONICA BAY
26800 PCH and Associates, LLP	Gulls Way	MALIBU	CAG994001	3	DMISCEL	SANTA MONICA BAY
Al & Hugh Maguire	Angel Service Station	VENICE	CAG834001	2	HCNWTRS	VENICE BEACH
BOC Gases	BOC Gases - El Segundo	EL SEGUNDO	CAG994003	3	NNONCON	STORM DRAINS
LA Co Dept of Public Works	Hollyhills Drain Unit 7	LOS ANGELES	CAG994002	3	DCNWTRS	BALLONA CREEK
LA Co Dept of Public Works	Proj # 5241-Low Flow Diversion	LOS ANGELES	CAG994004		DCNWTRS	PACIFIC OCEAN
LA Co Dept of Public Works	Proj. # 501-Low Flow Diversion	LOS ANGELES	CAG994004		DCNWTRS	PACIFIC OCEAN
LA Co Dept of Public Works	West Coast Barrier Proj, 7	REDONDO BEACH	CAG994005		DMISCEL	SANTA MONICA BAY
LA Co Dept of Public Works	West Coast Barrier Proj, 6	REDONDO BEACH	CAG994005		DMISCEL	SANTA MONICA BAY
LA Co Dept of Public Works	West Coast Barrier Proj, 8	REDONDO BEACH	CAG994005		DMISCEL	SANTA MONICA BAY
Laxfuel Corp.	Laxfuel Corp.	LOS ANGELES	CAG914001	2	HCNWTRS	SANTA MONICA BAY

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
SSR Western Multifamily LLC	Alliance Property Management	SANTA MONICA	CAG994003	3	NMISCEL	SANTA MONICA BAY
Unocal Corp.	Unocal Ss #5894	RANCHO PALOS VERDES	CAG834001	2	HCNWTRS	SANTA MONICA BAY
WB Ltd	12100 Wilshire Blvd	LOS ANGELES	CAG994001	3	DMISCEL	SANTA MONICA BAY
West Basin Municipal Water Dis	West Basin Water Recycling	EL SEGUNDO	CAG674001	3	DMISCEL	SANTA MONICA BAY
Western LA County Council	Camp Joseph Boy Scout Camp	PACIFIC PALISADES	CAG994001	3	NMISCEL	RUSTIC CANYON CREEK
Dominguez Channel – LA/LB Harbors Watershed Management Area Wastewater Permits - NPDES						
MAJORS						
BP West Coast Products LLC	Carson Refinery	CARSON	CA0000680	2	DCNWTRS	DOMINGUEZ CHANNEL
ConocoPhillips Company	LA Refinery, Carson Plant	CARSON	CA0063185	2	DSTORMS	DOMINGUEZ CHANNEL
Mobil Oil Corp.	Torrance Refinery	TORRANCE	CA0055387	1	HSTORMS	DOMINGUEZ CHANNEL
Shell Oil Products US	Carson Terminal	CARSON	CA0000809	2	DSTORMS	DOMINGUEZ CHANNEL
Shell Oil Products US	L.A. Refining Co. (Wilmington)	WILMINGTON	CA0003778	1	HCONTAC	DOMINGUEZ CHANNEL
MINOR						
Air Products & Chemicals, Inc.	Hydrogen Plant & Related Fac.	WILMINGTON	CA0063363	2	DSTORMS	DOMINGUEZ CHANNEL
BP West Coast Products LLC	Carson Crude Oil Terminal	CARSON	CA0060232	3	DSTORMS	DOMINGUEZ CHANNEL ESTUARY
California Sulphur Co.	Sulfur Pelletizing, Wilmington	WILMINGTON	CA0059064	2	DSTORMS	DOMINGUEZ CHANNEL
Churchill Downs California Co.	Hollywood Park	INGLEWOOD	CA0064211	3	DMISCEL	DOMINGUEZ CHANNEL
ConocoPhillips Company	ConocoPhillips LA Lub. Plant	LOS ANGELES	CA0059846	2	DSTORMS	DOMINGUEZ CHANNEL
Dayton Superior specialty Chem	Edoco	CARSON	CA0002941	3	DSTORMS	DOMINGUEZ CHANNEL
Elixir Industries	Elixir Industries	GARDENA	CA0062537	3	HCNWTRS	DOMINGUEZ CHANNEL
ExxonMobil Refining Supply Co.	RAS#7-8712	TORRANCE	CA0063304	1	DMISCEL	DOMINGUEZ CHANNEL
Fairchild Holding Corp.	Voi-Shan Redondo Bch	REDONDO BEACH	CA0060631	3	HCNWTRS	DOMINGUEZ CHANNEL
Gardena, City of	Primm Memorial Swimming Pool	GARDENA	CA0056413	3	DFILBRI	DOMINGUEZ CHANNEL

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Greene's Ready Mixed Concrete	Greene's Ready Mixed Concrete	TORRANCE	CA0002992	3	DSTORMS	DOMINGUEZ CHANNEL
Honeywell Inc.	Torrance Facility	TORRANCE	CA0058688	3	DNONCON	DOMINGUEZ CHANNEL
Honeywell Inc.	Honeywell Inc.	GARDENA	CA0062162	3	HCNWTRS	DOMINGUEZ CHANNEL
Kinder Morgan (Former GATX)	Carson Terminal	CARSON	CA0056863	2	DSTORMS	DOMINGUEZ CHANNEL
Los Angeles City of DWP	Olympic Tank Farm Skim Pond	WILMINGTON	CA0057568	3	DSTORMS	DOMINGUEZ CHANNEL
Permalite Inc.	Permalite Inc.	CARSON	CA0059871	2	DSTORMS	DOMINGUEZ CHANNEL
Plaskolite West, Inc.	Plaskolite West Inc.	COMPTON	CA0060798	3	DCONTAC	DOMINGUEZ CHANNEL
Praxair, Inc.	Praxair, Wilmington	WILMINGTON	CA0001848	2	DCONTAC	DOMINGUEZ CHANNEL
Redman Equipment & Mfg Co	Redman Equiment & Mfg.Co	TORRANCE	CA0058726	3	DSTORMS	DOMINGUEZ CHANNEL
Shell Oil Products US	Carson Sulfur Recovery Plant	CARSON	CA0002020	2	DSTORMS	DOMINGUEZ CHANNEL
Equilon Enterprises, LLC	Former Texaco Service Station	TORRANCE	CAG834001	2	DCNWTRS	DOMINGUEZ CHANNEL
Inglewood, City of	City of Inglewood Water System	INGLEWOOD	CAG994001	3		DOMINGUEZ CHANNEL
Inglewood, City of	Well No. 6	INGLEWOOD	CAG994005		NMISCEL	DOMINGUEZ CHANNEL
Kinder Morgan (Former GATX)	Gatx, Carson	CARSON	CAG674001	3	DMISCEL	DOMINGUEZ CHANNEL
LA Co Dept of Parks&Recreation	Lennox County Park	LOS ANGELES	CAG994003	3	DMISCEL	DOMINGUEZ CHANNEL
LA Co Dept of Public Works	Dominguez Gap Barrier Project	WILMINGTON	CAG994001	3	DMISCEL	DOMINGUEZ CHANNEL
LA Co Dept of Public Works	Dominguez Gap Proj. Part 2B	CARSON	CAG994002	3	HMISCEL	DOMINGUEZ CHANNEL
LA Co Dept of Public Works	Dominger Drain & Pump Station	CARSON	CAG994004		NMISCEL	DOMINGUEZ CHANNEL
Pacific Terminals LLC	Systems Wide Pipelines		CAG674001	3	IMISCEL	DOMINGUEZ CHANNEL
Port of Long Beach	Pier T Terminal Development	LONG BEACH	CAG994004		IMISCEL	DOMINGUEZ CHANNEL
Radisson Los Angeles Airport	Radisson Los Angeles Airport	LOS ANGELES	CAG994003	3	IMISCEL	DOMINGUEZ CHANNEL
Southern California Water Co.	Truro Fe & Mn Filtration Plant	INGLEWOOD	CAG994003	3	NFILBRI	DOMINGUEZ CHANNEL
Southern California Water Co.	Goldmedal Plant	HAWTHORNE	CAG994003	3	DMISCEL	DOMINGUEZ CHANNEL

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Southern California Water Co.	Doty Wells #1 & #2	HAWTHORNE	CAG994005		DMISCEL	DOMINGUEZ CHANNEL
Southern California Water Co.	Dalton Well	GARDENA	CAG994005		NMISCEL	DOMINGUEZ CHANNEL
Southern California Water Co.	Chicago & Compton Doty Wells	LAWNDALE	CAG994005		DMISCEL	DOMINGUEZ CHANNEL
Southern California Water Co.	Southern No. 6	GARDENA	CAG994005		HCNWTRS	DOMINGUEZ CHANNEL
Southern California Water Co.	Yukon No. 5	INGLEWOOD	CAG994005		HCNWTRS	DOMINGUEZ CHANNEL
Southern California Water Co.	129th Street Water Well #2	GARDENA	CAG994005		NMISCEL	DOMINGUEZ CHANNEL
Southern California Water Co.	Drinking Well-Ballona Plant	GARDENA	CAG994005			DOMINGUEZ CHANNEL
Tesoro Petroleum	Target Store-290	GARDENA	CAG914001	2	IMISCEL	DOMINGUEZ CHANNEL
U.S. Geological Survey	Dominguez Channel - Hydrologic	LOS ANGELES	CAG994005		NCNWTRS	DOMINGUEZ CHANNEL
UNOCAL	Unocal Service Station #7196	HAWTHORNE	CAG834001	2	HCNWTRS	DOMINGUEZ CHANNEL
Unocal/Arco	Unocal/Arco Hawthorne	HAWTHORNE	CAG834001	2	HCNWTRS	DOMINGUEZ CHANNEL
Water Replenishment Dist of SC	West Coast Basin Desalter	TORRANCE	CA0064238	3	DFILBRI	LOS ANGELES RIVER
Yeager Skanska	Anaheim Pump Station De-wateri	WILMINGTON	CAG994004			DOMINGUEZ CHANNEL
Harbor discharges						
MAJORS						
LA City Bureau of Sanitation	Terminal Island WWTP	SAN PEDRO	CA0053856	1	DDOMEST	LOS ANGELES/LONG BEACH OUTER HARBOR
Long Beach Generation LLC	Long Beach Generating Station	LONG BEACH	CA0001171	1	DNONCON	LONG BEACH HARBOR
Los Angeles City of DWP	Harbor Generating Station	WILMINGTON	CA0000361	1	DNONCON	LOS ANGELES HARBOR
United States Borax & Chem Cor	Wilmington Plant	WILMINGTON	CA0000787	2	HNONCON	LOS ANGELES INNER HARBOR
MINOR						
Al Larson Boat Shop	Al Larson Boat Shop	TERMINAL ISLAND	CA0061051	3	DSTORMS	LOS ANGELES INNER HARBOR
BP West Coast Products LLC	Long Beach Marine Terminal 2	LONG BEACH	CA0000442	2	DSTORMS	LONG BEACH INNER HARBOR
BP West Coast Products LLC	Long Beach Marine Terminal 3	LONG BEACH	CA0000451	3	DSTORMS	LONG BEACH HARBOR

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
BP West Coast Products LLC	Marine Terminal 1,Berth 121,LB	LONG BEACH	CA0059285	3	DSTORMS	LONG BEACH HARBOR
BP Wilmington Calciner	BP Wilmington Plant	WILMINGTON	CA0059153	2	DSTORMS	CERRITOS CHANNEL
ExxonMobil Oil Corporation	Southwestern Terminal-Area I	TERMINAL ISLAND	CA0003689	3	DPROCES	LOS ANGELES HARBOR
Harbor Cogeneration Company	Harbor Cogeneration Company	WILMINGTON	CA0060003	2	DFILBRI	CERRITOS CHANNEL
Kinder Morgan (Former GATX)	San Pedro Marine Terminal	SAN PEDRO	CA0001911	2	DMISCEL	LOS ANGELES HARBOR
Kinder Morgan (Former GATX)	Los Angeles Harbor Terminal	SAN PEDRO	CA0055816	2	DSTORMS	LOS ANGELES HARBOR
Long Beach, City of	Southeast Resource Recovery	LONG BEACH	CA0059544	3	DSTORMS	CERRITOS CHANNEL
Los Angeles City of DWP	Harbor Steam Plant,N Skim Tank	WILMINGTON	CA0056383	3	DMISCEL	LOS ANGELES INNER HARBOR
Los Angeles City of DWP	Harbor G.S. - Marine Tank Farm	WILMINGTON	CA0057037	3	DSTORMS	LOS ANGELES INNER HARBOR
Metropolitan Stevedore Co.	Metropolitan Stevedore Co.	LONG BEACH	CA0057746	2	DSTORMS	LONG BEACH HARBOR
Morton Salt/Rohm and Haas	Morton Salt - Long Beach	LONG BEACH	CA0061476	3	DSTORMS	LONG BEACH HARBOR
Petro Diamond Terminal Company	Marine Terminal, Berth 83, LB	LONG BEACH	CA0059358	3	DSTORMS	LONG BEACH HARBOR
Port of Los Angeles	New Dock St Pump Station	TERMINAL ISLAND	CA0064157	3	DMISCEL	CERRITOS CHANNEL
Shell Oil Products US	Mormon Island Marine Terminal	WILMINGTON	CA0003557	3	DSTORMS	LOS ANGELES INNER HARBOR
Shore Terminal LLC	Wilmington Marine Terminal	WILMINGTON	CA0055263	2	DSTORMS	LOS ANGELES HARBOR
Southern Ca. Marine Institute	Southern Ca. Marine Institute	TERMINAL ISLAND	CA0058556	3	DMISCEL	LOS ANGELES HARBOR
Southwest Marine, Inc.	Southwest Marine, Inc.	TERMINAL ISLAND	CA0000868	3	DNONCON	LOS ANGELES HARBOR
Tidelands Oil Production Co.	Wilmington and Terminal Island	WILMINGTON	CA0001813	2	DSTORMS	CERRITOS CHANNEL
Ultramar Inc.	Marine Term, Berth 164	WILMINGTON	CA0055719	3	DSTORMS	LOS ANGELES INNER HARBOR
US Navy Defense Logistics Agen	Defense Fuel Supply Pier 12 Lb	LONG BEACH	CA0060496	3	DSTORMS	LONG BEACH INNER HARBOR
Vopak Terminal Long Beach Inc	Vopak Terminal Long Beach Inc.	SAN PEDRO	CA0064165	2	DWSHWTR	LONG BEACH INNER HARBOR

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Westway Terminal Company	Westway Terminal-Berths 70-71	SAN PEDRO	CA0002186	2	DSTORMS	LOS ANGELES HARBOR
GENERAL						
Arco Terminal Services Corp.	Marine Terminal #3	LONG BEACH	CAG674001	3	NMISCEL	LONG BEACH HARBOR
California Water Service Co.	Dominguez 23201, 23202 & 27501	TORRANCE	CAG994005		NMISCEL	HARBOR LAKE
Charles King Company	L. A. Harbor Siphon Crossing	LOS ANGELES	CAG994002	3	DMISCEL	LOS ANGELES HARBOR
ConocoPhillips Company	76 Station #3768	LONG BEACH	CAG834001	2	DCNWTRS	LOS ANGELES HARBOR
Defense Energy Support	Berth 100 Backland Dev. Proj	LOS ANGELES	CAG994004			LOS ANGELES HARBOR
Defense Fuel Support Point	DFSP San Pedro-Pump House Area	SAN PEDRO	CAG834001	2	DCNWTRS	LOS ANGELES INNER HARBOR
ExxonMobil Oil Corporation	LA Channel Crossing Pipeline	WILMINGTON	CAG674001	3	NMISCEL	LOS ANGELES/LONG BEACH HARBOR MARINAS
Kinder Morgan (Former GATX)	Berth 118-119	SAN PEDRO	CAG674001	3	DMISCEL	LOS ANGELES HARBOR
LA Co Dept of Public Works	Dominguez Gap Barrier Project	WILMINGTON	CAG994001	3	DMISCEL	LOS ANGELES INNER HARBOR
Lomita, City of	City Water System Well No. 5	ROLLING HILLS ESTATES	CAG994005		NMISCEL	HARBOR LAKE
Los Angeles City of DWP	Los Angeles Harbor WRP	SAN PEDRO	CAG674001	3	IMISCEL	LOS ANGELES HARBOR
Los Angeles City of DWP	Los Angeles Harbor WRP	SAN PEDRO	CAG994002	3	DMISCEL	LOS ANGELES HARBOR
Pacific Terminals LLC	Systems Wide Pipelines		CAG674001	3	IMISCEL	LONG BEACH HARBOR
Pacific Terminals LLC	Systems Wide Pipelines		CAG674001	3	IMISCEL	LOS ANGELES HARBOR
Pacific Terminals LLC	Systems Wide Pipelines		CAG994002	3	DMISCEL	LONG BEACH HARBOR
Pacific Terminals LLC	Systems Wide Pipelines		CAG994002	3	DMISCEL	LOS ANGELES HARBOR
Port of Long Beach	Piers G/J Terminal Project		CAG994004		DCNWTRS	LONG BEACH HARBOR
Port of Long Beach	Pier S Dewatering	LONG BEACH	CAG994004		HCNWTRS	LONG BEACH INNER HARBOR
Shell Oil Products US	Equilon Marine Terminal-Pier B	LONG BEACH	CAG674001	3	NMISCEL	LONG BEACH INNER HARBOR
Shell Oil Products US	Shell Mormon Island Marine Ter	WILMINGTON	CAG674001	3	NMISCEL	LOS ANGELES HARBOR
Shell Oil Products US	Shell Signal Hill Terminal	LONG BEACH	CAG674001	3	NMISCEL	LOS ANGELES/LONG BEACH OUTER HARBOR

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Thums Long Beach Company	Power Plant @Port of LongBeach	LONG BEACH	CAG994004		DCNWTRS	LONG BEACH HARBOR
Los Angeles River Watershed Wastewater Permits - NPDES						
MAJORS						
Burbank, City of Public Works	Burbank WWRP	BURBANK	CA0055531	1	DDOMIND	BURBANK WESTERN CHANNEL
LA City Bureau of Sanitation	L.A.-Glendale WWRP	LOS ANGELES	CA0053953	1	DDOMIND	LOS ANGELES RIVER
LA City Bureau of Sanitation	Tillman WWRP	VAN NUYS	CA0056227	1	DDOMIND	LOS ANGELES RIVER
LA Co Sanitation Districts	Whittier Narrows WWRP	EL MONTE	CA0053716	1	DDOMIND	RIO HONDO
Las Virgenes MWD	Tapia WRF	CALABASAS	CA0064271	1	DDOMEST	LOS ANGELES RIVER
Pacific Terminals LLC	Dominguez Hills Tank Farm	COMPTON	CA0052949	3	DMISCEL	COMPTON CREEK
The Boeing Company	Rocketdyne Div. - Santa Susana	SIMI HILLS	CA0001309	1	DSTORMS	LOS ANGELES RIVER
MINOR						
3M Company	3M Pharmaceuticals	NORTHRIDGE (NORTH LOS ANGELES)	CA0063312	2	HCNWTRS	LOS ANGELES RIVER
Bank Of America	Nt & Sa L.A. Data Center	LOS ANGELES	CA0057690	2	DMISCEL	LOS ANGELES RIVER
BP West Coast Products LLC	East Hynes Facility	LONG BEACH	CA0059561	3	DSTORMS	LOS ANGELES RIVER
Chevron U.S.A. Inc.	Van Nuys Terminal	VAN NUYS	CA0059293	3	DSTORMS	LOS ANGELES RIVER
Coltec Industries Inc.	Former Menasco Aerosystem Faci	BURBANK	CA0064319	3	DCNWTRS	BURBANK WESTERN WASH
Dial Corp, The	Southwest Grease Business	COMMERCE	CA0062022	3	DSTORMS	LOS ANGELES RIVER
Eastman Chemical Co	Eastman Chemical Co	LYNWOOD	CA0063908	2	DCNWTRS	LOS ANGELES RIVER
Edington Oil Co.	Long Beach Refinery - Rainfall	LONG BEACH	CA0057363	2	DSTORMS	LOS ANGELES RIVER
ExxonMobil Refining Supply Co.	RAS#7-8712	TORRANCE	CA0063304	1	DMISCEL	LOS ANGELES RIVER
Kaiser Aluminum Extruded Prod.	Kaiser Aluminum Extruded Prod.	COMMERCE	CA0000892	3	DPROCES	LOS ANGELES RIVER
LA Co Metro Trans Authority	Segments 1,2A,2B,3 Operations	LOS ANGELES	CA0064092	1	HCNWTRS	LOS ANGELES RIVER
Lincoln Avenue Water Co.	South Coulter Water Treatment	ALTADENA	CA0064068	3	DMISCEL	ARROYO SECO S. OF DEVIL'S GATE (UPPER)

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Los Angeles City of DWP	**GENERAL** Office Building	LOS ANGELES	CA0056855	3	DMISCEL	LOS ANGELES RIVER
Los Angeles City of DWP	Tunnel # 105	NEWHALL	CA0064149	3	DMISCEL	LOS ANGELES RIVER
Los Angeles City of Rec&Parks	Los Angeles Zoo Griffith Park	LOS ANGELES	CA0056545	2	DDOMEST	LOS ANGELES RIVER
Los Angeles Turf Club	Santa Anita Park	ARCADIA	CA0064203	3	DMISCEL	ARCADIA WASH (LOWER, HY UNIT 405.33)
Lubricating Specialties Co.	Pico Rivera, Oil Blending	PICO RIVERA	CA0059013	3	DSTORMS	RIO HONDO
MCA / Universal City Studios	Universal City Studios	UNIVERSAL CITY (MOVIE STUDIO)	CA0002739	3	DFILBRI	LOS ANGELES RIVER
Metropolitan Water Dist. Of SC	Rio Hondo Power Plant	SOUTH GATE	CA0059633	3	DNONCON	LOS ANGELES RIVER
Owens-Brockway Glass Container	Glass Container Div, Vernon	VERNON	CA0056464	2	DNONCON	LOS ANGELES RIVER
Pabco Paper Products	Paperboard & Carton Mfg,Vernon	VERNON	CA0057274	3	DSTORMS	LOS ANGELES RIVER
Saint-Gobain Containers,LLC	Saint-Gobain Containers,LLC	EL MONTE	CA0000884	3	DPROCES	RIO HONDO
Sta - Lube/CRC Industries Inc.	Sta - Lube/CRC Industries Inc.	RANCHO DOMINGUEZ	CA0064025	2	DPROCES	COMPTON CREEK
GENERAL						
21300 Victory Blvd. Ltd. Co.	Warner Corporate Center	WOODLAND HILLS	CAG994004		DMISCEL	LOS ANGELES RIVER
550 S. Hope Street Associates	550 S. Hope St. Building	LOS ANGELES	CAG994001	3	DMISCEL	LOS ANGELES RIVER
Arco Service Station	Arco Service Staion (Glen Smit	LONG BEACH	CAG834001	2		LOS ANGELES RIVER TO ESTUARY
Arco Terminal Services Corp.	East Hynes Terminal	LONG BEACH	CAG674001	3	NMISCEL	LOS ANGELES RIVER
Atlantic Richfield Company	West Hynes Pump Station	LONG BEACH	CAG674001	3	DMISCEL	LOS ANGELES RIVER
Atlantic Richfield Company	Arco Station No. 6035	EL MONTE	CAG834001	2	DCNWTRS	LOS ANGELES RIVER
Atlantic Richfield Company	Former Arco Service Stn. #1860	LOS ANGELES	CAG994004		DCNWTRS	LOS ANGELES RIVER
Atlantic Richfield Company	Former Arco Service Stn. #1860	LOS ANGELES	CAG994004		DCNWTRS	LOS ANGELES RIVER
Bell Gardens, City of, DPW	Domestic Water Well	BELL GARDENS	CAG994005		DMISCEL	RIO HONDO

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Burbank, City of Public Servic	Burbank Public Service Dept	BURBANK	CAG994001	3	DMISCEL	LOS ANGELES RIVER
Burbank, City of Public Servic	Reservoir Forebay	BURBANK	CAG994002	3	DMISCEL	LOS ANGELES RIVER
Calclean Inc.	Davis-LeGrand Company	LONG BEACH	CAG834001	2	DMISCEL	LOS ANGELES RIVER
California Water Service Co.	Well 29401	LONG BEACH	CAG994001	3	DMISCEL	LOS ANGELES RIVER
California Water Service Co.	Well 29701	LONG BEACH	CAG994001	3	DMISCEL	LOS ANGELES RIVER
California Water Service Co.	Wells 27201 & 29001	LONG BEACH	CAG994001	3	NMISCEL	COMPTON CREEK
California Water Service Co.	Wells 21501 & 21502	LONG BEACH	CAG994005		DMISCEL	LOS ANGELES RIVER
California Water Service Co.	Dominguez 27201, 29001 & 29701	RANCHO DOMINGUEZ	CAG994005		NMISCEL	COMPTON CREEK
California Water Service Co.	Rio Hondo Water Supply Wells	COMMERCE	CAG994005		NMISCEL	RIO HONDO
California Water Service Co.	East Los Angeles Water Well	LOS ANGELES	CAG994005		NMISCEL	LOS ANGELES RIVER
Caltrans	LA-105 Garfield/Ardis Ave.	DOWNEY	CAG914001	2	DCNWTRS	LOS ANGELES RIVER
Caltrans	Los Angeles River Watershed	LOS ANGELES	CAG994001	3	DMISCEL	LOS ANGELES RIVER
CarrAmerica Realty Corp.	CarrAmerica Office Building	WOODLAND HILLS	CAG994004		DNONCON	LOS ANGELES RIVER
CH2M Hill	Whittier Narrows Early Action	SOUTH EL MONTE	CAG914001	2	DCNWTRS	RIO HONDO
Coast Packing Co.	Coast Packing Co.	VERNON	CAG994003	3	DNONCON	LOS ANGELES RIVER
Compton Municipal Water Dept.	Municipal Water Supply Wells	COMPTON	CAG994005		DMISCEL	COMPTON CREEK
Dba "Ultimate"	Dba "Ultimate"	LOS ANGELES	CAG994003	3	DNONCON	LOS ANGELES RIVER
DDR Urban LP	Queens Way Bay Retail Entertai	LONG BEACH	CAG994001	3	IMISCEL	LOS ANGELES RIVER
Douglas Emmett Warner CtrTower	Plaza 6, Warner Center	WOODLAND HILLS	CAG994004		DMISCEL	LOS ANGELES RIVER
Douglas Emmett Warner CtrTower	Plaza 3, Warner Center	WOODLAND HILLS	CAG994004		DMISCEL	LOS ANGELES RIVER
DTSC/England & Assoc.	Former Southland Oil Site	COMMERCE	CAG914001	2	DCNWTRS	RIO HONDO BELOW SPREADING GROUNDS

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
East Pasadena Water Co.	Water Well No. 10 and 8	PASADENA	CAG994005		IMISCEL	RIO HONDO
EMIF IV, LP c/o Hazard Mgmt	Lynwood Town Center GW Treat	LYNWOOD	CAG994004		IMISCEL	LOS ANGELES RIVER
ExxonMobil Oil Corporation	Mobil SS#11-FRN	ENCINO	CAG834001	2	HCNWTRS	LOS ANGELES RIVER
Figueroa at Wilshire LLC	Sanwa Bank Plaza	LOS ANGELES	CAG994001	3	DMISCEL	LOS ANGELES RIVER
Forest Lawn	Well No. 2A	GLENDALE	CAG994005			LOS ANGELES RESERVOIR
Former Shell SS/Equilon Enter.	Hanna's Arco (former Shell SS)	LOS ANGELES	CAG834001	2	HCNWTRS	LOS ANGELES RIVER
G & K Management Co., Inc.	Grand Promenade	LOS ANGELES	CAG994004		DMISCEL	LOS ANGELES RIVER
G & M Oil Co.	G & M Oil Co. Station #57	LYNWOOD	CAG834001	2	NMISCEL	LOS ANGELES RIVER
Glendale Adventist Med. Center	Physicians Medical Terrace	GLENDALE	CAG994003	3	DNONCON	LOS ANGELES RIVER
Glendale Docker Partnership	Central Stocker Ltd.	GLENDALE	CAG994003	3	DNONCON	LOS ANGELES RIVER
Glendale II Associates, Ltd.	Glendale Galleria Office	GLENDALE	CAG994003	3	DNONCON	LOS ANGELES RIVER
Grand Central Square	Parking Structure	LOS ANGELES	CAG994001	3	DMISCEL	LOS ANGELES RIVER
Grifols Biologicals Inc.	Blood Fractionation & Process	LOS ANGELES	CAG994003	3	DNONCON	LOS ANGELES RIVER
HANKEY INVESTMENT COMPANY	Midway Ford	LOS ANGELES	CAG834001	2	NMISCEL	LOS ANGELES RIVER
Hermetic Seal Corp.	Hermetic Seal Corp.	ROSEMEAD	CAG914001	2	HCNWTRS	RIO HONDO
Hermetic Seal Corp.	Hermetic Seal Corp.	ROSEMEAD	CAG994003	3	DMISCEL	EATON WASH
Interstate Brands Corp.	Interstate Brands	GLENDALE	CAG834001	2	HCNWTRS	LOS ANGELES RIVER
IRP Legacy Cahuenga Assoc. LLC	California Credit Union	LOS ANGELES	CAG994001	3	DMISCEL	LOS ANGELES RIVER
J&M Oil Company (dba United Oi	United Oil Station #33	LYNWOOD	CAG834001	2	DMISCEL	LOS ANGELES RIVER
Jamison Properties	Encino Executive Plaza	ENCINO	CAG994002	3	DMISCEL	LOS ANGELES RIVER
Jet Propulsion Laboratory	Jet Propulsion Lab.	PASADENA	CAG994004		DMISCEL	DEVIL'S GATE RESERVOIR (LOWER, 405.31)
Jewish Home for the Aging	Jewish Home for the Aging	RESEDA	CAG994004		HMISCEL	LOS ANGELES RIVER

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Jones Lang la Salle	Bank of America Harbor Bldg	LOS ANGELES	CAG994004		DMISCEL	LOS ANGELES RIVER
L & R Auto Parks, Inc.	Parking Structure 220 S.Spring	LOS ANGELES	CAG994003	3	DMISCEL	LOS ANGELES RIVER
LA Co Dept of Public Works	Dominguez Gap Proj. Part 2B	CARSON	CAG994002	3	HMISCEL	LOS ANGELES RIVER
LA Co Parking Authority	Walt Disney Hall Parking	LOS ANGELES	CAG994001	3	DMISCEL	LOS ANGELES RIVER
Laeroc 1998 Income Fund, L.P.	Carbon Cannister Water Trt Sys	LOS ANGELES	CAG994003	3	DCNWTRS	LOS ANGELES RIVER
Leatherman Property	Leatherman Property	GRANADA HILLS	CAG834001	2	NMISCEL	BULL CREEK
Los Angeles City of DWP	Sepulveda Trunk Line Project	GRANADA HILLS	CAG674001	3	NMISCEL	LOS ANGELES RIVER
Los Angeles City of DWP	River Supply Conduit	LOS ANGELES	CAG674001	3	NMISCEL	LOS ANGELES RIVER
Los Angeles City of DWP	Encino Reser Water Qty Proj.	LOS ANGELES	CAG674001	3	NMISCEL	LOS ANGELES RIVER
Los Angeles City of DWP	City Trunk Line-South	LOS ANGELES	CAG674001	3	NMISCEL	LOS ANGELES RIVER
Los Angeles City of DWP	Valley Generating Station	SUN VALLEY	CAG674001	3		LOS ANGELES RIVER
Los Angeles City of DWP	Burbank Trunk Line	BURBANK	CAG674001	3		LOS ANGELES RIVER
Los Angeles City of DWP	Pollock Wells Treatment Plant	LOS ANGELES	CAG914001	2	DMISCEL	LOS ANGELES RIVER
Los Angeles City of DWP	Sepulveda Trunk Line Project	GRANADA HILLS	CAG994002	3	DCNWTRS	PACOIMA WASH
Los Angeles City of DWP	Burbank Trunk Line	BURBANK	CAG994002	3	HCNWTRS	BURBANK WESTERN WASH
Los Angeles City of DWP	Distributing Station 87	LOS ANGELES	CAG994002	3	HMISCEL	LOS ANGELES RIVER
Los Angeles County I.S.D.	W. San Fernando Courthouse	CHATSWORTH	CAG994001	3	DMISCEL	LOS ANGELES RIVER
Maguire Partners	The Gas Company Tower	LOS ANGELES	CAG994003	3	NDRILLS	LOS ANGELES RIVER
Mammoth Apartments, LLC	Mammoth Apartments	SHERMAN OAKS	CAG994001	3	IMISCEL	LOS ANGELES RIVER
Metropolitan Water Dist. Of SC	Greg Avenue Power Plant	SUN VALLEY	CAG994003	3	DMISCEL	LOS ANGELES RIVER
Mobil Oil Corp.	Vernon Terminal	VERNON	CAG674001	3	IMISCEL	LOS ANGELES RIVER
Monterey Park, City of	Delta Plant Well No. 5	ROSEMEAD	CAG914001	2	DCNWTRS	RIO HONDO

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Monterey Park, City of	Delta Plant	ROSEMEAD	CAG914001	2		RIO HONDO
Newlowe Properties c/o HMC	Newlowe Properties c/o HMC	LOS ANGELES	CAG914001	2	DMISCEL	LOS ANGELES RIVER
One California Plaza	One California Plaza	LOS ANGELES	CAG994004		DMISCEL	LOS ANGELES RIVER
Pacific Pipeline System LLC	West Hynes Station	LONG BEACH	CAG994004		DCNWTRS	LOS ANGELES RIVER
Pacific Terminals LLC	Systems Wide Pipelines		CAG674001	3	IMISCEL	LOS ANGELES RIVER
Pacific Terminals LLC	Systems Wide Pipelines		CAG994001	3	DMISCEL	LOS ANGELES RIVER
Pasadena, City of	Garfield Well	PASADENA	CAG994005		DMISCEL	ARROYO SECO
Pasadena, City of	Well #59	PASADENA	CAG994005		DMISCEL	RIO HONDO
Pasadena, City of	Well #58	PASADENA	CAG994005		NMISCEL	LOS ANGELES RIVER
Pico Water District	Pico Water District	PICO RIVERA	CAG994001	3	DMISCEL	LOS ANGELES RIVER
Pure Effect Incorporated	LAC/USC Replacement Project	LOS ANGELES	CAG994004		DCNWTRS	LOS ANGELES RIVER
Robert Chan	B.C. Plaza	LOS ANGELES	CAG994003	3	DMISCEL	LOS ANGELES RIVER
Rubio Canon Land & Water Assoc	Rubio-Well No. 7	ALTADENA	CAG994005		DCNWTRS	ARROYO SECO
Shell Oil Products US	Shell Van Nuys Terminal	VAN NUYS	CAG674001	3	NMISCEL	SEPULVEDA FLOOD CONTROL BASIN
Shell Oil Products US	Shell Station	LYNWOOD	CAG834001	2	DCNWTRS	LOS ANGELES RIVER
Sierracin/Sylmar Corp.	Sierracin.Sylmar Corp.	SYLMAR	CAG994003	3	DNONCON	PACOIMA WASH
South Montebello Irrigation	Water Well #6	MONTEBELLO	CAG994005		DMISCEL	RIO HONDO
South Montebello Irrigation	Water Well #7	MONTEBELLO	CAG994005		DMISCEL	RIO HONDO
Southern California Edison Co.	Compton Service Cen.	COMPTON	CAG834001	2	HCNWTRS	LOS ANGELES RIVER
Southern California Gas Co.	Southern Calif. Gas-Pico Rive	PICO RIVERA	CAG674001	3		RIO HONDO
Southern California Water	Bissell Plant	BELL	CAG994005			LOS ANGELES RIVER
Southern California Water Co.	Goodyear Site	LOS ANGELES	CAG994002	3	IMISCEL	LOS ANGELES RIVER
Southern California Water Co.	Nadeau Site	LOS ANGELES	CAG994002	3	IMISCEL	LOS ANGELES RIVER
Southern California Water Co.	San Gabriel Plant	ROSEMEAD	CAG994003	3	IFILBRI	RIO HONDO TO SPREADING GROUNDS

DISCHARGER'S NAME*	FACILITY NAME	CITY	NPDES #	R	WASTE TYPE	RECEIVING WATER
Southern California Water Co.	Encinita WTP	TEMPLE CITY (RUDELL)	CAG994003	3	IMISCEL	EATON WASH
Southern California Water Co.	Century Site	PARAMOUNT	CAG994003	3	IMISCEL	LOS ANGELES RIVER
Southern California Water Co.	Gage Site Water Wells	BELL GARDENS	CAG994005		DCNWTRS	LOS ANGELES RIVER
Southern California Water Co.	Priory Site	BELL GARDENS	CAG994005		IMISCEL	LOS ANGELES RIVER
Southern California Water Co.	Otis Well No. 3	BELL	CAG994005		NMISCEL	LOS ANGELES RIVER
Southern California Water Co.	Belhaven Plant	LOS ANGELES	CAG994005		NMISCEL	COMPTON CREEK
Trillium Property, LLC	Trillium Towers	WOODLAND HILLS	CAG994004		DMISCEL	LOS ANGELES RIVER
Two Calif Plaza/Arden Realty	Two Calif Plaza/Equity Office	LOS ANGELES	CAG994001	3	DMISCEL	LOS ANGELES RIVER
U.S. Geological Survey	Los Angeles River - Hydrologic	LOS ANGELES	CAG994005		NCNWTRS	LOS ANGELES RIVER
United Storm Water, Inc.	Storm Drain Cleaning I	LOS ANGELES	CAG994004		DMISCEL	COMPTON CREEK
Univar USA Inc.	Former Vopak USA Inc.	LOS ANGELES	CAG914001	2	HMISCEL	LOS ANGELES RIVER
University Of Southern Calif.	MarlyneNorris Cancer Res Tower	LOS ANGELES	CAG994004		DMISCEL	LOS ANGELES RIVER
Walnut Park Mutual Water Co.	Well # 11	HUNTINGTON PARK	CAG994005		DMISCEL	LOS ANGELES RIVER
Warner Brothers Inc.	Warner Brothers Studio Facilit	BURBANK	CAG994003	3	IMISCEL	LOS ANGELES RIVER
Washington Mutual	Sherman Oaks Branch	SHERMAN OAKS	CAG994004		DMISCEL	LOS ANGELES RIVER
World Oil Marketing Co.	World Oil Marketing	ARTESIA	CAG834001	2	HCNWTRS	LOS ANGELES RIVER

Major dischargers are either (1) Publically Owned Waste Water Treatment Works (POTWs) with a yearly average flow of over 0.5 MGD, (2) industrial sources with a yearly average flow of over 0.1 MGD, or (3) those with lesser flows but with acute or potential adverse environmental impacts.
Minor dischargers are all other discharges that are not categorized as a Major.
General permits are NPDES permits that covers several facilities that have the same type of discharge and are located in a specific geographic area. A general permit applies the same or similar conditions to all dischargers covered under the general permit.

Ratings
"1" = Major threat to water quality
"2" = Moderate threat to water quality
"3" = Minor threat to water quality

Waste Types Categories (prior to treatment or disposal)
First Letter of Code:
Hazardous – influent or solid wastes that contain toxic, corrosive, ignitable, or reactive substances (prior to treatment or disposal) managed according to applicable Department of Health Services standards
Designated – influent or solid wastes that contain **nonhazardous wastes** (prior to treatment or disposal) that pose a significant threat to water quality because of their high concentrations (e.g., BOD, hardness, chloride). Manageable hazardous wastes (e.g., inorganic salts and heavy metals) are included in this category.
Nonhazardous – influent or solid wastes that contain putrescible and nonputrescible solid, semisolid, and liquid wastes (e.g., garbage, trash, refuse, paper, demolition and construction wastes, manure, vegetable or animal solid and semisolid wastes) (prior to treatment or disposal) and have little adverse impact on water quality
Inert – influent or solid wastes that do not contain soluble pollutants or organic wastes (prior to treatment or disposal) and have little adverse impact on water quality. Such wastes could cause turbidity and siltation. Uncontaminated soils, rubble and concrete are examples of this category.
CNSOIL – contaminated soil
CNWTRS – contaminated groundwater
CONTAC – contact cooling water
DOMEST – domestic sewage
DOMIND – domestic sewage & industrial waste
DRILLS – drilling muds
FILBRI – filter backwash brine waters
MISCEL – dewatering, rec. lake overflow, swimming pool wastes, water ride wastewater, or groundwater seepage
NONCON – noncontact cooling water
PROCES – process waste (produced as part of industrial/manufacturing process)
STORMS – stormwater runoff
WSHWTR – washwater waste (photo reuse washwater, vegetable washwater)

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APPENDIX F . 303(d) Listed Waters/Reaches for mainland watersheds, beaches and harbors in greatest proximity to Channel Islands National Park. Watersheds are listed in order from North to South, from Point Conception in Santa Barbara County to the mouth of the Los Angeles River in Los Angeles County, south of the Palos Verdes Peninsula. Relevant jurisdictions are the Central Coast Regional Water Quality Control Board (CC-WQMB, State Regional Board #3 - or "Region 3") and the Los Angeles Regional Water Quality Control Board (LA-WQMB, State Regional Board #4 - or "Region 4"). Relevant waters from Region 3 in the table are from the *South Coast Hydrologic Unit 15* (which includes mostly first order streams draining the coastal mountains from Point Arguello to Carpinteria) and *Unit 16* (which includes San Miguel, Santa Rosa and Santa Cruz Islands), as designated by Region 3. Waters from Region 4 are listed by *Watershed Management Areas* (WMAs), which are designations of Region 4. Three of the islands in Channel Islands National Park (San Miguel, Santa Rosa, and Santa Cruz) fall under the jurisdiction of Region 3 and are contained in Unit 16. Two of the islands in Channel Islands National Park (Anacapa and Santa Barbara) fall under the jurisdiction of Region 4, and are contained in the "Channel Islands WMA". *According to the CA 303(d) lists, no impaired waters are found on any of the Channel Islands.*

Listed River Segment, Beach or Harbor	Impairments
Region 3: Central Coast Water Quality Management Board	
Hydrologic Unit #15 (coastal streams from Pt. Arguello to Carpinteria	
Arroyo Burro Creek	Pathogens
Carpinteria Creek	Pathogens
Carpinteria Marsh (El Estero Marsh)	Nutrients Low DO Priority Organics Sedimentation/Siltation
Goleta Slough/Estuary	Metals Pathogens Priority Organics Sedimentation/Siltation
Mission Creek	Pathogens Unknown toxicity
Pacific Ocean at Carpinteria State Beach (Carpinteria Creek mouth, Santa Barbara County	Fecal Coliform Total Coliform
Pacific Ocean at East Beach (mouth of Mission Creek, Santa Barbara County	Fecal Coliform Total Coliform
Pacific Ocean at East Beach (mouth of Sycamore Creek, Santa Barbara County	Total Coliform
Pacific Ocean at Gaviota Beach (mouth of Canada de la Gaviota Creek, Santa Barbara County)	Total Coliform
Pacific Ocean at Hammonds Beach (Santa Barbara County)	Fecal Coliform
Pacific Ocean at Hope Ranch Beach (Santa Barbara County)	Fecal Coliform
Pacific Ocean at Jalama Beach (Santa Barbara County)	Fecal Coliform Total Coliform
Pacific Ocean at Point Rincon (mouth of Rincon Cr, Santa Barbara County)	Fecal Coliform Total Coliform
Pacific Ocean at Refugio Beach (Santa Barbara County)	Total Coliform
San Antonio Creek (South Coast Watershed)	Sedimentation/Siltation
Hydrologic Unit #16 (San Miguel, Santa Rosa and Santa Cruz Islands)	
No impaired waters	

Appendix F. Continued

Listed River Segment, Beach or Harbor	Impairments
Region 4: Los Angeles Regional Water Quality Control Board	
Channel Islands WMA (Anacapa, Santa Barbara, San Nicolas, Santa Catalina and San Clemente Islands)	
No impaired waters	
Miscellaneous Ventura Coastal WMA	
Channel Islands Harbor	Lead (sediment) Zinc (sediment)
Channel Islands Harbor Beach	coliform
Hobie Beach (Channel Islands Harbor)	coliform
Mandalay Beach	beach closures
McGrath Beach	coliform
McGrath Lake	chlordane (sediment) coliform, fecal dieldrin (sediment) PCBs (sediment) Sediment toxicity DDT (sediment)
Ormond Beach (area 50 yds N of Oxnard Industrial Dr and a 50 yd area south of J St Dr)	coliform
Port Hueneme Harbor (Back Basins)	DDT (tissue), PCBs (tissue)
Promenade Park Beach	coliform
Rincon Beach	coliform
San Buenaventura Beach	coliform
Santa Clara River Estuary Beach/Surfers Knoll	coliform
Surfers Point at Seaside	coliform
Ventura Harbor: Ventura Keys	coliform
Ventura River WMA	
Canada Larga (Ventura River Watershed)	coliform, fecal, Low DO
Matilija Creek Reach 1 (Jct. With N. Fork to Reservoir)	fish barriers
Matilija Creek Reach 2 (above Reservoir)	fish barriers
Matilija Reservoir	fish barriers
San Antonio Creek (tributary to Ventura River Reach 4)	nitrogen
Ventura River Estuary	algae coliform, fecal coliform, total eutrophic Trash
Ventura River Reach 1 (estuary to Main St.)	algae
Ventura River Reach 2 (Main St. to Weldon Canyon)	algae
Ventura River Reach 3 (Weldon Canyon to confl. w/ Coyote Cr.)	Pumping, water diversions
Ventura River Reach 4 (Coyote Creek to Camino Cielo Rd.)	Pumping, water diversions

Appendix F. Continued

Listed River Segment, Beach or Harbor	Impairments
Santa Clara River WMA	
Brown Barranca/Long Canyon	nitrate + nitrite
Elizabeth Lake	eutrophic low DO/organic enrichment pH trash
Hopper Creek	sulfate total dissolved solids
Lake Hughes	algae eutrophic fish kills odors trash
Mint Canyon Creek Reach 1	nitrate + nitrite
Munz Lake	eutrophic trash
Piru Creek (tributary to Santa Clara River Reach 4)	pH
Pole Creek (tributary to Santa Clara River Reach 3)	sulfate total dissolved solids
Santa Clara River Estuary	ChemA* (tissue) coliform toxaphene
Santa Clara River Reach 3 (Freeman Diversion to A street))	ammonia chloride total dissolved solids
Santa Clara River Reach 7 (Blue Cut to West Pier Hwy 99)	ammonia chloride nitrate + nitrite
Santa Clara River Reach 8 (W Pier Hwy 99 to Bouquet Cyn Rd Bridge)	chloride coliform
Santa Clara River Reach 9 (Bouquet Cyn Rd to abv Lang Gaging)	coliform
Sespe Creek (tributary to Santa Clara River Reach 3)	chloride pH
Torrey Canyon Creek	nitrate + nitrite
Wheeler Canyon/Todd Barranca	nitrate + nitrite sulfate total dissolved solids
Calleguas Creek WMA	
Calleguas Creek Reach 1 (was Mugu Lagoon)	chlordane (tissue) Copper DDT (tissue & sediment) endosulfan (tissue) Mercury nickel nitrogen PCBs (tissue) sediment toxicity sedimentation/siltation Zinc

Appendix F. Continued

Listed River Segment, Beach or Harbor	Impairments
Calleguas Creek Reach 2 (estuary to Potrero Rd - was Calleguas Creek Reaches 1 and 2)	Ammonia ChemA* (tissue) chlordane (tissue) copper, dissolved DDT (tissue & sediment) endosulfan (tissue) fecal coliform nitrogen PCBs (tissue) sediment toxicity sedimentation/siltation toxaphene (tissue & sediment)
Calleguas Creek Reach 3 (previously Potrero Rd upstream to confluence with Conejo Ck)	Chloride nitrate + nitrite sedimentation/siltation total dissolved solids
Calleguas Creek Reach 4 (was Revolon Slough Main Branch: Mugu Lagoon to Central Ave.)	Algae Boron ChemA* (tissue) chlordane (tissue & sediment) chlorpyrifos (tissue) coliform, fecal DDT (tissue & sediment) dieldrin (tissue) endosulfan (tissue & sediment) nitrogen nitrate as nitrogen (NO3) PCBs (tissue) sedimentation/siltation Selenium sulfate total dissolved solids toxaphene (tissue & sediment) toxicity trash
Calleguas Creek Reach 5 (was Beardsley Channel)	algae ChemA* (tissue) chlordane (tissue & sediment) chlorpyrifos (tissue) dacthal (sediment) DDT (tissue & sediment) dieldrin (tissue) endosulfan (tissue & sediment) nitrogen PCBs (tissue) sedimentation/siltation toxaphene (tissue & sediment) toxicity trash

Appendix F. Continued

Listed River Segment, Beach or Harbor	**Impairments**
Calleguas Creek Reach 6 (was Arroyo Las Posas Reaches 1 and 2)	ammonia chloride coliform, fecal DDT (sediment) nitrate + nitrite sedimentation/siltation sulfate total dissolved solids
Calleguas Creek Reach 7 (was Arroyo Simi Reaches 1 and 2)	ammonia Boron chloride coliform, fecal organophosphorus pesticides sedimentation/siltation sulfate total dissolved solids
Calleguas Creek Reach 8 (was Tapo Canyon Reach 1)	Boron chloride sedimentation/siltation sulfate total dissolved solids
Calleguas Creek Reach 9A (was lower part of Conejo Creek Reach 1)	algae ChemA* (tissue) chlordane (tissue) coliform, fecal DDT (tissue) dieldrin (tissue) endosulfan (tissue) hexachlorocyclohexane (HCH) (tissue) nitrate (NO3) nitrate as nitrogen nitrite as nitrogen PCBs (tissue) sulfate total dissolved solids toxaphene (tissue & sediment)
Calleguas Creek Reach 9B (was part of Conejo Creek Reaches 1 and 2)	Algae ammonia ChemA* (tissue) chloride coliform, fecal DDT (tissue) endosulfan (tissue) sulfate total dissolved solids toxaphene (tissue & sediment) toxicity

Appendix F. Continued

Listed River Segment, Beach or Harbor	**Impairments**
Calleguas Creek Reach 10: Conejo Ck-Hill Canyon (was part of Conejo Creek Reaches 2 and 3, and lower Conejo Crk/Arroyo Conejo N Fork)	Algae ammonia ChemA* (tissue) chloride coliform, fecal DDT (tissue) endosulfan (tissue) nitrite as nitrogen sulfate total dissolved solids toxaphene (tissue & sediment) toxicity
Calleguas Creek Reach 11: Arroyo Santa Rosa (was part of Conejo Creek Reach 3)	algae ammonia ChemA* (tissue) coliform, fecal DDT (tissue) endosulfan (tissue) sedimentation/siltation sulfate total dissolved solids toxaphene (tissue & sediment) toxicity
Calleguas Creek Reach 12 (was Conejo Creek/Arroyo Conejo N. Fork)	ammonia chlordane (tissue) DDT (tissue) sulfate total dissolved solids
Calleguas Creek Reach 13: Conejo Creek South Fork (was Conejo Creek Reach 4 and part of Reach 3)	algae ammonia ChemA* (tissue) chloride DDT (tissue) endosulfan (tissue) sulfate total dissolved solids toxaphene (tissue & sediment) toxicity
Duck pond agric. drain/Mugu Drain/Oxnard Drain #2	ChemA* (tissue) DDT (tissue & sediment) nitrogen sediment toxicity toxaphene (tissue) toxicity chlordane (tissue)
Fox Barranca (tributary to Calleguas Creek Reach 6)	Boron nitrate + nitrite sulfate total dissolved solids

Appendix F. Continued

Listed River Segment, Beach or Harbor	Impairments
Rio de Santa Clara/Oxnard Drain #3	ChemA* (tissue) chlordane (tissue) DDT (tissue) nitrogen PCBs (tissue) sediment toxicity toxaphene (tissue)
Santa Monica Bay WMA	
Ashland Avenue Drain	coliform low DO/organic enrichment toxicity
Ballona Creek	cadmium (sediment) ChemA* (tissue) chlordane (tissue) coliform copper, dissolved DDT (tissue) dieldrin (tissue) enteric viruses Lead, dissolved PCBs (tissue) pH sediment toxicity Selenium, total silver (sediment) toxicity zinc, dissolved
Ballona Creek Estuary	chlordane (tissue & sediment) coliform DDT (sediment) Lead (in sediment) PAHs (sediment) PCBs (tissue & sediment) sediment toxicity shellfish harvesting advisory Zinc (sediment)
Ballona Wetland	exotic vegetation habitat alteration hydromodification reduced tidal flushing trash
Lake Lindero	algae chloride eutrophic odors specific conductance trash

Appendix F. Continued

Listed River Segment, Beach or Harbor	**Impairments**
Lake Sherwood	algae ammonia eutrophic low DO/organic enrichment Mercury (tissue)
Las Virgenes Creek	coliform low DO/organic enrichment nutrients (algae) scum/foam-unnatural sedimentation/siltation Selenium trash
Lindero Creek Reach 1	algae coliform scum/foam-unnatural Selenium trash
Lindero Creek Reach 2 (above lake)	algae coliform scum/foam-unnatural Selenium trash
Malibou Lake	algae eutrophic low DO/organic enrichment
Malibu Creek	coliform fish barriers nutrients (algae) scum/foam-unnatural sedimentation/siltation trash
Malibu Lagoon	benthic comm. effects coliform enteric viruses eutrophic pH shellfish harvesting advisory swimming restrictions
Marina del Rey Harbor - Back Basins	chlordane (tissue & sediment) copper (sediment) DDT (tissue) dieldrin (tissue) fish consumption advisory Lead (sediment) PCBs (tissue & sediment) sediment toxicity zinc (sediment)

Appendix F. Continued

Listed River Segment, Beach or Harbor	**Impairments**
Medea Creek Reach 1 (lake to confl. with Lindero)	algae coliform sedimentation/siltation selenium trash
Medea Creek Reach 2 (abv. confl. with Lindero)	algae coliform sedimentation/siltation selenium trash
Palo Comado	coliform
Pico Kenter Drain	ammonia coliform copper enteric viruses lead PAHs toxicity trash
Santa Monica Bay Nearshore and Offshore Zone	chlordane (sediment) debris fish consumption advisory PAHs (sediment) PCBs (tissue & sediment) sediment toxicity
Santa Monica Bay Nearshore and Offshore Zone (centered on Palos Verdes Shelf)	DDT (tissue & sediment)
Santa Monica Canyon	coliform lead
Sepulveda Channel	ammonia coliform lead
Stokes Creek	coliform
Topanga Cyn Creek	lead
Triunfo Cyn Creek Reach 1	lead mercury sedimentation/siltation
Triunfo Cyn Creek Reach 2	lead mercury sedimentation/siltation
Westlake Lake	algae ammonia eutrophic lead low DO/organic enrichment
Abalone Cove Beach	beach closures DDT PCBs
Amarillo Beach	DDT PCBs

Appendix F. Continued

Listed River Segment, Beach or Harbor	**Impairments**
Big Rock Beach	beach closures coliform DDT PCBs
Bluff Cove Beach	beach closures DDT PCBs
Cabrillo Beach (Outer)	beach closures coliform DDT PCBs
Carbon Beach	beach closures DDT PCBs
Castlerock Beach	beach closures coliform DDT PCBs
Dan Blocker Memorial Beach	coliform
Dockweiler Beach	beach closures coliform
Escondido Beach	beach closures DDT PCBs
Flat Rock Point Beach Area	beach closures DDT PCBs
Inspiration Point Beach	beach closures DDT PCBs
La Costa Beach	beach closures DDT PCBs
Las Flores Beach	coliform DDT PCBs
Las Tunas Beach	beach closures DDT PCBs
Leo Carillo Beach (south of County line)	beach closures coliform
Long Point Beach	coliform DDT PCBs
Lunada Bay Beach	beach closures
Malaga Cove Beach	beach closures DDT PCBs

Appendix F. Continued

Listed River Segment, Beach or Harbor	Impairments
Malibu Beach	beach closures DDT
Malibu Lagoon Beach (Surfrider)	beach closures coliform DDT PCBs
Marina Del Rey Harbor Beach	beach closures coliform
Nicholas Canyon Beach	beach closures DDT PCBs
Palos Verdes Shoreline Point Beach	pathogens pesticides
Paradise Cove Beach	beach closures coliform DDT PCBs
Peninsula Beach	coliform
Point Dume Beach	beach closures DDT PCBs
Point Fermin Park Beach	beach closures DDT PCBs
Point Vicente Beach	beach closures
Portugese Bend Beach	beach closures DDT PCBs
Puerco Beach	beach closures DDT PCBs
Redondo Beach	beach closures coliform DDT PCBs
Resort Point Beach	beach closures
Robert H. Meyer Memorial Beach	beach closures DDT PCBs
Rocky Point Beach	beach closures
Royal Palms Beach	beach closures DDT PCBs
Santa Monica Beach	beach closures coliform

Appendix F. Continued

Listed River Segment, Beach or Harbor	Impairments
Sea Level Beach	beach closures DDT PCBs
Topanga Beach	beach closures coliform DDT PCBs
Torrance Beach	beach closures coliform
Trancas Beach (Broad Beach)	beach closures coliform DDT PCBs
Venice Beach	beach closures coliform
Whites Point Beach	beach closures DDT PCBs
Will Rogers Beach	beach closures coliform
Zuma (Westward Beach)	beach closures DDT PCBs
Dominguez WMA	
Cabrillo Beach (Inner) LA Harbor area	beach closures DDT (fish consumption advisory) PCBs (fish consumption advisory)
Dominguez Channel (above Vermont)	aldrin (tissue) ammonia ChemA* (tissue) chlordane (tissue) Chromium (sediment) coliform Copper (sediment) DDT (tissue & sediment) dieldrin (tissue) Lead (tissue) PAHs (sediment) PCBs (tissue) Zinc (sediment)

Appendix F. Continued

Listed River Segment, Beach or Harbor	Impairments
Dominguez Channel Estuary (to Vermont)	aldrin (tissue) ammonia benthic comm. effects ChemA* (tissue) chlordane (tissue) Chromium (sediment) coliform DDT (tissue & sediment) dieldrin (tissue) Lead (tissue) PAHs (sediment) Zinc (sediment)
Long Beach Harbor (part. Main Ch., SE Basin, West Basin, Pier J, and breakwater)	benthic comm. effects DDT (tissue) PAHs (sediment) PCBs (tissue) sediment toxicity
Los Angeles Harbor: Fish Harbor	DDT PAHs PCBs
Los Angeles Harbor: Inner Breakwater	DDT PAHs PCBs
Los Angeles Harbor: Main Channel	beach closures Copper (tissue & sediment) DDT (tissue & sediment) PAHs (tissue & sediment) PCBs (tissue & sediment) sediment toxicity Zinc (tissue & sediment)
Los Angeles Harbor: Consolidated Slip	benthic comm. effects cadmium (sediment) chlordane (tissue & sediment) Chromium (sediment) DDT (tissue & sediment) dieldrin (tissue) Lead (sediment) Mercury (sediment) Nickel (sediment) PAHs (sediment) PCBs (tissue & sediment) sediment toxicity Zinc (sediment)

Appendix F. Continued

Listed River Segment, Beach or Harbor	Impairments
Los Angeles Harbor: Southwest Slip	sediment toxicity PCBs (fish consumption advisory) DDT (fish consumption advisory)
Machado Lake (Harbor Park Lake)	algae ammonia ChemA* (tissue) chlordane (tissue - fish consumption advisory) DDT (fish consumption advisory) dieldrin (tissue) eutrophic odors PCBs (tissue) trash
San Pedro Bay nearshore and offshore zones	Chromium (sediment) Copper (sediment) PAHs (sediment) sediment toxicity DDT (fish consumption advisory) PCBs (fish consumption advisory) Zinc (sediment)
Torrance Carson Channel	coliform Copper (sediment) Lead (sediment)
Wilmington Drain	ammonia coliform Copper (sediment) Lead (sediment)
Los Angeles River WMA	
Aliso Canyon Wash	Selenium
Arroyo Seco Rch 1 (d/s Devil's Gate Dam)	coliform nutrients (algae) trash
Arroyo Seco Rch 2 (W. Holly Ave. to Devil's Gate)	coliform nutrients (algae) trash
Bell Creek	coliform
Burbank Western Channel	algae ammonia Cadmium odors scum/foam-unnatural trash

Appendix F. Continued

Listed River Segment, Beach or Harbor	**Impairments**
Compton Creek	coliform Copper Lead PH
Dry Canyon Creek	coliform Selenium, total
Echo Park Lake	algae ammonia Copper eutrophic Lead odors PCBs (tissue) PH
Lake Calabasas	ammonia DDT (tissue) eutrophic low DO/organic enrichment odors pH
Lincoln Park Lake	ammonia eutrophic Lead low DO/organic enrichment odors
Los Angeles River Estuary (Queensway Bay)	chlordane (sediment) DDT (sediment) Lead (sediment) PCBs (sediment) Zinc (sediment)
Los Angeles River Reach 1(u/s Carson St. to estuary)	Aluminum, total ammonia cadmium, dissolved coliform copper, dissolved Lead nutrients (algae) pH scum/foam-unnatural zinc, dissolved
Los Angeles River Reach 2 (Figueroa St. to u/s Carson St.)	ammonia coliform Lead nutrients (algae) odors oil scum/foam-unnatural

Appendix F. Continued

Listed River Segment, Beach or Harbor	**Impairments**
Los Angeles River Reach 3 (Riverside Dr. to Figueroa St.)	ammonia nutrients (algae) odors scum/foam-unnatural
Los Angeles River Reach 4 (Sepulveda Dam to Riverside Dr.)	ammonia coliform Lead nutrients (algae) odors scum/foam-unnatural
Los Angeles River Reach 5 (within Sepulveda Basin)	ammonia nutrients (algae) odors oil scum/foam-unnatural
Los Angeles River Reach 6 (u/s of Sepulveda Basin)	coliform Dichloroethylene/1,1-DCE Tetrachloroethylene/PCE Trichloroethylene/TCE
McCoy Canyon Creek	coliform nitrate (NO3) nitrate as nitrogen Selenium, total
Monrovia Cyn Creek	Lead
Peck Rd Lake	chlordane (tissue) DDT (tissue) Lead low DO/organic enrichment odors
Rio Hondo Reach 1 (Santa Ana Fwy to Los Angeles River)	coliform Copper Lead pH Trash Zinc
Rio Hondo Reach 2 (Whittier Narrows Flood Control Basin to Spreading Grounds)	coliform
Tujunga Wash (d/s Hansen Dam to Los Angeles River)	ammonia coliform Copper odors scum/foam-unnatural Trash
Verdugo Wash Reach 1 (LA River to Verdugo Rd)	algae coliform Trash
Verdugo Wash Reach 2 (above Verdugo Road)	algae coliform Trash

APPENDIX G
Synopses of Water Quality for Coastal WMAs in Region 4
Source:
(http://www.waterboards.ca.gov/losangeles/html/programs/regional_programs.html#Watershed)

Channel Islands WMA (the southern Channel Islands)

The U.S. Navy has facilities on San Nicolas (and a desalination plant) and San Clemente Islands with a small package treatment plant on the latter. San Clemente Island is the primary maritime training area for the U.S. Department of the Navy Pacific Fleet, U.S. Navy SEALs, and the U.S. Marine Corps. The city of Avalon is located on Santa Catalina Island and also has a small treatment plant. Water quality in the vicinity of the islands is generally good. There are some potential threats from the naval facilities and the small treatment plants; however, there is only one area (Avalon Beach) with an impairment listing, for bacteria.

Miscellaneous Ventura WMA.

This WMA consists of four separate drainage areas are typified by either small coastal streams, wetlands, or marinas: Channel Islands Harbor, Port Hueneme Harbor, Ventura Marina, and McGrath Lake. Most of the 24 NPDES permittees in the watershed discharge to coastal streams.

Channel Islands Harbor: The harbor is on the 2002 303(d) list for lead and zinc. During the early to mid-1980s, the State Mussel Watch Program (SMWP) found low to intermediate levels of metals and organics except for one especially high accumulation of DDT. Sediment sampling for metals conducted by Regional Board staff in 1988 revealed slightly to moderately elevated levels. Copper at one site was nearly 50 ppm and zinc was as high as 76 ppm. Arsenic was slightly elevated (4 ppm) at a sampling site located next to a drain possibly connected to a nearby agricultural field. Under the Bay Protection and Toxic Cleanup Program (BPTCP), the harbor is listed as site of concern due to DDT and silver sediment concentrations and sediment toxicity (but not recurrent toxicity); further monitoring is needed here.

Port Hueneme Harbor: The harbor is on the 2002 303(d) list for PAHs, DDT, PCBs, TBT, and zinc. The SMWP has found elevated levels of Cu, Zn, PAHs, and PCBs. Zinc was at elevated levels on the commercial side while PCBs were very high on the Navy side. The Navy side is suspected of using large amounts of pentachlorophenol for treatment of wood pilings. An Army Corps DEIR released in 1985 covering extension of one channel stated that water quality was good. The document also briefly discussed the port's biota which CF&G found to be "fairly healthy" and typical of southern California harbors. Sediment core samples were collected in 1985 and 1996 as part of a proposed dredge project. Relatively low levels of metals were found and no pesticides were detected. It may well be that flushing is good in the harbor and only locating a station directly next to a source will result in bioaccumulation. The BPTCP found fairly minimal levels of sediment toxicity but the harbor is considered a site of concern under the program due to accumulation of DDT, PCBs, TBT, PAHs, and zinc in mussel tissue. However, more recent monitoring conducted as part of dredging projects have found much lower concentrations of many pollutants, at least in sediment.

Ventura Marina: The marina (the Keys area) is on the 2002 303(d) list for coliform problems. The City of Ventura monitors six stations within the Keys and the nearby Arundell Barranca (open drain carrying mostly agricultural runoff) for coliform on a regular basis. There are currently ongoing discussions concerning the possibility of re-rerouting the barranca away from the marina. The SMWP has found moderately elevated levels of metals, DDT, and chlordane in the marina from sampling conducted in the late 1980s; however, it is not listed as a site of concern under the BPTCP.

McGrath Lake: The lake is on the 2002 303(d) list for pesticides. The BPTCP found varying amounts of sediment toxicity and sediment levels of many pesticides were very high; the lake is listed as a toxic hot spot due to sediment concentrations of DDT, chlordane, dieldrin, toxaphene and endosulfan above sediment quality guidelines. A major crude oil spill into the lake occurred in late 1993 and runoff from nearby agricultural fields is ongoing. A characterization study revealed the large extent to which the sediment is contaminated; however, since the likelihood of cleanup is currently low, planning for habitat restoration proceeding.

Open Coastline: Little is known of water quality in the Ormond Beach area. The Oxnard Treatment Plant discharges secondary effluent to the ocean off of Oxnard. The facility is currently investigating approaches to remove upstream brine dischargers in order to move toward water reclamation. Part of the reclaimed water is proposed for use in a seawater intrusion barrier project to protect the Oxnard Plain ground water basin. The ocean immediately off of the coast was part of Bight'98 and the 1994 Southern California Bight Pilot Project.

Ventura River WMA

The majority of water quality problems involve eutrophication (excessive nutrients and effects), especially in the estuary/lagoon although some DDT and metals have been found in mussel and fish tissue (on the 303(d) list for these). A large storm drain enters the river near the estuary and homeless persons live in and frequent the river bed. Sediment in the estuary, however, appears relatively uncontaminated and in laboratory tests conducted through the BPTCP, little sediment toxicity was found. In some subwatersheds, high TDS concentrations impair the use of water for agriculture. The watershed's water quality problems are, for the most part, nonpoint source-related. There have also been incidents of releases of toxic materials into storm drains entering the lower river.

There is only one major discharger, a small POTW (3.0 MGD) in the middle reach of the Ventura River which has recently upgraded (end of 1997) to tertiary treatment The treatment plant effluent had been implicated in nuisance growth of aquatic plants and low dissolved oxygen found at times downstream of the discharge. For much of the year, the facility's effluent can make up two-thirds of the total river flow. The major concern was the facility's inability to meet the nutrients and suspended solids discharge limitations in its NPDES permit. Additionally, high biochemical oxygen demand (BOD) in the effluent resulted in dissolved oxygen concentrations in the river that could not support cold water aquatic habitat. The facility was required to upgrade under a Regional Board Cease and Desist Order. The most recent monitoring has shown the quality of the effluent has significantly improved including a reduction of nitrate-nitrogen from 20 mg/l to 4 mg/l, a reduction of suspended solids from 12 mg/l to 2 mg/l, and a reduction of BOD from 10 mg/l to 2 mg/l. Dissolved oxygen levels in the river have improved dramatically to about 11 mg/l and algal growth is greatly reduced below the plant; however, nonpoint sources (agriculture and horse stables) still appear to be contributing to algal growth above the plant.

Water diversions, dams, and groundwater pumping also are thought to limit surface water resources needed to support a high quality fishery. Reduced water supplies affect water quality and thus beneficial uses, particularly with regards to the endangered steelhead trout (steelhead trout are known to utilize the River and some of its tributaries historically supported annual steelhead runs of 5000 – 6000 adults). Removal of the Matilija Dam (upper river) has recently been identified as a high priority.

Santa Clara River WMA

The Santa Clara River is the largest river system in southern California that remains in a relatively natural state; this is a high quality natural resource for much of its length. The river originates in the northern slope of the San Gabriel Mountains in Los Angeles County, traverses Ventura County, and flows into the Pacific Ocean halfway between the cities of San Buenaventura and Oxnard.

Extensive patches of high quality riparian habitat are present along the length of the river and its tributaries. The endangered fish, the unarmored stickleback, is resident in the river. One of the largest of the Santa Clara River's tributaries, Sespe Creek, is designated a wild trout stream by the state of California and supports significant spawning and rearing habitat. The Sespe Creek is also designated a wild and scenic river. Piru and Santa Paula Creeks, which are tributaries to the Santa Clara River, also support good habitats for steelhead. In addition, the river serves as an important wildlife corridor. A lagoon exists at the mouth of the river and supports a large variety of wildlife.

Increasing loads of nitrogen and salts in supplies of ground water threaten beneficial uses including irrigation and drinking water. Other threats to water quality include increasing development in floodplain areas which has necessitated flood control measures such as channelization that results in increased runoff volumes and velocities, erosion, and loss of habitat. In many of these highly disturbed areas the exotic giant reed (*Arundo donax*) is gaining a foothold.

Many of the smaller communities in this watershed remain unsewered. In particular, in the Agua Dulce area of the upper watershed, impacts on drinking water wells from septic tanks is a major concern. The community is undertaking a wellhead protection effort, with oversight by Board staff. Development pressure, particularly in the upper watershed, threatens habitat and the water quality of the river. The effects of septic system use in the Oxnard Forebay area is also of concern

IMPAIRMENTS: Limited data (beyond mineral quality and nitrogen) is available for much of the Santa Clara River. The Santa Clara River Estuary and Beach is on the 303(d) list for coliform while a portion of the river upstream of the estuary is listed for ammonia and coliform. Portions of the river have chloride exceedances. The Estuary is also listed for DDT in fish tissue. Two small lakes in the watershed are also on the 303(d) list for eutrophication, trash, DO, and pH problems. Two major spills of crude oil into the river occurred in the early 1990s although recovery has been helped somewhat by winter flooding events. Natural oil seeps discharge significant amounts of oil into Santa Paula Creek.

Calleguas Creek WMA

Aquatic life in both Mugu Lagoon and the inland streams of this watershed has been impacted by pollutants from nonpoint sources. DDT, PCBs, other pesticides, and some metals have been detected in both sediment and biota collected from surface waterbodies of this watershed. Additionally, ambient toxicity has been revealed in several studies from periodic toxicity testing in the watershed (ammonia from POTWs and pesticides such as diazinon and chlorpyrifos are implicated). Fish collected from Calleguas Creek and Revolon Slough exhibit skin lesions and have been found to have other histopathologic abnormalities. High levels of minerals and nitrates are common in the water column as well as in the groundwater. Sediment toxicity is also elevated in some parts of the lagoon. Reproduction is impaired in the resident endangered species, the light-footed clapper rail due to elevated levels of DDT and PCBs. Overall, this is a very impaired watershed. It appears that the sources of many of these pollutants are agricultural activities (mostly through continued disturbance and erosion of historically contaminated soils), which cover approximately 25% of the watershed along the inland valleys and coastal plain, although the nearby naval facility has also been a contributor. Other nonpoint sources include residential and urban activities, which are present over approximately 25% of the watershed. The remaining 50% of the watershed is still open space although there is a severe lack of benthic and riparian habitat.

Mugu Lagoon as well as the Calleguas Creek Estuary is considered a toxic hot spot owing to a BPTCP advisory level for mercury in fish, exceedance of the NAS guideline level for DDT in fish, sediment concentrations of DDT, PCB, chlordane, chlorpyrifos, sediment toxicity and degraded benthic infaunal community. Primary issues related to POTW discharges include ammonia toxicity and high mineral content (i.e., salinity), the latter, in part, due to imported water supplies.

Santa Monica Bay WMA

As a nationally significant water body, Santa Monica Bay was included in the National Estuary Program in 1989. It has been extensively studied by the Santa Monica Bay Restoration Project and a watershed plan was developed in 1995. The Santa Monica Bay Watershed Council was formed in 1994 to oversee implementation of the Plan. The Restoration Project staff will be coordinating with Regional Board staff to carry out the Board's watershed approach in the Santa Monica Bay Watershed.

Though relatively small in its size compared with watersheds in other parts of the country, the Santa Monica Bay WMA embraces a high diversity in geological and hydrological characteristics, habitat features, and human activities. Almost every beneficial use defined in the Basin Plan is identified in water bodies somewhere in the WMA. Yet many of these beneficial uses have been impaired for years. While some of the impaired areas are showing signs of recovery, beneficial uses that are in relatively good condition still face the threat of degradation.

Existing and potential beneficial use impairment problems in the watershed fall into two major categories: human health risk, and natural habitat (wildlife) degradation. The former are issues primarily associated with recreational uses of the Santa Monica Bay. The latter are issues associated with terrestrial, aquatic, and marine environments. Pollutant loadings that originate from human activities are common causes of both human health risks and habitat degradation.

Of the major NPDES dischargers in the Santa Monica Bay WMA, the three POTWs (particularly the two direct ocean discharges) are the largest point sources of pollutants to Santa Monica Bay. Pollutants from the minor discharges have been estimated to contribute less than two percent of the total pollutants being discharged to the Bay.

Dominguez Channel and Los Angeles/Long Beach Harbors WMA

Two areas within Los Angeles Harbor are considered to be toxic hot spots under the BPTCP: Dominguez Channel/Consolidated Slip, based on sediment concentrations of DDT, PCB, cadmium, copper, lead, mercury, zinc, dieldrin, chlordane (all exceed sediment quality guidelines), sediment toxicity, and degraded benthic infaunal community; and Cabrillo Pier area, based on sediment concentrations of DDT, PCB and copper, sediment toxicity and issuance of a human health (fishing) advisory for DDT and PCB in white croaker and exceedances of National Academy of Science guidelines for DDT in fish and shellfish. Several locations have been listed as sites of concern under the BPTCP: Inner Fish Harbor, due to sediment concentrations of DDT, PCB, copper, mercury and zinc and sediment toxicity (not recurrent); Kaiser International, due to sediment concentrations of DDT, PCB, PAH, copper and endosulfan; Hugo Neu-Proler, due to PCB sediment concentrations; Southwest Slip, due to sediment concentrations of DDT, PCB, PAH, mercury, and chromium, and sediment toxicity (not recurrent); Cerritos Channel, due to sediment concentrations of DDT, PCB, metal, chlordane, TBT, sediment toxicity and accumulation in mussel tissue; Long Beach Outer Harbor, due to sediment concentrations of DDT and chlordane and sediment toxicity (not recurrent); and West Basin, due to sediment concentrations of DDT and PCB, sediment toxicity (not recurrent) and accumulation in clam tissue. There is need for further monitoring in all of these areas to clarify their status. Potential sources of these materials are considered to be historical deposition, discharges from the nearby POTW (especially for metals), spills from ships and industrial facilities, as well as stormwater runoff. Many areas of the harbors have experienced soil and/or groundwater contamination, which may result in possible transport of pollutants to the harbors' surface waters.

Los Angeles Inner Harbor

Although the area is dramatically cleaner now than twenty-five years ago, parts of LA Inner Harbor are still suffering the effects of historic deposits of pollutants in the sediment and current point and nonpoint source discharges. Fish caught in the East Basin have exhibited histopathological abnormalities (liver lesions). The abnormalities are indicative of aromatic and chlorinated hydrocarbon contamination. There is also significant degradation in the biological community of a part of Inner Harbor with high levels of PCB and DDT; and toxicity of the surface water microlayer of one part of the harbor to a test fish species (larval kelp bass). Additionally, Cal EPA's Office of Environmental Health Hazard Assessment now advises against consumption of white croaker in the harbor and recommends no more than one meal every two weeks of black croaker, queenfish, and surfperches if caught in the harbor. On the other hand, the benthic community in many other areas of the inner harbor are healthy and sediments, though high in many pollutants, do not cause a great deal of toxicity in controlled lab tests.

LA Inner Harbor is on the 2002 303(d) list due to DDT, metals, PAHs, chlordane, TBT, and PCBs. Some of the contamination in sediment is historic with resuspension potential. Dominguez Channel was the recipient of runoff from the Montrose Chemical Facility which manufactured DDT for several decades until the early 1970s. There are also mostly nonpoint source inputs from several problem sites, spills, and storm drain runoff. The problems tend to be exacerbated by the poor circulation and flushing. The Port is in the process of filling in a large part of Outer Harbor and deepening some channels as part of their "2020 Plan". Pier 400, a 590-acre site of new land created by diking and filling harbor waters, was completed in April 2000. As a result, the potential exists for greater stagnation and more problems from deposition of new contaminants.

Mussel tissue data from the SMWP have documented high levels of metals, PCBs, TBT, and PAHs in mussel tissue at several locations in LA Inner Harbor. The BPTCP found a number of inner harbor areas with elevated pollutant levels but a smaller number of those have exhibited sediment toxicity.

Sediment data collected by Regional Board staff, the Port of LA, and various other researchers, have revealed several areas of heavy contamination with metals, PCBs, and DDT, and occasionally PAHs. Regional Board data show that the level of contamination within particular regions of the inner harbor vary considerably from site to site. Additionally, it is difficult to separate the effects of historic contamination from current inputs.

Dominguez Channel

The results of sampling in 2002 found that for several chemicals, the maximum concentrations observed in Consolidated Slip sediments exceeded the NOAA ERM values. (ERM, Effects Range Medium, is the concentration threshold for a particular constituent above which 50% of samples show deleterious biological effects; ERL, Effects Range Low, is the threshold above which 10% of samples cause deleterious biological effects). Average concentrations (based on all data collected over the past 10 years) were close to or above the ERM for copper, lead, mercury, DDT, PCB and chlordane (this table was not in the draft report). Contour maps of the contaminants show different patterns according to the chemical (lead and DDT have different distributions in Consolidated Slip) and with depth (the surficial sediments show different distributions than medium depth and deep cores). Sediment sampling for DDT was conducted in the Dominguez Channel by a consultant for Montrose during 1990; DDT levels were 300 - 13,000 ppb. NOAA's ERL amd ERM for DDT in sediment are 3 ppb and 350 ppb, respectively.

Of major concern in the mid-1980s was discharge of zinc chromate as an additive in cooling water/boiler blowdown. There may have been some justification for that concern. Sediment sampling conducted by Regional Board staff in 1988 revealed zinc levels as high as 447 ppm, chromium as high as 67 ppm, and lead as high as 231 ppm.

A Region 4 study conducted in 1975 found that the aquatic biota of the Dominguez Channel were largely marine in origin and were a continuation of LA Inner Harbor biota. The number and abundance of aquatic species declined with distance inland from the harbor. A fairly abrupt decline in benthic species between Alameda and Wilmington Streets was attributed to the effects of pollution. *Capitella capitata* was one of the most abundant benthic species in the area and is generally associated with polluted areas. An absence of benthic fish species adjacent to one oil refinery was considered to be indicative of oxygen-poor bottom water. There was a degraded benthic community at several stations in Consolidated Slip during BPTCP sampling.

Long Beach Inner Harbor

While historic contamination is a definite problem in the older parts of the harbor (including the naval base), Pier J has only recently been constructed, utilizing some highly contaminated dredge material. Some other likely problem sites include: Cerritos Channel with its inputs at times from Consolidated Slip, a creosote manufacturing site, several oil terminals, a defunct ship repair yard (and several active ones), and the naval base, which is closed, while the attached shipyard remains open.

Contamination in the LB Inner Harbor is known to be sporadic. Little information is available on contamination in Southeast Basin except for TBT water concentrations of up to 380 ppt found in a 1988 statewide study of harbors and low levels of PCBs found in mussel tissue in 1986. The most recent SMWP data for the Inner Harbor show some areas of elevated DDT, most notably at those stations located in or near Cerritos Channel.

Moderate PCB levels were found in mussel tissue in front of the creosote facility located in Channel 2 and somewhat higher levels were found in Cerritos Channel which is likely related to its proximity to Consolidated Slip and other LA Harbor point and nonpoint sources. Long Beach Inner Harbor is on the 2002 303(d) list for DDT, PAHs, and PCBs, while San Pedro Bay is listed for DDT, PAHs, PCBs, and some metals.

Los Angeles River WMA

The Los Angeles River watershed is one of the largest in Region 4. It is also one of the most diverse in terms of land use patterns. Approximately 324 square miles of the watershed are covered by forest or open space land including the area near the headwaters which originate in the Santa Monica, Santa Susana, and San Gabriel Mountains. The rest of the watershed is highly developed. The river flows through the San Fernando Valley past heavily developed residential and commercial areas. From the Arroyo Seco, north of downtown Los Angeles, to the confluence with the Rio Hondo, the river flows through industrial and commercial areas and is bordered by railyards, freeways, and major commercial and government buildings. From the Rio Hondo to the Pacific Ocean, the river flows through industrial, residential, and commercial areas, including major refineries and petroleum products storage facilities, major freeways, rail lines, and rail yards serving the Ports of Los Angeles and Long Beach.

Pollutants from dense clusters of residential, industrial, and other urban activities have impaired water quality in the middle and lower watershed. Added to this complex mixture of pollutant sources (in particular, pollutants associated with urban and stormwater runoff), is the high number of point source permits.Of the 1,336 dischargers enrolled under the general industrial storm water permit in the watershed, the largest numbers occur in the cities of Los Angeles (many within the community of Sun Valley), Vernon, South Gate, Long Beach, Compton, and Commerce. Metal plating, transit, trucking & warehousing, and wholesale trade are a large component of these businesses. This watershed has about twice the number of industrial stormwater dischargers as does the San Gabriel River Watershed and the most in this region.

IMPAIRMENTS: The majority of the LA River Watershed is considered impaired due to a variety of point and nonpoint sources. The 2002 303(d) list implicates pH, ammonia, a number of metals, coliform, trash, scum, algae, oil, chlorpyrifos as well as other pesticides, and volatile organics for a total of 107 individual impairments (reach/constituent combinations). Some of these constituents are of concern throughout the length of the river while others are of concern only in certain reaches (see chart below). Impairment may be due to water column exceedances, excessive sediment levels of pollutants, or bioaccumulation of pollutants. The beneficial uses threatened or impaired by degraded water quality are aquatic life, recreation, groundwater recharge, and municipal water supply.

APPENDIX H . Shipwrecks located in the Channel Islands National Marine Sanctuary. Table is from Ugoretz (2002). Not included in the table is the F/V Reliance which grounded and sank off the south point of Santa Rosa Island in June 2003.

Table 4-35. Shipwrecks with identified locations in the project area.

Vessel Name	Casualty Location	Year Built	Year Lost	Month	Cargo	Cause	Latitude	Longitude
Aristocratis*	Santa Rosa Island, SW side (near Johnson's Lee)	1943	1949	12	Coal	Navigation	330° 54 N	1200° 06 W
Blue Fin J 245	Santa Rosa Island, Becher's Bay?	1930	1944	09		Unknown	330° 56 N	1190° 57 W
Chickasaw	Santa Rosa Island, near South Point	1942	1962	02	Toys	Navigation	330° 53 N	1200° 07 W
Comet	San Miguel Island, Wilson Rock, Simonton Cove	1886	1911	08	Lumber, 5000 board feet	Navigation, faulty chronometer	340° 03 N	1200° 23 W
Crown of England	Santa Rosa Island, Ford Point	1891	1894	11	Ballast	Navigation	330° 54 N	1200° 02 W
Cuba	San Miguel Island, Point Bennett	1897	1923	09	Coffee, Silver	Navigation	340° 01 N	1200° 27 W
Dante Alighieri II	Santa Barbara Island, SW shore of	1937	1938	11	Fish	Navigation	330° 27 N	1190° 02 W
Del Rio	Anacapa Island, 3 miles off light (Frencys Cove)	1935	1952	10	Fish	Fire	340° 00 N	1190° 24 W
Dora Bluhm	Santa Rosa Island, Southwest of Bee Rock	1883	1910	05	Lumber	Navigation	330° 57 N	1200° 12 W
G. W. Prescott	San Miguel Island, Point Bennett	1874	1879	08	Railroad ties	Navigation	340° 01 N	1200° 27 W
Goldenhorn	Santa Rosa Island, Southwest Side	1883	1892	09	Coal, bituminous	Northeast currents, 100 miles off course, "strong unknown currents"	330° 58 N	1200° 13 W
H T P Co IX	Santa Barbara Island, 4 miles off	1916	1921	01	Fish	Fire	330° 27 N	1190° 02 W
J. M. Colman	San Miguel Island, Point Bennett	1888	1905	09	Lumber	Navigational	340° 01 N	1200° 27 W
Jane L. Stanford	Santa Rosa Island, Skunk Pt.	1892	1929	08		Allision	330° 58 N	1190° 58 W
Kate and Anna	San Miguel Island, Cuyler Harbor	1879	1902	04	Sealing outfit	Anchor chain parted	340° 03 N	1200° 21 W
Lady Christine*	San Miguel Island, North West End	1988	1997	11	None	Improper Lookout	340° 03 N	1200° 23 W
Legend	San Miguel Island, Point Bennett	1951	1967	08	None	Navigation	340° 01 N	1200° 27 W
Lotus	Anacapa Island, off	1901	1921	09	General	Fire	340° 00 N	1190° 11 W
Magic	Santa Rosa Island, Lake Anchorage?	1889	1899	08	None	Lost Mooring	330° 56 N	1190° 57 W
Patria*	Santa Rosa Island, 1 mile north of East Point 100 yards off the beach, Skunk Point	1944	1954	06	Coal	Navigational error	330° 56 N	1190° 57 W
Pectan*	San Miguel Island, Adams Cove	1902	1914	01	Ballast	Stormy	340° 01 N	1200° 26 W
Santa Cruz	Santa Cruz Island, Prisoners Harbor	1893	1960	12		Lost mooring	340° 01 N	1190° 41 W
Santa Rosa	San Miguel Island, Cuyler Harbor	1879	1899	11	Lumber	Heavy swell	340° 03 N	1200° 21 W
W T Co No. 3	San Miguel Island, Point Bennett	1922	1935	07	Film crew	Unseaworthy	340° 01 N	1200° 27 W
Wampas (aka Grey Ghost)	Santa Cruz Island, Valley Anchorage		1926	11	see comments		330° 59 N	1190° 39 W
Watson A. West	San Miguel Island, near Point Bennett	1901	1923	02	Lumber	Navigation	340° 01 N	1200° 27 W
Winfield Scott	Anacapa Island, Middle	1850	1853	12	Gold Bullion & Mail	Navigation In Fog	340° 01 N	1190° 23 W

*Not a total loss

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APPENDIX I. Time series plots for bacteria, TN, TP, and suspended sediment from selected stream sampling sites on Santa Rosa Island from 1993-2002.

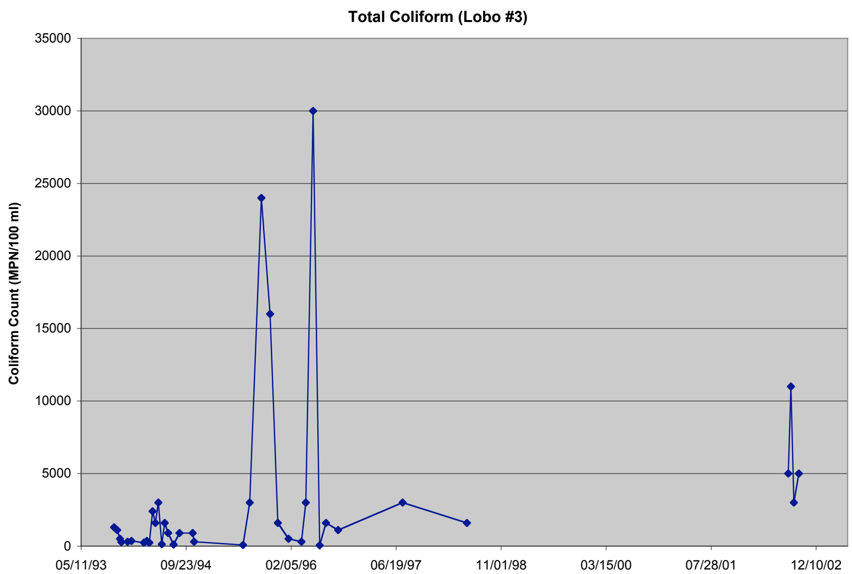

Figure 1. Time series for total coliform counts at Lobo Canyon stream site #3. California limit for Water Contact Recreation (a marine criteria) is 1000 MPN/100 ml. Figure reproduced from CINP (2002b).

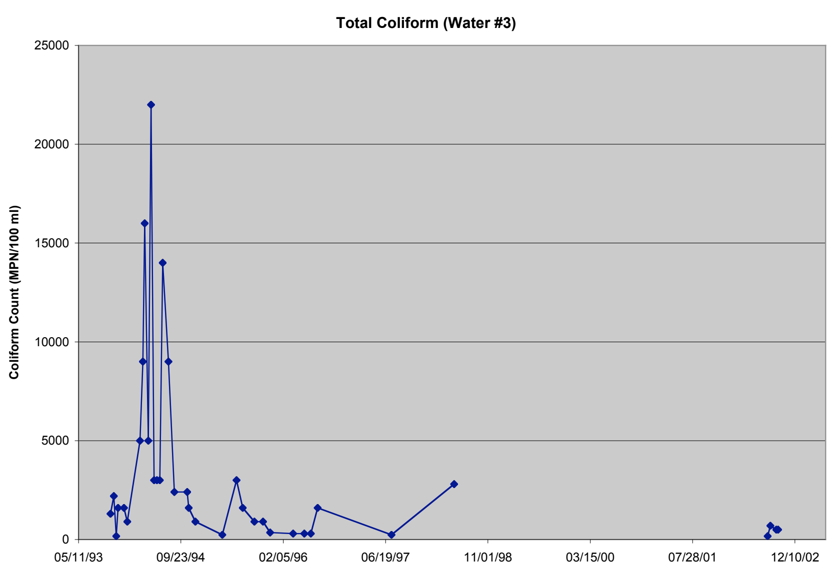

Figure 2. Time series for total coliform counts at Water Canyon stream site #3. California limit for Water Contact Recreation (a marine criteria) is 1000 MPN/100 ml. Figure reproduced from CINP (2002b).

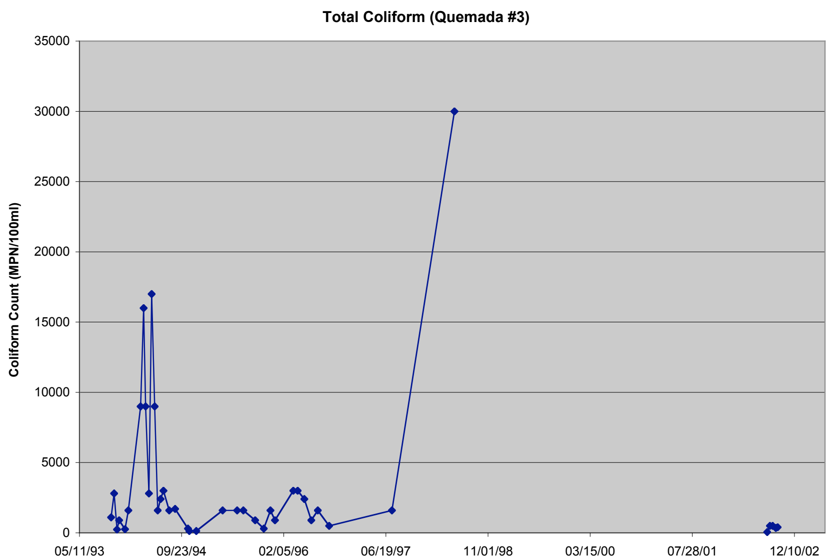

Figure 3. Time series for total coliform counts at Quemada Canyon stream site #3. California limit for Water Contact Recreation (a marine criteria) is 1000 MPN/100 ml. Figure reproduced from CINP (2002b).

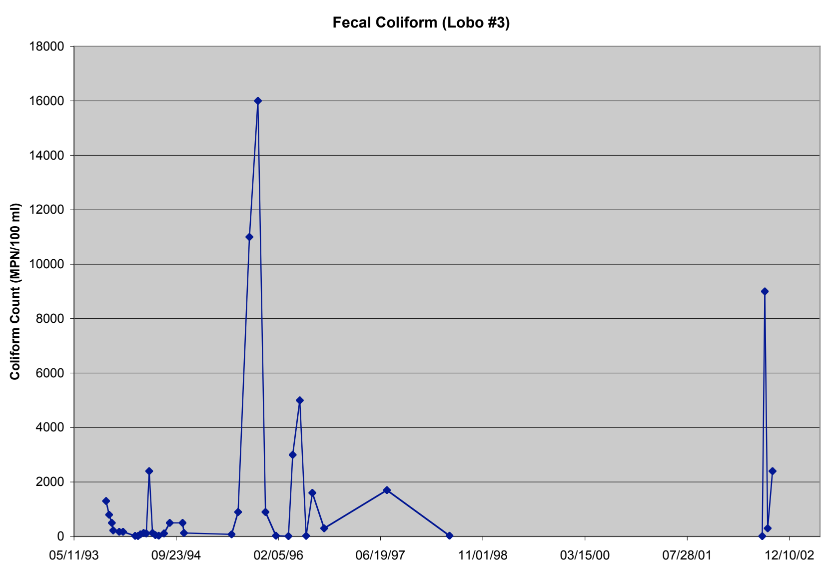

Figure 4. Time series for fecal coliform counts at Lobo Canyon stream site #3. California upper limit for fecal coliform (Freshwater Contact Recreation) is 200 MPN/100 ml (for geometric means of 5 or more samples), or 400 MPN/100ml (for single samples). Figure reproduced from CINP (2002b).

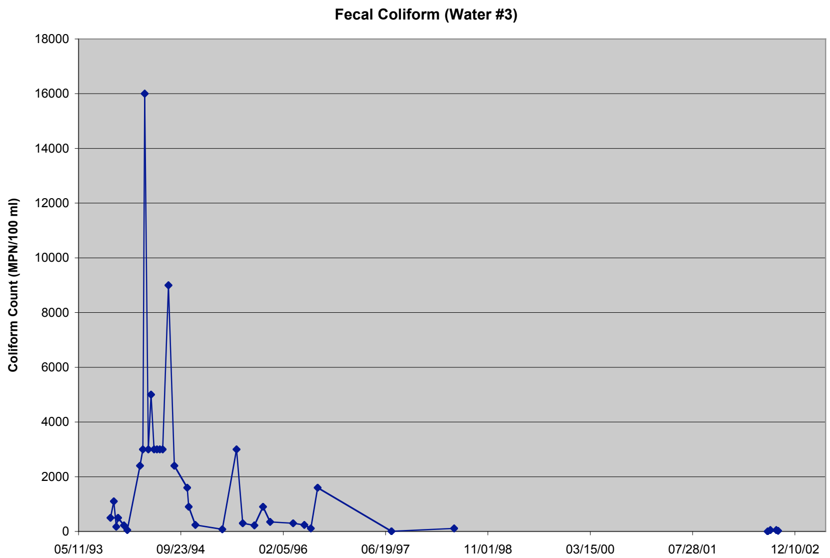

Figure 5. Time series for fecal coliform counts at Water Canyon stream site #3. California upper limit for fecal coliform (Freshwater Contact Recreation) is 200 MPN/100 ml (for geometric means of 5 or more samples), or 400 MPN/100ml (for single samples). Figure reproduced from CINP (2002b).

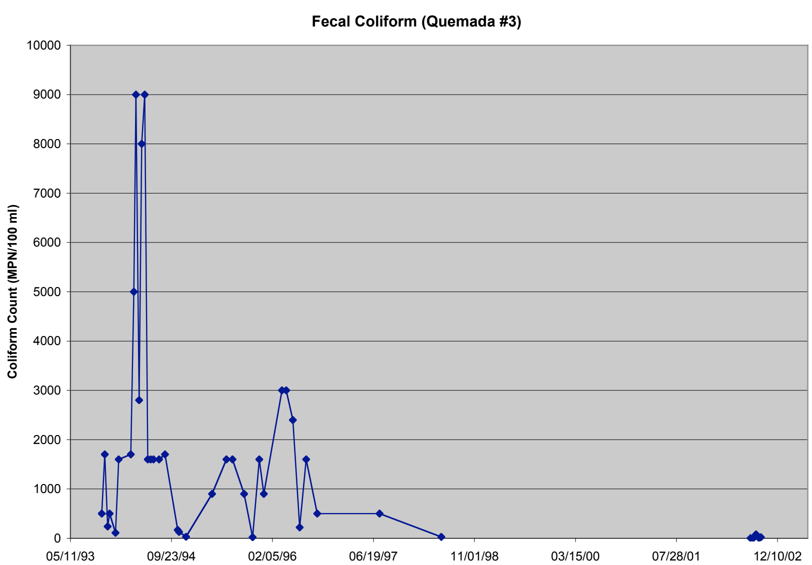

Figure 6. Time series for fecal coliform counts at Quemada Canyon stream site #3. California upper limit for fecal coliform (Freshwater Contact Recreation) is 200 MPN/100 ml (for geometric means of 5 or more samples), or 400 MPN/100ml (for single samples). Figure reproduced from CINP (2002b).

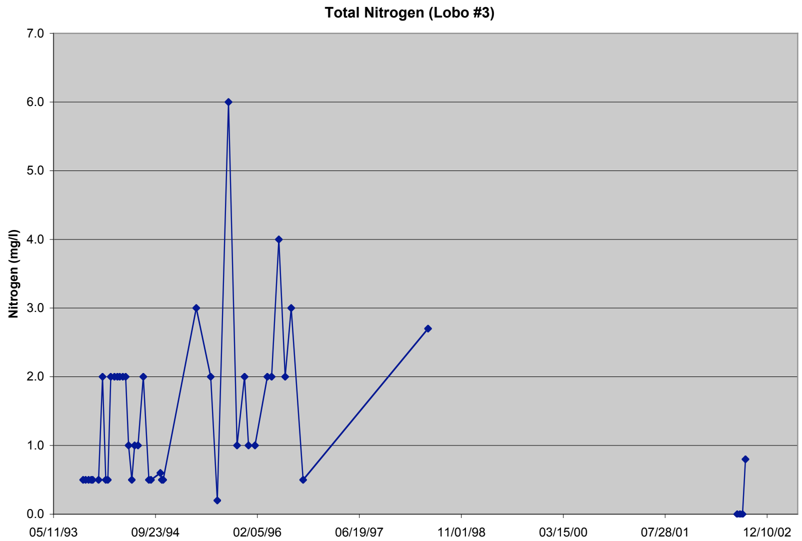

Figure 7. Time series for TN at Lobo Canyon stream site #3. Figure reproduced from CINP (2002b). EPA-recommended upper limit for TN in rivers and streams is 0.38 mg/L.

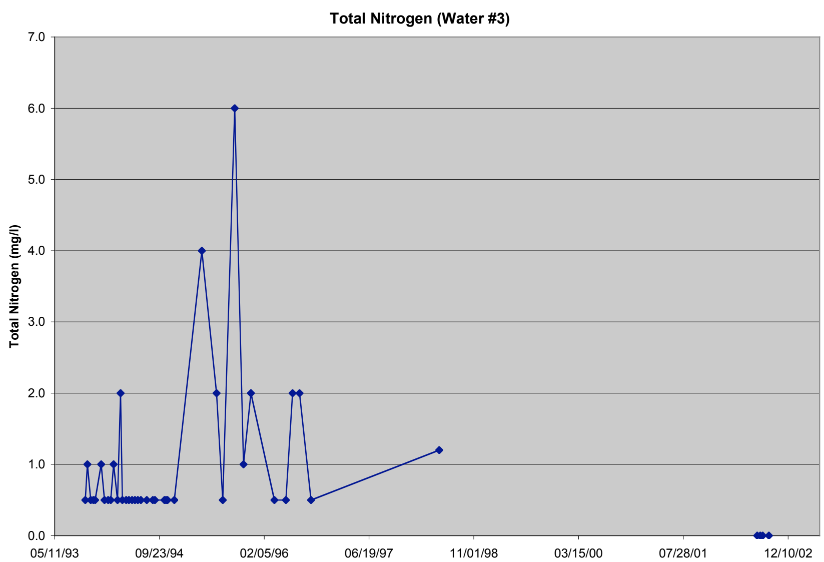

Figure 8. Time series for TN at Water Canyon stream site #3. Figure reproduced from CINP (2002b). EPA-recommended upper limit for TN in rivers and streams is 0.38 mg/L.

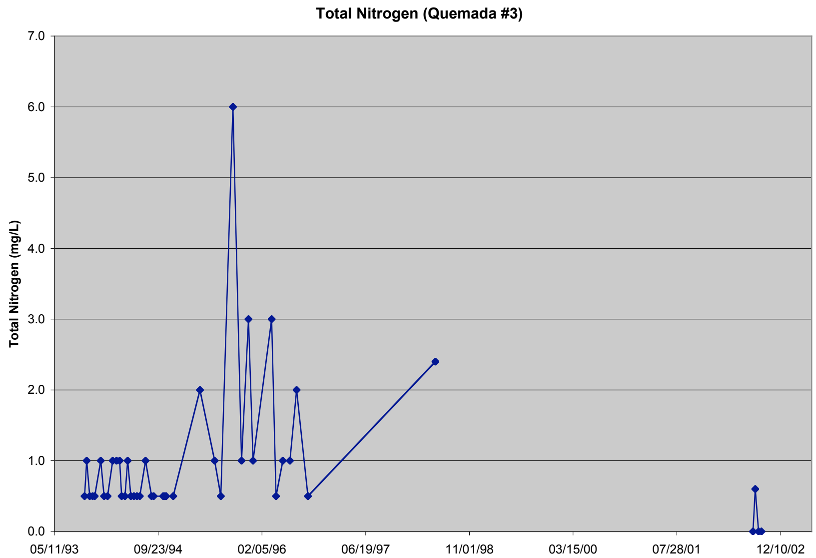

Figure 9. Time series for TN at Quemada Canyon stream site #3. Figure reproduced from CINP (2002b). EPA-recommended upper limit for TN in rivers and streams is 0.38 mg/L.

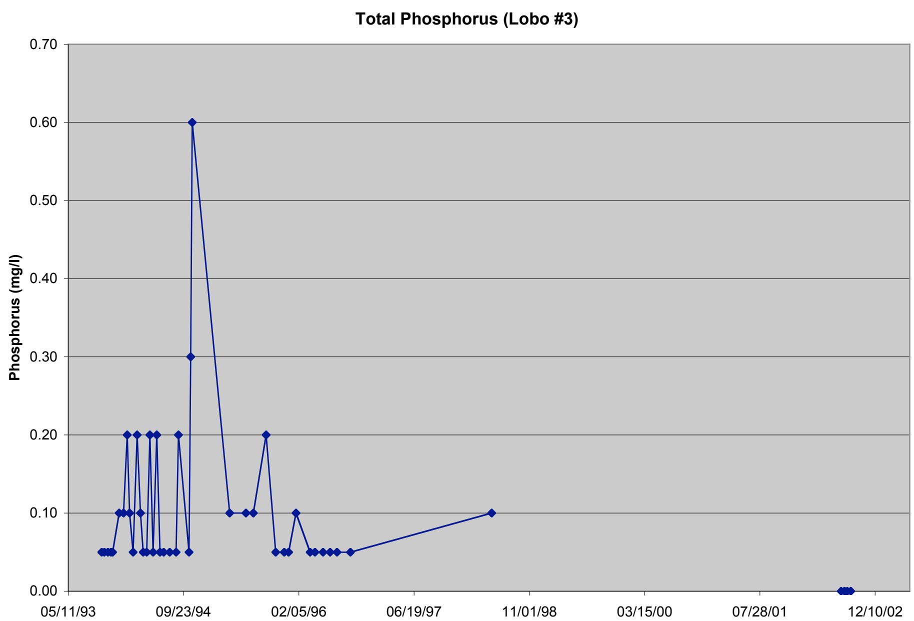

Figure 10. Time series for TP at Lobo Canyon stream site #3. Figure reproduced from CINP (2002b). EPA-recommended upper limit for TP in rivers and streams is 0.022 mg/L.

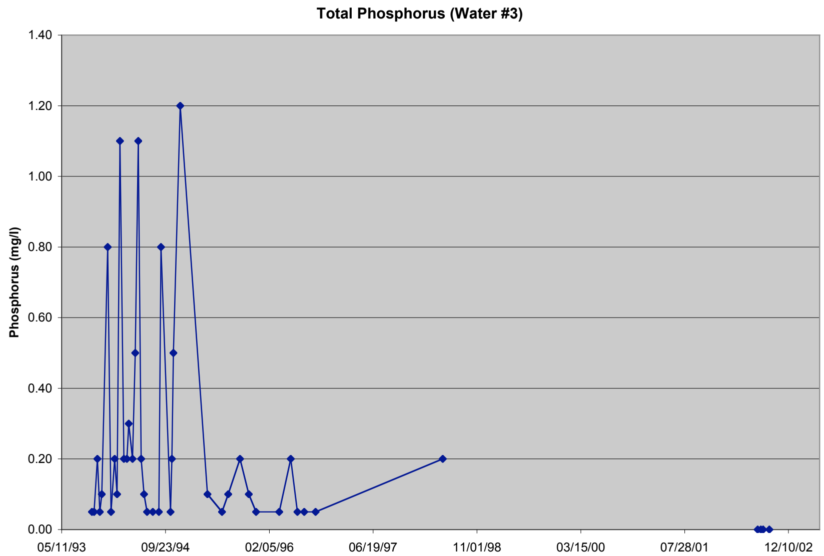

Figure 11. Time series for TP at Water Canyon stream site #3. Figure reproduced from CINP (2002b). EPA-recommended upper limit for TP in rivers and streams is 0.022 mg/L.

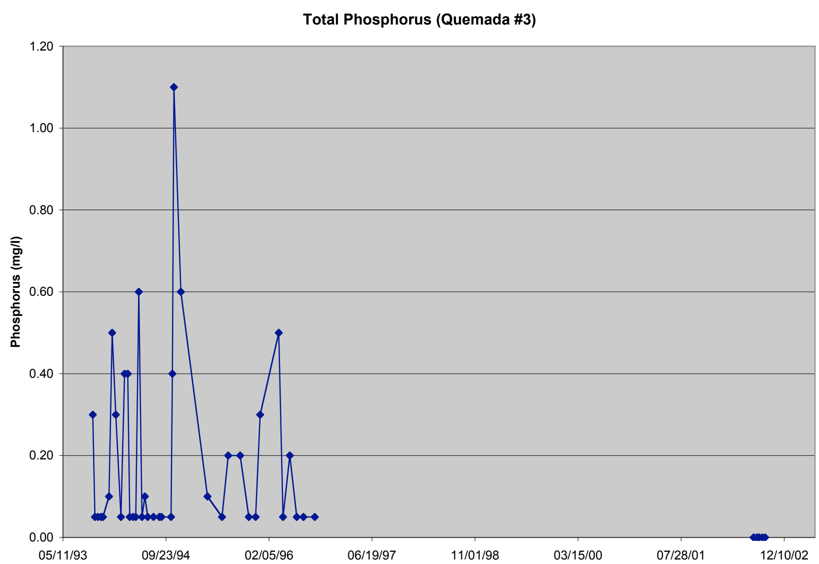

Figure 12. Time series for TP at Quemada Canyon stream site #3. Figure reproduced from CINP (2002b). EPA-recommended upper limit for TP in rivers and streams is 0.022 mg/L.

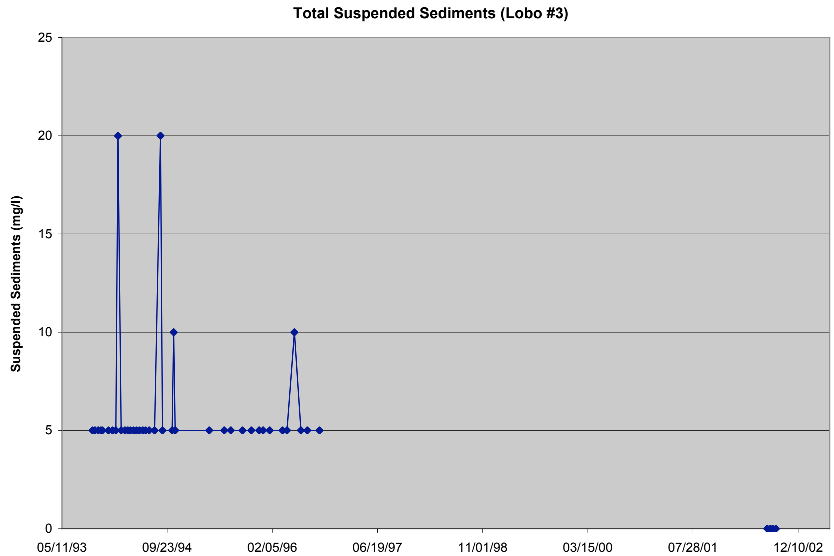

Figure 13. Time series for total suspended solids at Lobo Canyon stream site #3. Figure reproduced from CINP (2002b).

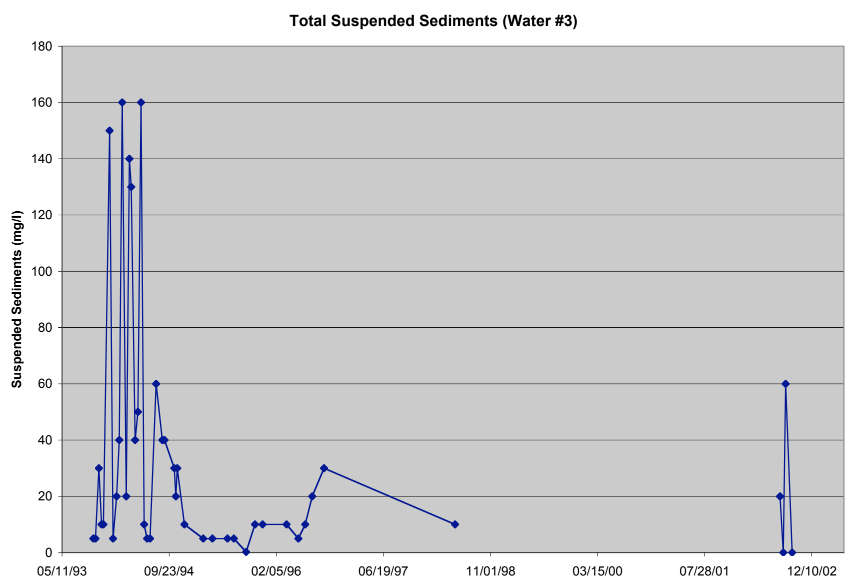

Figure 14. Time series for total suspended solids at Water Canyon stream site #3. Figure reproduced from CINP (2002b).

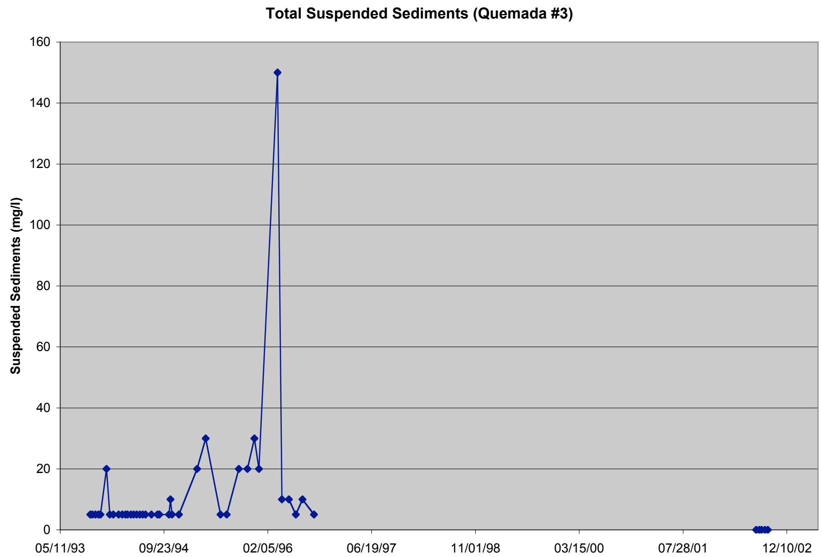

Figure 15. Time series for total suspended solids at Quemada Canyon stream site #3. Figure reproduced from CINP (2002b).

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-195, August 2006